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1.0 INTRODUCTION

1.1 PURPOSE

This Manual describes the operation, inspection, maintenance, and repair requirements for cranes, hoists, fork trucks, slings, rigging hardware, and hoisting equipment at the U.S. Department of Energy’s (DOE) Hanford Site. Occasionally lifting is performed with equipment other than cranes, hoists, and fork trucks; when using any equipment for material handling, follow the equipment manufacturer’s instructions.

EXAMPLE: Excavation equipment, such as a backhoe, may have a hook installed on the bucket. It is acceptable to use such equipment for hoisting and rigging if the manufacturer provides instructions for such use. The manufacturer's instructions should include load capacity information.

See footnote 1 for examples of equipment not within the scope of this Manual. When using rigging devices/hardware in conjunction with the equipment not covered by this Manual for the purpose of raising, lowering, or otherwise lifting material, the rigging devices/hardware and their use shall comply with the applicable sections of this Manual.

1.2 SCOPE

This Manual supports the objectives of the DOE, Richland Operations Office (RL) and Office of River Protection (ORP), by controlling hoisting and rigging (H&R) activities in a safe and cost-effective manner.

It is the responsibility of the user of this Manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. The American Society of Mechanical Engineers (ASME) standards provide the most comprehensive information.

This Manual is intended to be a user’s guide to requirements, codes, laws, regulations, standards, and practices that apply to DOE contractors at the Hanford Site. This manual, or any part of this manual, is applicable to subcontractors that handle/lift government owned, furnished, or fabricated items for the Hanford Site as invoked by contract documents.

Hoisting and rigging work is required by law and DOE to be in compliance with the Occupational Safety and Health Act of 1970 (OSHA) (29 Code of Federal Regulations [CFR] 1910 or 29 CFR 1926 Subpart CC) and ASME B30 Standards. Work involving critical and special/engineered lifts shall follow this Manual. As a minimum, acceptability of equipment and rigging shall be verified by the RL/ORP contractor and critical lift procedures shall be reviewed and approved by the responsible RL/ORP contractor.

NOTE: Refer to 29 CFR 1926, Subpart R, for special hoisting and rigging requirements relating to steel erection.

Footnote 1: For example, the following types of equipment are not within the scope of this manual: elevators, dumbwaiters, escalators, moving walks, conveyor systems, drill and pump setting rigs, tree trimming and tree removal work, manipulators, specially insulated hoists for handling high-voltage lines, door- and hatch-opening equipment, vehicle-mounted elevating and rotating aerial devices, elevating work platforms, aerial lifts, and earth-moving and excavation equipment. Although not within the scope of this Manual, this equipment shall be maintained in a safe condition (reference OSHA General Duty Clause). Consult applicable equipment manufacturer information, OSHA, and/or ASME standards to ensure safe condition and use of the equipment.
The following ASME B30 standards shall be implemented as applicable. The underlined standards are addressed in chapters of this manual.

- **ASME B30.1-2015**  Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries
- **ASME B30.2-2011**  Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
- **ASME B30.3-2016**  Tower Cranes
- **ASME B30.4-2015**  Portal and Pedestal Cranes
- **ASME B30.5-2014**  Mobile and Locomotive Cranes
- **ASME B30.6-2015**  Derricks
- **ASME B30.7 2016**  Winches
- **ASME B30.8-2015**  Floating Cranes and Floating Derricks
- **ASME B30.9-2014**  Slings
- **ASME B30.10-2014**  Hooks
- **ASME B30.11-2010**  Monorails and Underhung Cranes Consolidated with B30.17-2015
- **ASME B30.12-2011**  Handling Loads Suspended from Rotorcraft
- **ASME B30.13-2011**  Storage/Retrieval (S/R) Machines and Associated Equipment
- **ASME B30.14-2015**  Side Boom Tractors
- **ASME B30.16-2012**  Overhead Hoists (Underhung)
- **ASME B30.17-2015**  Cranes and Monorails (with Underhung Trolley or Bridges)
- **ASME B30.18-2016**  Stacker Cranes (Top or Under Running Bridge, Multiple Girder with Top or Under Running Trolley Hoist)
- **ASME B30.19-2016**  Cableways
- **ASME B30.20-2013**  Below-the-Hook Lifting Devices
- **ASME B30.21-2014**  Lever Hoists
- **ASME B30.22-2016**  Articulating Boom Cranes
- **ASME B30.23-2011**  Personnel Lifting Systems
- **ASME B30.24-2013**  Container Cranes
- **ASME B30.25-2013**  Scrap and Material Handlers
- **ASME B30.26-2015**  Rigging Hardware
- **ASME B30.27-2014**  Material Placement Systems
- **ASME B30.28-2015**  Balanced Lifting Units
- **ASME B30.29-2012**  Self-Erecting Tower Cranes

The following ASME standards are specifically addressed in chapters of this manual, and shall be implemented as applicable:

- ASME BTH-1-2014, Design of Below-the-Hook Lifting Devices
- ASME PASE-2014, Portable Automotive Service Equipment (PASE)

Other equipment not specifically addressed in this manual, may be within the scope of this manual (see Chapter 19, *OSHA 29 CFR 1926, Subpart CC*).

Forklifts, when equipped with a hoist or a hook and a rotating upper structure, fall within the requirements of a mobile crane.
Rigging equipment addressed in this manual shall comply with the applicable ASME and OSHA requirements. When equipment is used in a manner other than intended by the manufacturer, written authorization/approval shall be obtained from the manufacturer. The equipment shall be labeled for its intended use and the statement “Not to be used for lifting service” shall be attached to the device. The equipment shall be maintained and inspected per the manufacturer’s instructions. Rigging equipment used for other purposes than its original design shall not be returned to lifting service.

1.3 BACKGROUND

This Manual is a rewrite of the original Hanford Hoisting and Rigging Manual (WHC-CM-6-4), issued in August 1988 for RL contractors. Similar to that original manual, this Manual was prepared with input from the Hanford H&R Committee with representatives from various RL contractors and trade unions, with overview by RL. Unlike the original Hanford Hoisting and Rigging Manual, this Manual is issued by the RL.

Any lack of clarity, errors, omissions, or discrepancies should be submitted either to RL or a member of the Hanford H&R Committee.

1.4 MANUAL ORGANIZATION

This is a “user’s manual.” It designates areas of responsibility regarding H&R activities, specifies qualification and training requirements, and stipulates operation, maintenance, and repair requirements for H&R equipment and components. Topics have been grouped to make the Manual user friendly and to minimize “jumping around” within the manual. While selected design considerations are included in this Manual, primarily as information to operators and inspectors, this Manual is a user’s manual, not a design manual.

1.5 MANDATORY AND ADVISORY RULES

Mandatory rules are characterized by use of the word shall. If a provision is of an advisory nature, it is indicated by use of the word should and is to be considered; its advisability depends on the facts in each situation.

1.6 MANUAL REVISIONS

Any user may prepare written requests for Manual revision. Revision requests shall be submitted to a member of the Hanford H&R Committee or to the RL H&R Program Manager.

1.7 VARIANCES, EXEMPTIONS, WAIVERS, AND INTERPRETATIONS

1.7.1 Variances, Exemptions, and Waivers

Variances and exemptions are frequently referred to as “waivers,” however, it is appropriate to recognize that a waiver is really a variance or an exemption. The difference between a variance and an exemption and their approval processes are as follows:

a. A variance is an administrative decision that allows an employer to meet a requirement in a

2Comments, questions, or revision requests may be sent via e-mail to: Hanford_Hoisting_and_Rigging@rl.gov.
different manner than stated in the requirement or standard. To do this, the employer must show that the level of worker protection is “at least as effective” as that dictated by the requirement or standard.

b. An exemption is an administrative decision that frees an employer from complying with a requirement. In other words, if an exemption from a requirement is granted, that requirement would not apply to the specific operation or facility in question.

c. Usually, variance or exemption decisions concerning site-specific requirements can be made at the Hanford contractor or RL level. Requests concerning mandatory standards (such as OSHA, ANSI, ASME standards) will be elevated to DOE Headquarters for a decision.

d. Requests for variances or exemptions shall be submitted to the responsible RL Contracting Officer in accordance with the contractor’s internal procedures. The contractor shall also send a copy of the request to the RL H&R Program Manager, for information purposes. Upon receipt of the request from the contractor, the RL Contracting Officer shall evaluate the request and, in coordination with the RL H&R Program Manager, determine if it can be decided at the local level or if it must be elevated to DOE Headquarters.

e. Following approval or disapproval, the RL Contracting Officer shall respond to the contractor in writing. Costs incurred while awaiting administrative action typically will not be considered.

1.7.2 Interpretations

An “interpretation” asks the meaning of a requirement, or whether a proposed method fulfills a given requirement. See Chapter 17, Interpretations, for a description of the process used to request interpretations and to review previous interpretations.

If a request for interpretation is determined to actually be a request for a variance or exemption, process the request as outlined in paragraph 1.7.1(d).
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2.0 RESPONSIBILITIES

2.1 SCOPE

This section provides guidance in delineating the responsibilities of personnel and organizations directly involved in hoisting and rigging (H&R) activities at the Hanford Site.

Job classification terms used in this manual (e.g., rigger, operator, and inspector) refer to the function performed and in no way relate to a classification in any union or bargaining unit.

2.2 PERSONNEL RESPONSIBILITIES

2.2.1 Contractor Responsibilities

Hanford Site contractors shall establish programs based on equipment manufacturers’ specifications and limitations for operation, maintenance, and inspection of equipment addressed by this manual. Where manufacturers’ specifications are not available, operation limitations and maintenance and inspection requirements assigned to the equipment shall be based on determinations of a qualified person competent in this field and such determinations shall be appropriately documented and disseminated to equipment operators and maintenance and test personnel.

2.2.2 Supervisor or Manager, Hoisting and Rigging Operations

A supervisor or manager shall be responsible for each H&R operation and shall ensure that:

a. Qualified personnel are assigned to operate equipment and perform hoisting and rigging tasks.

b. Equipment is operated safely.

c. Preplanned and approved H&R instructions are used when necessary and always for critical lifts.

d. Equipment found to be unsafe or requiring restrictive use is properly tagged.

e. The equipment custodian is notified of equipment problems.

f. A designated leader (DL)/lift director shall be assigned to hoisting and rigging operations that require more than one person. See paragraphs 2.2.4 and 2.2.5.

2.2.3 Equipment Maintenance Supervisor or Manager

A supervisor or manager shall be responsible for inspection, maintenance, and repair on H&R equipment and components and shall ensure the following:

a. Equipment is properly inspected, maintained, tested, and repaired by qualified personnel.

b. Inspection, maintenance, and repair personnel have the tools to safely accomplish their work.

c. Ensure that records of the maintenance, repair, inspection, and testing are available for audit in a maintenance file.

d. Responsible inspection, maintenance, and test personnel have access to the following information, as applicable:

   1. Operating instructions

   2. Maintenance, repair, and parts information furnished by the manufacturer or the responsible maintenance/engineering organization

   3. The manufacturer’s recommendations as to points and frequency of lubrication, maintenance of lubrication levels, and types of lubricant to be used
4. Maintenance or repair procedures from the manufacturer or responsible maintenance/engineering organization

5. Wiring diagrams

   e. Inspection, maintenance, and repair activities are documented in accordance with the requirements of this manual

   f. Personnel responsible for inspection or maintenance are familiar with the applicable contents of all equipment manuals.

2.2.4 Designated Leader (DL)/Lift Director for Critical Lifts

Management shall assign a DL/lift director for critical lifts. The DL/lift director may be a crew member or any qualified person. (See Chapter 4, Personnel Qualifications and Training Requirements, for DL/lift director qualifications.) The DL/lift director for critical lifts shall perform those activities listed in 2.2.5 as well as ensuring that:

   a. A critical lift procedure is prepared.

   b. The critical lift procedure is properly approved before implementing (refer to Chapter 3.0, paragraph 3.5.1, Critical Lift Plan Approval).

   c. A documented pre-lift meeting is held and personnel understand how the job will be done.

   d. Management provides qualified personnel (e.g., operators, riggers, flagman, DL/lift director).

   e. Proper equipment and hardware are identified in the critical lift procedure.

   f. The lifting operation is directed by a DL/lift director to ensure that the job is done safely and efficiently.

   g. Involved personnel are familiar with, and follow, the critical lift procedure.

   h. After the critical lift is completed, critical lift documentation is transmitted to the manager for whom the lift was done. The DL/lift director should advise responsible personnel that this documentation is subject to audit for one year. (See Chapter 3.0, paragraph 3.7.)

2.2.5 Designated Leader

A designated leader shall be appointed to H&R activities that involve more than one person. Normal forklift truck material handling operations are not considered H&R activities and do not require a DL/lift director. The DL/lift director may be the operator, a crew member, or any qualified person. (See Chapter 4, Personnel Qualification and Training Requirements) The DL/lift director shall:

   a. Ensure that a flagman or signaler, if required, is assigned and identified to the hoist/crane/equipment operator.

   b. Ensure that management provides qualified personnel and personnel understand how the job is to be done.

   c. Ensure that the weight of the load is determined, that the proper equipment and hardware are selected and inspected, and that the capacity of the lifting device is not exceeded.

   d. Ensure that the equipment is properly set up and positioned.

   e. Examine the work area for hazardous or unsafe conditions.

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

   g. Ensure that the job is stopped when any potentially unsafe condition is recognized.

   h. Be present at the jobsite during lifting operations.
i. Stop operations if alerted to an unsafe condition affecting those operations.

j. Ensure that the preparation of the ground conditions needed to support crane operations has been completed before crane operations commence when mobile cranes are used. If the operator, DL/lift director, or AD director have concerns pertaining to ground conditions they shall notify the controlling entity.

k. Ensure swing radius hazards are addressed, when applicable, per OSHA 1926.1424 (see Chapter 19, OSHA 29 CFR 1926 Subpart CC) and only authorized personnel are allowed in identified hazard areas.

l. Ensure only authorized personnel enter the fall zone to perform or conduct activity that cannot be performed other than when a load is suspended or being landed.

m. Use hoisting routes that minimize the exposure of employees to hoisted loads where available.

n. Ensure necessary traffic controls are in place to restrict unauthorized access to the crane’s work area.

If an injury or accident occurs, ensure that the emergency is promptly reported. (Call 911; call 373-0911 if using a cellular phone.) Take charge of the accident scene pending arrival of emergency services personnel.

2.2.6 Operator

The operator shall perform the following activities:

a. Safely operate equipment.

b. Follow the equipment operating guidelines and the load charts.

c. Perform the pre-use and frequent equipment inspection.

d. Ensure that the load will not exceed the rated capacity of the equipment.

e. Abide by any restrictions placed on the use of the equipment.

f. Ensure inspections are current via inspection sticker, other documentation, or verbal confirmation from the equipment custodian.

2.2.7 Rigger

The rigger shall perform the following activities:

a. Ensure that the rigging equipment and materials have the required capacity for the job and that all items are in good condition, are currently qualified (inspection is up to date), and are properly used.

b. Verify that rigging equipment and material are in compliance with the procedure, if applicable.

c. Confirm that the load path is clear of personnel and obstacles.
2.2.8 Equipment Custodian

Management shall designate an individual who shall have custodial responsibility for each crane, hoist, lift truck, or other H&R equipment that requires scheduled maintenance, inspection, and record keeping. (The custodian may be thought of as the equipment “owner.”) The custodian can be assigned by facility, geographical area, individual equipment item, or other method as deemed appropriate by management. The custodian shall perform the following activities:

a. Verify that operating equipment is maintained and maintenance, inspection, and testing of the equipment remain current.

b. Verify that equipment is properly tagged and, if necessary, removed from service when discrepancies are found during inspection or operation.

NOTE: (1) It is important that equipment users know how to contact the equipment custodian. A method should be devised so that equipment users can easily identify and contact the equipment custodian.

(2) See Chapter 6.0, Section 6.2.2 for specific duties of a forklift truck custodian.

(3) Duties listed in Section 2.2.8 are considered a summary of an equipment custodian’s responsibility. It is important to recognize that more specific, and possibly additional, responsibilities are stated in individual chapters.

2.2.9 Assembly/Disassembly Director

The Assembly/Disassembly Director (A/D Director) is responsible to direct both the assembly and/or disassembly of equipment (cranes) covered under OSHA 29 CFR 1926 Subpart CC and ASME B30 standards. With regard to tower cranes, “erecting and climbing” replaces the term “assembly,” and “dismantling” replaces the term “disassembly.” Regardless of whether the crane is initially erected to its full height or is climbed in stages, the process of increasing the height of the crane is an erection process. See Chapter 4, Personnel Qualifications and Training Requirements, and Chapter 19, OSHA 29 CFR 1926 Subpart CC.

2.2.10 Approvers of Hoisting and Rigging Lift Plans

The following personnel’s approvals on a hoisting and rigging lift plan indicate endorsement of the subject and content of the plan and fulfillment of the signer’s area of responsibility.

- **Manager** – Verifies the lift plan approvers are qualified in the area they approved and authorizes the plans implementation.

- **Qualified Rigging Engineer** – Verifies the lift plan calculations are accurate for capacities based on rigging and the configuration of the item to be lifted, design and dimensions, load description, weight and field conditions. The condition of the item to be lifted including the lift points are confirmed by the Rigging Engineer or his designee.

- **Qualified Safety Representative** – Verifies the lift plan address and provides applicable administrative and physical controls to mitigate potential and identified hazards.

- **Technical Approver** – Verifies the lift plan, as a minimum, addresses and contains the appropriate information that complies with the technical requirements applicable to the personnel, equipment, and activity covered by the plan as required by this Manual.
2.3 ORGANIZATIONAL RESPONSIBILITIES

2.3.1 Responsible Safety Organization

The responsible safety organization shall monitor H&R operations to ensure that they are performed safely. In addition, vendor-owned and operated equipment shall be monitored in the following manner:

a. Vendor-Owned or Operated Equipment—The safety organization in the company that initiates the contract is responsible for ensuring that the vendor equipment and personnel meet pertinent H&R safety requirements (e.g., OSHA 29 CFR 1910 and 29 CFR 1926 Subpart CC).

b. Vendors Directly Contracted by the U.S. Department of Energy (DOE), Richland Operations Office (RL)—Compliance with pertinent H&R safety requirements shall be coordinated by the cognizant RL Division.

2.3.2 Responsible Training Organization

The responsible training organization shall provide training to ensure that personnel qualifications meet requirements of this manual and shall ensure that the following activities are completed:

a. Training provided is documented (see Chapter 4.0, Personnel Qualifications and Training Requirements).

b. Training and evaluation is provided in accordance with the contractor’s qualification program for instructors.

c. Evaluation methods and standards are established.

2.3.3 Controlling Entity

The controlling entity shall:

a. Ensure that ground preparations necessary to ensure ground conditions are firm, drained, and graded to a sufficient extent so that, in conjunction (if necessary) with the use of supporting materials, the equipment manufacturer’s specifications for adequate support and degree of level of the equipment are met. The requirement for the ground to be drained does not apply to marshes/wetlands.

b. Inform the user of the equipment and the operator of the location of hazards beneath the equipment set-up area (such as voids, tanks, utilities) if those hazards are identified in documents (such as site drawings, as-built drawings, and soil analyses) that are in the possession of the controlling entity (whether at the site or off-site) or the hazards are otherwise known to that controlling entity.

2.4 RL ROLES AND RESPONSIBILITIES

2.4.1 RL Hoisting and Rigging Program Manager

The RL H&R Program Manager (PM) shall:

a. Ensure consistency in implementation and interpretation of this Manual across the Hanford Site.

b. Be the RL authority having jurisdiction over interpretation of this Manual.

c. For H&R events:

1. Help ensure that the pertinent H&R issues are identified during subsequent investigations or critiques.
2. Help ensure that identified H&R issues are adequately addressed in corrective actions or lessons learned issued.

3. Help ensure that any Occurrence Reporting and Processing System (ORPS) report or official lessons learned issued adequately addresses the H&R aspects, corrective actions, and lessons learned for the event.

d. Periodically assess line management implementation of the H&R program at the Hanford Site.

e. When requested, assist RL program or line organizations in matters relating to H&R (This could include H&R surveillances, reviews of critical or major lift procedures or work packages, hostile environment plans, participation in the H&R aspects of Readiness Assessments, Operational Readiness Reviews, etc.).

f. When requested, assist Hanford Site contractors in addressing issues related to compliance with, implementation of, or interpretation of this Manual.

g. Represent RL on the Hanford H&R Committee.

h. Maintain the Manual.

i. Be the RL authority for the review and approval of revisions to this Manual. Ensure the RL program and line organizations are kept up to date with the latest Manual changes, bulletins, or important issues applicable to their organizations.

2.4.2 RL Program/Line Organizations

The RL program and line organizations shall:

a. Notify the PM as soon as possible after an H&R event, preferably before any critique or investigation. Notification as soon as possible will enable the PM to better carry out his duties and responsibilities of Section 2.4.1.c.

b. Contact the PM in matters of the H&R Manual interpretations or application where there is a conflict between program or line organizations and the contractor.

c. Contact the PM when RL personnel have a question concerning the application or interpretation of the Manual.

d. Per the FRAM (Functions, Responsibilities, and Authorities Manual), verify that Hanford Site contractors are implementing the Manual effectively.
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4.0 PERSONNEL QUALIFICATIONS AND TRAINING REQUIREMENTS

4.1 SCOPE

This section specifies qualification and training requirements for personnel with the following responsibilities:

1. Direct hoisting and rigging (H&R) activities
2. Supervise H&R activities
3. Perform H&R activities
4. Inspect and maintain H&R equipment
5. Provide technical approval of procedures, lift plans or work instructions for H&R activities
6. Develop lift plans
7. Provide signals for H&R activities
8. Train and evaluate personnel for H&R activities and equipment operation
9. Provide safety oversight
10. Perform H&R engineering functions

Contracting organizations shall review, verify, and document that subcontractors have an acceptable training and qualification program. The contracting organization shall ensure that the program meets the requirements of this section to ensure that personnel are qualified to perform work covered by this Manual.

NOTE: Refer to 29 CFR 1926, Subpart R, for special H&R requirements relating to steel erection.

4.2 GENERAL

4.2.1 Program Requirements

Personnel shall be trained and qualified to a level of proficiency consistent with their assigned tasks. Managers responsible for work assignments shall ensure that work assignments do not exceed personnel qualifications. Posting a list of qualified operators adjacent to or on appropriate equipment is recommended.

4.2.2 Qualification Prerequisites

Personnel whose work falls within the scope of this Manual shall meet the following qualifications.

1. Be at least 18 years old
2. Be able to communicate in written and spoken English
3. Be able to meet the physical requirements of the job assignment
4.2.3 Physical Examination and Substance Abuse Testing Requirements

4.2.3.1 Physical Examination Requirements for Mobile Locomotive, and Cab- or Pulpit-Operated Overhead Crane Operators

Before operating mobile, locomotive, and cab- or pulpit-operated overhead cranes, operators, operator trainees, maintenance personnel, and inspectors shall pass a crane operator physical examination initially and at least every 36 months thereafter. The physical examination shall meet the requirements of the American Society of Mechanical Engineers (ASME) B30.17 and B30.5. The operator shall retain evidence of successfully passing the physical examination.

A mobile crane operator who successfully passes a commercial motor vehicle (CMV) driver’s physical in accordance with the requirements of 49 CFR 391 Subpart E, \textit{Physical Qualification and Examination}, satisfies the crane operator physical exam requirements.

\textbf{NOTE}: A company’s contract, agreement, and/or memorandum of understanding regarding physical examinations will determine the medical examiner chosen to perform the physical examination. In general, the Site Occupational Medical Director will clear all medical examinations.

4.2.3.2 Substance Abuse Testing for Mobile Crane Operators

Mobile or locomotive crane operators, operator trainees, maintenance personnel, and inspectors shall pass, with a negative result, a substance abuse test initially and at least every 36 months thereafter. A recognized laboratory shall perform the test.

4.2.3.3 Crane Operator Certification

Operators of the following cranes shall be certified by an operator testing organization that is accredited by a nationally recognized accrediting agency as defined in OSHA 1926.1427 (Option 1). The certification shall meet the previous training requirements defined in 4.3.1, \textit{Previous Training and Qualification}. \textbf{NOTE}: Maintenance and inspection personnel that are required to operate cranes in the performance of their duties are excluded from this certification requirement; however, they must maintain mobile crane operator qualification under the Hanford Site training requirements and this chapter.

- Articulating cranes (such as knuckle-boom cranes)
- Crawler cranes
- Floating cranes
- Cranes on barges
- Locomotive cranes
- Mobile cranes (wheel-mounted, rough-terrain, all-terrain, commercial truck-mounted, and boom truck cranes)
- Multi-purpose machines when configured to hoist and lower (by means of a winch or hook) and horizontally move a load
- Industrial cranes (such as carry-deck cranes)
- Dedicated pile drivers
4.2.4 Substance Abuse Testing for Commercial Motor Vehicle Drivers

The CMV definition found in 49 CFR 383.5 (see Appendix A, “commercial motor vehicle,” for the definition), shall apply to truck-mounted mobile cranes and forklifts designed for highway use with a gross vehicle weight rating of 26,001 lb or more.

CMV drivers are subject to substance abuse testing independent of the mobile crane operator’s substance abuse testing requirements (see Section 4.2.3.2). The same substance abuse test can meet both CMV and crane operator requirements, but the crane operator must be retested at least every 36 months.

4.3 TRAINING AND QUALIFICATION PROGRAMS

Contractors shall have a documented training and qualification program that includes the following elements.

1. Classroom or computer-based training
2. Written tests
3. On-the-job training (OJT) (see Section 4.3.3)
4. On-the-job evaluations (OJE) (see Section 4.3.4)
5. Established and documented pass/fail criteria (see Section 4.5)
4.3.1 Previous Training and Qualification

Documented evidence of previous training or experience may be accepted to meet training requirements.

1. Previous training or experience may include the following:
   a. Vendor or equipment manufacturer training
   b. Completion of an apprenticeship program
   c. Journeyman status in an applicable trade

2. For previous training to be acceptable for Hanford Site qualification, documented evidence of the topics listed in Appendix A of this chapter shall be included, along with the type and class of equipment operated. For qualifications not related to equipment operation, personnel shall have documented evidence of training related to an activity covered by this Manual. Previous training must include a written knowledge test. As a minimum, documented evidence may be any of the following.
   a. Certificates of training (See Note 4.1)
   b. Journeyman card or documents issued by a trade union
   c. A degree or accreditation from a college or trade school

3. When previous training or experience are reviewed for compliance to this manual, accepted and documented, personnel shall be considered qualified after they have satisfactorily completed an On-the-Job Evaluation (OJE) for the equipment or activity being performed. Operators of mobile locomotive and cab- or pulpit-operated overhead cranes shall have met the Physical Examination and Substance Abuse Testing requirements identified in 4.2.3.

4. When previous training or experience is reviewed for compliance to this manual and not accepted, personnel will be required to complete the applicable Hanford Site approved course, the applicable challenge examination for the approved course, or an off-site course that meets the requirements of this manual.

4.3.2 Training Subjects

Appendix A, Training Subject Content by Activity and/or Equipment, contains subjects (listed by qualification area) that should be included in the training process. All approved courses must include a written knowledge test.

4.3.3 On-the Job Training

Contractors shall make OJT available for crane and forklift operators. If a forklift or crane operator will use attachments, the OJT shall include installation and use of approved attachments (Example: Forklift boom and barrel-handling attachments and crane jibs and boom extensions). Personnel shall satisfy training requirements (see Appendix A, Training Subject Content by Activity and/or Equipment) before performing OJT. The OJT shall be based on the equipment manufacturer’s operating instructions, typical tasks, operating environment, and facility or contractor-specific procedures.

The OJT shall provide training and practice under the direct supervision of a qualified operator or qualified OJT instructor in the appropriate work environment, using the appropriate OJE forms of Section 4.3.4. Complexity of equipment and tasks, along with the operator’s experience shall determine the need
for OJT. Management may allow previously qualified or experienced personnel to bypass the OJT and undergo an OJE (see Section 4.3.4). The completion or bypassing of OJT shall be documented.

### 4.3.4 On-the-Job Evaluations

Sections 4.3.4.1 through 4.3.4.4 contain classes of cranes, forklifts, or H&R activities that require personnel to pass an OJE before being granted qualifications. The OJEs shall have pass and fail criteria, and shall require personnel to demonstrate that they have the knowledge and skills to safely operate equipment or perform the H&R function. Personnel shall be evaluated for each type and class of equipment they operate. Personnel who pass an evaluation for a type and class of equipment are considered qualified on all equipment of the same type and class. Contractors, facilities, and organizations may choose to implement additional facility-specific OJT and/or OJE requirements. OJEs are required to be documented. As a minimum, documentation shall contain:

1. The name and signature of the person being evaluated
2. Name and signature of the qualified evaluator
3. Evaluation score
4. Instructions for the evaluator and the person being evaluated
5. Type and class of equipment or activity
6. Attachments
7. Date of the evaluation

Examples of OJE forms can be found on the Hanford Intranet at http://apweb01.rl.gov/siteforms/.

#### 4.3.4.1 Powered Industrial Trucks

Personnel are qualified to operate powered industrial trucks according to the following designations. See Chapter 6.0, **Forklift Trucks**, for sample views of each industrial truck class designation.

<table>
<thead>
<tr>
<th>Class</th>
<th>Powered Industrial Truck Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; 2</td>
<td>Electric motor, sit-down and stand-up rider, counter balanced, and narrow-isle trucks, solid and pneumatic tires</td>
</tr>
<tr>
<td>3</td>
<td>Electric motor, hand trucks or hand/rider trucks, solid tires</td>
</tr>
<tr>
<td>4 &amp; 5</td>
<td>Internal combustion engine trucks, solid and pneumatic tires</td>
</tr>
<tr>
<td>6</td>
<td>Electric and internal combustion engine tractors, solid and pneumatic tires</td>
</tr>
<tr>
<td>7</td>
<td>Rough terrain vertical-mast forklift trucks</td>
</tr>
<tr>
<td>8</td>
<td>Rough terrain telescopic boom forklift trucks</td>
</tr>
</tbody>
</table>

#### 4.3.4.2 Overhead Cranes

Personnel are qualified to operate overhead cranes according to the following designations:

<table>
<thead>
<tr>
<th>Class</th>
<th>Overhead Crane Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overhead cranes, floor-operated (Facilities may designate specific qualifications to selected cranes.)</td>
</tr>
<tr>
<td>2</td>
<td>Overhead cranes, cab-operated.</td>
</tr>
</tbody>
</table>
4.3.4.3 Mobile Cranes

Personnel are qualified to operate mobile cranes according to the following designations:

<table>
<thead>
<tr>
<th>Class</th>
<th>Mobile Crane Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lattice boom truck cranes (multiple control stations)</td>
</tr>
<tr>
<td>2</td>
<td>Lattice boom crawler cranes</td>
</tr>
<tr>
<td>3</td>
<td>Telescopic boom cranes, (single control stations)</td>
</tr>
<tr>
<td>4</td>
<td>Telescopic boom cranes, (multiple control stations)</td>
</tr>
<tr>
<td>5</td>
<td>Commercial truck-mounted crane telescoping boom</td>
</tr>
<tr>
<td>6</td>
<td>Commercial truck-mounted crane non-telescoping boom</td>
</tr>
<tr>
<td>7</td>
<td>Telescoping boom crawler crane</td>
</tr>
<tr>
<td>8</td>
<td>Lattice boom wheel mounted (single control station)</td>
</tr>
<tr>
<td>9</td>
<td>Telescoping boom fixed control station (non-rotating operator cab)</td>
</tr>
<tr>
<td>10</td>
<td>Locomotive cranes</td>
</tr>
</tbody>
</table>

4.3.4.4 Training and Evaluation

Personnel are qualified to perform H&R OJT instruction or evaluation once they are designated as an On-the-Job Training Instructor or an On-the-Job Evaluator.

4.3.5 Qualification

Personnel shall be considered qualified when they accomplish the following:

1. Satisfactorily complete Hanford Site approved training, testing, and qualification or meet the requirements of previous training (see Section 4.3.1)

2. Satisfactorily complete equipment specific On-the-Job Training (OJT) for equipment operators. Management may determine that previous qualification or experience fulfills the requirement for OJT.

3. Pass an equipment specific OJE for personnel performing rigging activities and equipment operators.

4.3.6 Requalification

4.3.6.1 Requalification Frequencies

Personnel who perform any of the following tasks shall requalify in those task areas every 60 months:

1. Use rigging or perform rigging activities

2. Function as a designated lead (DL)/lift director

3. Perform OJEs
4. Operate mobile cranes, overhead cranes, and monorails

5. Develop lift plans

6. Perform signal person duties for H&R activities

7. Perform periodic document inspections of equipment

8. Provide technical approval of lift procedures

9. Provide safety oversight of H&R operations

10. Supervise or direct H&R operations (includes DLs/lift directors)

11. Perform activities as an equipment custodian

12. Maintenance, inspection, or repair personnel who operate mobile cranes, cab- or pulpit-operated overhead cranes

Personnel who operate forklifts shall requalify every 36 months.

**NOTE:** *It is recommended that personnel who have not performed work or operated equipment, for which they were trained and qualified, for 12 continuous months be re-evaluated.*

### 4.3.6.2 Requalification Methods

Personnel performing the following activities may be requalified by the methods indicated. Personnel, who do not satisfactorily complete requalification by an identified method, shall complete training as listed in Sections 4.3.1.3.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Requalification Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powered industrial trucks (forklifts) operation.</td>
<td>OJE</td>
</tr>
<tr>
<td>Overhead crane and monorail operation.</td>
<td>OJE</td>
</tr>
<tr>
<td>Mobile crane operation (includes maintenance repair or inspection personnel who operate mobile cranes).</td>
<td>OJE</td>
</tr>
<tr>
<td>Incidental rigging (using slings, rigging hardware, hoists, and below-the-hook lifting devices). Rigging from overhead cranes.</td>
<td>OJE</td>
</tr>
<tr>
<td>Mobile equipment rigging (using slings, rigging hardware, hoists, and below-the-hook lifting devices). Rigging from forklifts, excavators, backhoes, loaders, etc.</td>
<td>OJE</td>
</tr>
<tr>
<td>Advanced rigging (using slings, rigging hardware, hoists, and below-the-hook lifting devices). Rigging from a mobile crane.</td>
<td>OJE</td>
</tr>
<tr>
<td>Inspect mobile or overhead cranes (mechanical or electrical), forklifts, wire rope, rigging hardware, below-the-hook lifting devices, hooks, and hoists.</td>
<td>OJE or written test</td>
</tr>
<tr>
<td>Task Description</td>
<td>Method</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Approving technical lift procedures, acting as Designated Leader for,</td>
<td>OJE or written test</td>
</tr>
<tr>
<td>Safety Oversight or supervision of hoisting and rigging operations.</td>
<td></td>
</tr>
<tr>
<td>Acting as equipment custodian.</td>
<td>Written test</td>
</tr>
<tr>
<td>On-the-job training or evaluation of personnel. – Note: - On-the-job Trainers</td>
<td>Written test or OJE.</td>
</tr>
<tr>
<td>and Evaluators must maintain and demonstrate both their instructional proficiency and technical proficiency.</td>
<td></td>
</tr>
</tbody>
</table>
4.4 RETRAINING

Retraining shall consist of satisfactorily completing training requirements for that activity or equipment (see note in paragraph 4.3.6). Personnel shall be retrained when any of the following occurs:

1. Equipment with new operating characteristics is acquired
2. Existing equipment is modified, changing the operation characteristics
3. Personnel receive an unsatisfactory performance evaluation
4. Changes in standards or requirements occur that could affect safety
5. Personnel are directly involved in a documented incident that compromises safety of personnel, equipment, or the environment in the performance of H&R activities
6. Personnel performance is determined to be unsatisfactory or diminished skill level is observed

4.5 WRITTEN AND PERFORMANCE TESTS

Written, oral, and performance tests shall have established pass/fail criteria, be developed using the guidance in DOE-HDBK-1205-97, Guide to Good Practices for Design Development and Implementation of Examinations, and DOE-HDBK-1206-98, Guide to Good Practices for on-the-Job Training, and require students to demonstrate knowledge and skills identified by training objectives.

4.6 TRAINING AND QUALIFICATION RECORDS

4.6.1 Training Completion Records

Training completion records (TCR) shall:

1. Be maintained by the issuing organization or employer for the duration of qualification
2. Contain written examinations and performance evaluation of knowledge and skills
3. Contain documentation supporting evaluation of previous training and qualifications, when applicable
4. Indicate the activity and/or equipment type and class for which qualification was issued
5. Contain the name of the qualified individual and the date the qualification was issued
6. Contain the name and signatures of instructors and students, and the date instruction was given
7. Contain the name and signature of the evaluator, the person evaluated, and the date the evaluation was conducted
4.6.2 Course Records

The following documents are considered course records:

1. Course description
2. Current lesson plans
3. Student handouts, if applicable
4. Performance evaluations
5. Written examinations or the bank of test questions

4.6.3 Qualification Cards

Qualified personnel may be issued cards identifying their equipment/activity qualifications. Information on these cards shall be derived from and supported by training and qualification records (see Section 4.6.1). If used, these cards shall contain the following information:

1. Activity covered by the qualification
2. Type of equipment or activity
3. Class of equipment
4. Date of training and/or evaluation
5. Name of qualified individual
6. Signature of qualified individual
7. Name and signature of the OJT instructor
8. Name and signature of the OJT evaluator
Appendix A Training Subject Content by Activity and/or Equipment

A. Powered Industrial Truck (Forklift) Operation

Training for operation of powered industrial trucks (forklifts) is divided into three categories and should cover the following:

1. Fundamentals
   a. Inspection and maintenance
   b. Responsibilities
   c. Standards
   d. Operating instructions, warnings, precautions, etc.
   e. Braking methods and characteristics
   f. Visibility with and without a load
   g. Stability characteristics to include center of gravity, stability triangle (with and without a load or attachments), requirement and approvals for using attachments
   h. Controls: location, function, methods of operation, identification of symbols
   i. Load-handling capabilities of forks and attachments
   j. Fueling and battery charging
   k. Guards and protective devices
   l. Difference between industrial trucks and automobiles
   m. Engine or motor operation
   n. Steering and maneuvering
   o. Other characteristics

2. Operating Environment
   a. Floor or ground conditions, including temporary conditions
   b. Ramps and inclines, with and without a load
   c. Trailers, railcars, and dock boards, including the use of wheel chocks, jacks, or other securing devices
   d. Fueling and battery-charging facilities
   e. Use of “classified” trucks in areas classified as hazardous because of a risk of fire or explosion, as defined in ANSI/NFPA 505
   f. Narrow aisles, doorways, overhead wires, piping, and other areas of limited clearance
   g. Areas where the truck may be operated near other powered industrial trucks or vehicles
   h. Operation near pedestrians
   i. Use and capacities of elevators
   j. Operation near the edge of a dock or improved surface
   k. LP gas bottle change-out
   l. Other special operating conditions and hazards that could be encountered.
3. Operation
   a. Proper pre-shift inspection and the approved method for removing a truck in need of repair from service
   b. Fork/tine adjustments
   c. Load-handling techniques (lifting, lowering, picking up, placing, and tilting)
   d. Traveling with a load, without a load, and turning corners
   e. Parking and shutdown procedures
   f. Other special operating conditions for the specific application
   g. Operating safety rules and practices (e.g. Designated Leader [DL]/lift director assignment)
   h. Other rules, regulations, or practices required by the employer at the location where the powered truck will be used
   i. LP gas bottle change-out
   j. Lessons learned
   k. Hand Signals
   l. Operating near power lines

B. Forklift Inspection and Maintenance

Training for forklift inspection and maintenance should cover the following:

1. Inspection criteria
2. Determining who can make repairs
3. Fork inspection criteria
4. Forklift testing criteria
5. Hydraulic systems
6. Capacity, operational, maintenance, and name plate requirements
7. Rated capacity
8. Stability criteria
9. Maintenance and rebuilding practices
10. Forklift type
11. Controls
12. Operating mechanism
13. Components and attachments
14. Safety and warning devices
15. Operating instructions
16. Modifications requirements
17. Replacement parts and suspect counterfeit items.
C. Wire Rope and Rigging Hardware Inspection and Maintenance

Training for wire rope and rigging hardware inspection and maintenance is divided into four categories and should cover the following:

1. Wire Ropes
   a. Manufacturer recommendations
   b. Standards
   c. Lift service return inspections
   d. Wire rope replacement criteria
   e. Work site receipt
   f. Rope storage
   g. Unreeling, cutting, seizing
   h. Lubrication type and frequency
   i. Replacement
   j. Extra-long rope
   k. Frequent, monthly, and periodic inspection criteria
   l. Terminal end
   m. Installation
   n. Before initial load cycle
   o. Initial load cycle
   p. New rope stretch
   q. Fastener verification
   r. Replacement documentation
   s. Rope qualification
   t. Lessons learned
   u. Suspect counterfeit items.

2. Slings
   a. Documentation
   b. Standards
   c. Defective slings
   d. Rated loads
   e. Sling identification
   f. Effects of environment
   g. Attachments
   h. Operating practices
   i. Proof test
   j. Repairs
   k. Minimum lengths
   l. Rope grades
   m. Rope properties
   n. General guidelines and inspection criteria
   o. End attachments
   p. Replacement
   q. Cautions and prohibitions
   r. Fabrication
   s. Coatings
   t. Design factors
   u. Removal criteria
   v. Construction
   w. Webbing
   x. Fittings
   y. Marking
   z. Suspect counterfeit items
   aa. Lessons learned

3. Hooks
   a. New hooks
   b. Standards
   c. Throat latches
   d. Frequent inspection criteria and intervals
   e. Proof load testing and tagging
   f. Inspection records
   g. Nondestructive testing
   h. Rigging Hardware
   i. Marking and tagging
   j. Inspection criteria
   k. Periodic inspection criteria and intervals
   l. Qualification standards
   m. Lessons learned
   n. Suspect counterfeit items
4. Below-the-Hook Lifting Devices
   a. Design factors   l. Suspect counterfeit items
   b. Standards   m. Inspection records
   c. Welding   n. Repairs
   d. Guarding   o. Preventive maintenance
   e. Electrical   p. Replacement parts
   f. Analysis   q. Testing
   g. Marking   r. Operational tests
   h. Modifications   s. Rated load test
   i. Initial inspection   t. Manufacturers certification in lieu of rated load test
   j. Frequent inspection criteria and intervals   u. Periodic inspection criteria and intervals
   k. Service classifications   v. Lessons learned

D. Overhead Crane Operation

Training for overhead crane operation should cover the following:

1. Load and capacity   11. Suspect counterfeit items
2. Math skills   12. Operator conduct and responsibilities
3. Crane-specific information   13. Operating practices
4. Standards   14. Attaching the load
5. Operational characteristics   15. Holding the load
7. Prestart and post-start inspections   17. Personnel lifting
8. Maneuvering and maneuvering skills   18. Signaling and signals
10. Crane manufacturer operation and maintenance instructions   20. DL/lift director assignment
E. Overhead Crane Inspection and Maintenance

Training for overhead crane inspection and maintenance should cover the following:

1. Inspection classification
2. Standards
3. Frequent inspection criteria and intervals
4. Periodic inspection criteria and intervals
5. Determination of conditional hazards
6. Operating mechanisms (including remote operating systems, if applicable)
7. Upper-limit devices
8. Tanks, valves, pumps, lines, and other parts of air or hydraulic systems
9. Hooks and hook latches
10. Hoist ropes and end connections
11. Spooling of rope on drums and sheaves
12. Deformed, cracked, or corroded members
13. Bolts, nuts, pins, or rivets
14. Suspect counterfeit items
15. Sheaves and drums
16. Pins, bearings, wheels, shafts, gears, rollers, locking and clamping devices
17. Bumpers and stops
18. Brake system parts
19. Drive sprockets and excessive drive chain stretch
20. Controllers, master switches, contacts, limit switches, and push-button stations
21. Wind indicators
22. Gasoline, diesel, electric, or other power plants
23. Motion limit devices
24. Rope reeving
25. Function, instruction, caution, and warning labels or plates
26. Cranes not in regular service
27. Inspection records
28. Operational tests for new, reinstalled, altered, repaired, or modified cranes
29. Rated load test
30. Preventive maintenance
31. Maintenance procedure(s)
32. Adjustments, repairs, and replacements
33. Lubrication
34. Rope inspection (see Section C)
35. Lessons learned
F. Overhead Mechanical and Electrical Hoist Maintenance

Training for overhead mechanical and electrical hoist maintenance should cover the following:

1. Inspection classification
2. Standards
3. Hoists not in regular service
4. Periodic inspection criteria and intervals
5. Roller chain inspection, maintenance, and replacement
6. Frequent inspection criteria and intervals
7. Operational tests
8. Load test
9. Preventive maintenance
10. Maintenance procedure
11. Adjustments, repairs, and replacements
12. Lubrication
13. Rope inspection and maintenance (see Section C)
14. Welded-link chain inspection, maintenance, and replacement
15. Suspect counterfeit items
16. Lessons learned

G. Riggers/Signal Persons

Training for rigging activities should cover the following:

1. Capacities
2. Math skills
3. Design factors
4. Sling angles and effects on capacity
5. Load weight calculations
6. Definitions
7. Load center of gravity, effects and determination
8. Inspections
9. Slings, types and applications
10. Rigging hardware, types and applications
11. Below-the-hook lifting devices types, applications, marking, and inspection
12. Safety requirements
13. Safe H&R practices
14. Attaching the load
15. Moving the load
16. Rigger responsibilities
17. Emergency response
18. Critical lift requirements
19. Standards
20. Signaling and signals
21. Lessons learned
22. Calculating sling loading using load angle factors, D/d ratios, and multi-leg slings
23. Calculating the center of gravity and determining pick points for symmetrically and unsymmetrically shaped loads
24. Performing flagging, setup, and working with mobile cranes
25. Working from suspended platforms
26. Working near energized sources and power lines
27. Assembling and disassembling lattice boom cranes and box-boom extensions and jibs
28. Performing critical lifts and two-crane lifts
29. Performing H&R in hostile environments
30. DL/lift director assignment
31. Crush/pinch points/struck-by hazards
H. Mobile Crane Operation

Training for mobile crane operation should cover the following:

|   | Mobile crane operation and setup | Load and capacity chart calculations in various configurations | Load moment indicators (LMI) | Math skills | Crane-specific and cab information | Standards | Operational characteristics | Controls and emergency control skills for fire and power-line contact | Crane performance and stability | Prestart and post-start inspections | Maneuvering and maneuvering skills | Shutdown and securing procedures | Crane manufacturer operation and maintenance instructions | Operator conduct and responsibility | Operating practices | Attaching the load | Holding the load | Moving the load | Personnel lifting | Signaling and signals | Operating near power lines | Traveling with and without a load | Suspect counterfeit items | Footing | DL/lift director assignment | Refueling procedure | Lessons learned | Operator aids. | Crush/pinch points/struck-by hazard |
| 1. | Mobile crane operation and setup | 15. Operating practices |
| 2. | Load and capacity chart calculations in various configurations | 16. Attaching the load |
| 3. | Load moment indicators (LMI) | 17. Holding the load |
| 4. | Math skills | 18. Moving the load |
| 5. | Crane-specific and cab information | 19. Personnel lifting |
| 6. | Standards | 20. Signaling and signals |
| 7. | Operational characteristics | 21. Operating near power lines |
| 8. | Controls and emergency control skills for fire and power-line contact | 22. Traveling with and without a load |
| 10. | Prestart and post-start inspections | 24. Footing |
| 11. | Maneuvering and maneuvering skills | 25. DL/lift director assignment |
| 12. | Shutdown and securing procedures | 26. Refueling procedure |
| 13. | Crane manufacturer operation and maintenance instructions | 27. Lessons learned |
| 29. | Crush/pinch points/struck-by hazard |

**NOTE:** For other crane types see Chapter 1.0, Introduction.
## I. Mobile Crane Inspection and Maintenance

Training for mobile crane inspection and maintenance shall include requirements and applicable subjects of Section H, “Mobile Crane Operation,” if inspection and maintenance personnel operate mobile cranes in performance of their duties. Training for mobile crane inspection and maintenance should cover the following subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inspection classification</td>
<td>23. Travel steering, braking, and locking devices</td>
</tr>
<tr>
<td>2. Standards</td>
<td>24. Hydraulic and pneumatic hose fittings and tubing inspection</td>
</tr>
<tr>
<td>3. Control mechanisms adjustments</td>
<td>25. Excessive abrasion or scrubbing of the outer surfaces</td>
</tr>
<tr>
<td>5. Control mechanisms contamination by lubricants or other foreign matter</td>
<td>27. Hydraulic filters</td>
</tr>
<tr>
<td>7. Hydraulic hoses</td>
<td>29. Inspection records</td>
</tr>
<tr>
<td>8. Hooks and latches</td>
<td>30. Operator aids</td>
</tr>
<tr>
<td>9. Rope reeving</td>
<td>31. Operational tests</td>
</tr>
<tr>
<td>10. Electrical apparatus</td>
<td>32. Crush/pinch points/struck-by hazards</td>
</tr>
<tr>
<td>11. Hydraulic system</td>
<td>33. Rated load test</td>
</tr>
<tr>
<td>12. Tires</td>
<td>34. Preventive maintenance</td>
</tr>
<tr>
<td>13. Crane structure and boom</td>
<td>35. Maintenance procedure</td>
</tr>
<tr>
<td>14. Suspect counterfeit items</td>
<td>36. Adjustments and repairs</td>
</tr>
<tr>
<td>15. Bolts or rivets</td>
<td>37. Functional operating mechanisms</td>
</tr>
<tr>
<td>16. Sheaves and drums</td>
<td>38. Safety devices</td>
</tr>
<tr>
<td>17. Pins, bearings, shafts, gears, rollers, and locking devices</td>
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J. Equipment Custodian

Training for equipment custodians should cover the following:

1. Verification of current maintenance
2. Standards
3. Verification of current inspection
4. Verification of current testing
5. Record keeping
6. Proper tagging and removal from service
7. Elements of this manual for the assigned equipment
8. Manufacturer’s operating and maintenance instructions.

K. Designated Leader (DL)/Lift Director

Training for DLs/lift directors should cover the following:

1. Preparation of critical lift procedures
2. Standards
3. Proper approval of critical lift procedures
4. Documented pre-lift meeting
5. Flagger assignment and identification
6. Personnel qualification
7. Equipment selection
8. Equipment setup and positioning
9. Work area overview
10. Directing operations
11. Elements of this Manual for the work and equipment used

L. Supervisor

Training for supervisors should cover the following:

1. Qualified personnel for equipment operation
2. Standards
3. Safe operation of equipment
4. Preplanned and approved H&R instructions
5. Proper tagging of unsafe or restricted-use equipment
6. Custodian notifications
7. DL/lift director assignments
8. Elements of this Manual for work assignments of the assigned crew

M. Lift Procedure Technical Approver/Lift Plan Developer

Training for technical approvers/lift plan developers should cover the following:

1. Chapter 3, Critical and Special Lifts, of this Manual
2. Elements of this Manual for the work to be done and equipment to be used. For subjects refer to each category of equipment and activity listed in Appendix A, Training Subject Content by Activity and/or Equipment, of this Chapter.
N. **On-the-Job Training Instructor**

OJT instructors shall have the technical information in the subject area of training assignments and should be trained in the following:

1. OJT techniques
2. Demonstrations
3. Hands-on exercises
4. Performance evaluation
5. Use of OJT forms
6. Records management

O. **On-the-Job Evaluator**

On-the-job evaluators shall have the technical information on the subject area of evaluations, be qualified to perform OJEs of proper operator actions, and should be trained in the following:

1. Evaluation techniques
2. Test administration
3. Performance evaluation
4. Use of OJE forms
5. Records management

P. **Classroom Instructors**

Classroom instructors presenting training on subjects identified in Appendix A, *Training Subject Content by Activity and/or Equipment*, of this chapter shall be technically competent and trained in the following instructional areas

1. Standards
2. Instructional techniques
3. Test administration
4. Instructional materials and media
5. Learning Objectives
6. Lesson plans
7. Lessons learned in subject area
8. Concepts of systematic approach to training
9. Principles of learning
10. Records Management

Q. **Safety Oversight**

Training for personnel responsible for safety oversight of hoisting and rigging activities should cover the following:

1. General safety standards related to H&R activities.
2. The DOE/RL-92-36 Hanford Site Hoisting and Rigging Manual content overview and pertinent safety requirements for personnel and equipment.
R. **Rigging Engineer**

Candidates for Rigging Engineers shall have a minimum of two years experience in H&R related work and have demonstrated capability in the technical aspects of similar work. This capability shall be achieved through education and experience.

*(NOTE: Designation as a rigging engineer does not qualify personnel to perform design calculations. A Registered Professional Engineer (RPE) typically performs design calculations of hoisting and rigging equipment.)*

Training for Rigging Engineers should cover the following items and may be accomplished by classroom training or by qualification card in accordance with section 4.6.3:

1. The contents of this Manual DOE-RL-92-36 – focused on those aspects of this manual pertaining to engineering.
2. The OSHA and ASME standards in Section 21.1, References, Chapter 21, *References and Bibliography*, of this Manual – focused on those aspects of this manual pertaining to engineering.
3. Reviewing structural calculations of lift points or lifting devices to determine compliance to applicable standards – determine when an RPE or a graduate of an accredited college or university is required, identification of standards (ASME, BTH-1, AISC, others), stress levels and factor of safety for types of stress (compression, tension, shear and load combinations), design media review process, identification of various types of materials and environmental effects.
4. Personnel assignments and responsibilities – determine when an RPE or graduate of an accredited college or university is required, engineering code of ethics, acceptable practice when OSHA requires an RPE.
5. Critical and special lift criteria – the different types of lifts (Critical, Special, Engineered), ASME P-30 Standard, ASME B30.5 Appendix, HSHRM Chapter 3, 29-CFR-1926 Multiple Crane Lift.
6. Slings, rigging hardware, and below-the-hook lifting devices characteristics and design factors – ASME B30.20, ASME BTH-1, types of lifters, BTH vs. lifting attachments. DOE-RL-92-36 added requirements, freight container lifting, metallurgical fracture limits, pin to hole diameter and effects on capacity.
7. Slings, rigging hardware, and below-the-hook lifting devices removal from service criteria – engineering requirements, what constitutes damage, manufacturer’s requirements, BTH design and grandfathered lifters, nondestructive testing types.
8. Mobile cranes, hoists, overhead cranes, and forklift operational characteristics, setup, and operation – equipment selection, ground loading, proper set-up and configuration, restrictions, hazard identification, fall zone, collapse zone, swing clearances required.
9. Mobile cranes, hoists, overhead cranes, and forklift testing and inspection requirements and removal from service criteria – requirements for assembly and disassembly, equipment transit weight vs. set-up weight, basic pre-use and periodic inspection requirements, hostile environment plans.
10. Mobile cranes, hoists, overhead cranes, and forklift attachments and effects on capacities – description of the various types of attachments, types allowed, effects of attachments on capacity, manufacturer’s approval requirements, assembly and disassembly requirements.
11. Mobile crane load chart calculations and capacities for specific configurations – two crane lift design requirements and lift planning, how to read a load chart, tipping moment, structural limits, outrigger load charts, ground bearing and soil stability factors, outrigger pad size requirements, outrigger material types, application and limitations.
12. Rope re-reeving – effect of improper inspection, effect of improper re-reeving.
13. Suspended platform use and requirements – design requirements for platforms, code requirements, and operating procedure requirements.
14. Working around electrical energized sources requirements – code requirements, RPE requirements, distance limits, arc-flash and grounding, required documentation.
15. Crane, forklift, and rigging rated/proof load testing requirements – design requirements for various types of equipment, forklift forks, crane load testing, and ASME B30 load test requirements for various hardware and slings.
16. Calculating slings and rigging hardware loading and effects on capacity – calculating sling loading using trigonometry, moment magnification factors on lifting attachments, forces and moments on lifting attachments and BTH lifters, cause of sling failures, types of sling protectors, sling cut protection and edge effects on slings, code requirements for “adequate” protection, D to d ratio.
17. Load weight calculations – weight estimates, contingencies for estimates, load impact factors for various types of hoisting equipment, potential hold up of liquid, and load factors.
18. Determining pick points (lifting attachments) – design criteria for lifting attachments, custom designed or ASME B30.26 type of lifting attachment, center of gravity and resulting load vectors to calculate stresses, qualification of lift points by analysis, qualification by inspection and load testing.
19. Calculating load center of gravity – calculating moments to determine center of gravity, potential danger of moving loads, potential danger of rotating loads and center of gravity lifting, the use of running blocks.
20. Safe H&R practices - lesson learned, review of most common types of accidents, accidents due to engineering errors, ground bearing failures and sling failures, transportation requirements such as cribbing, tie-downs, and not using lift points as tie-downs, moving suspended loads and rotating equipment from horizontal to vertical.
S. Assembly / Disassembly Director

Training for personnel responsible for Assembly/Disassembly of cranes activities shall cover the following:

1. Assembly/Disassembly procedures
2. Reviewing procedures
3. Blocking material
4. Crew instructions
5. Proper location of blocking
6. Verifying assist crane loads
7. Tasks, assignments, and associated hazards
8. Boom and jib pick points
9. Hazardous positions/locations during assembly and disassembly
10. Center of gravity
11. Protecting assembly/disassembly crew members out of operator view
12. Snagging
13. Working under the boom, jib, or other components
14. Stability upon pin removal
15. Capacity limits
16. Struck by counterweights
17. Addressing specific hazards
18. Boom hoist brake failure
19. Site and ground bearing conditions
20. Loss of backward stability
21. Wind speed and weather
22. Weight of components
23. Components and configuration
24. Manufacturer instructions
25. Post-assembly inspection
26. Shipping pins
27. Outriggers and Stabilizers
28. Rigging
29. Dismantling (including dismantling for changing the length of booms and jibs)
30. Assembly/Disassembly—employer procedures
31. Power line safety during assembly/disassembly operations
32. Wire Rope
33. Fall Protection
T. Mobile Crane Operator and Personnel Assigned to Work Around and with Mobile Cranes

Mobile Crane Operators and personnel assigned to work around and with mobile cranes shall receive training for working around power lines that, as a minimum, includes the following:

1. The procedure to be followed in the event of electrical contact with a power line. Such training must include:
   a. Information regarding the danger of electrocution from the operator simultaneously touching the equipment and the ground.
   b. The importance to the operator’s safety of remaining inside the cab except where there is an imminent danger of fire, explosion, or other emergency that necessitates leaving the cab.
   c. The safest means of evacuating from equipment that may be energized.
   d. The danger of the potentially energized zone around the equipment (step potential).
   e. The need for crew in the area to avoid approaching or touching the equipment and the load.
2. Safe clearance distance from power lines.
3. Power lines are presumed to be 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.
4. Power lines are presumed to be un-insulated unless the utility owner/operator or a registered engineer who is a qualified person with respect to electrical power transmission and distribution confirms that a line is insulated.
5. The limitations of an insulating link/device, proximity alarm, and range control (and similar) device, if used.
6. The procedures to be followed to properly ground equipment and the limitations of grounding.

U. Below-the-Hook Lifting Device Operation

Training on operation of Below-the-Hook Lifting (BTH) Devices should cover the following as applicable.

1. Manufacturer’s suggested operating procedures.
2. Instructions in any special operations or precautions.
3. Condition and configuration of the load required for operation of the lifter.
4. The load rating of the lifting device and the capacity of the hoisting equipment.
5. Application of the lifter to the load and adjustments.
6. Proper attachment of adapters on a lifting device for special load handling.
7. Proper storage of the lifter.
8. Demonstration of the ability to operate the BTH Lifting Device as instructed.
9. Charging of the battery (if required).
10. Purpose of indicators, meters, or alarms on a vacuum lifter.
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5.0 HOOKS

5.1 SCOPE

This chapter applies to the construction, installation, operation, inspection, testing, maintenance, and the safe use of hooks installed on cranes or hoists as prescribed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. This section implements required criteria from DOE/RL-92-36 and the following standards:


This chapter also implements the following criteria from the applicable national standards and/or federal specifications that are mandatory requirements for each item.

1. Markings/Identification (ASME B30.10)
2. Construction/Fabrication (ASME B30.10)
6. Testing (ASME B30.10)
7. Maintenance (ASME B30.10)
8. Operating Practices (ASME B30.10)

5.2 GENERAL REQUIREMENTS

Contractors should access ASME via one or more of the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. To print IHS file go to http://www.ihs.com/

2. Thomson Reuters TECHSTREET ENTERPRISE at techstreetsubscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.

3. To purchase directly from ASME go to http://www.asme.org

4. To access OSHA standards go to the following links:
5. To view read only ASME file go to:
   - ASME B30.10-2014

5.3 IMPLEMENTATION

Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36 and the hook manufacturers’ requirements. It is the responsibility of the user of this manual to implement all of the requirements. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Hoisting Rigging Committee (HHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0 for process to be followed when requesting an interpretation. Notify the Hanford Site Hoisting and Rigging Committee if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within 1 year.

5.4 INCONSISTENT STANDARDS

1. OSHA requires Monthly Documented Hook Inspections along with other critical items, while ASME B30.10-Hooks does not require monthly inspections to be documented. Therefore follow the OSHA requirements.
2. OSHA 29 CFR-1910.179-Overhead and Gantry Cranes set removal criteria for hooks at 15% of normal throat opening or more than 10 degree twist from the plane of the unbent hook, while ASME B30.10 sets hook removal criteria at 5% for throat opening not to exceed ¼ inch and any visibly apparent bend or twist from the plane of the unbent hook. Therefore follow the ASME requirements.
5.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

5.5.1 Monthly and Periodic Hook Inspections (Records Required)

5.5.1.1 Monthly and periodic inspections shall include the requirements of Frequent Inspection as identified in ASME B30.10, shall be done by a qualified person (see Chapter 4 Personnel Qualifications and Training Requirements), and shall be documented as required by OSHA 29 CFR-1910.180.

5.5.1.2 A monthly documented hook inspection is required on overhead, gantry, and mobile cranes. Monthly hook inspection is a visual inspection for deformation, throat opening, and wear. Measurements are only required if the inspector finds evidence of distortion or damage. Monthly hook inspections on such cranes should be done in conjunction with the monthly wire rope or chain inspection. On manually operated lever hoists, overhead (underhung) hoists, jibs, and monorail systems, periodic hook inspection is required, but monthly hook inspection is not required.

5.5.1.3 When monthly and periodic inspection fall in the same month, only the periodic documented hook inspection is required that month.

5.5.1.4 Crane hooks, hoist hooks, and miscellaneous hooks, as identified in ASME B30.10, shall be equipped with latches unless determined by a qualified person that the use creates a greater hazard for the specified application.

5.6 TEMPERATURE LIMITATIONS – CRANE HOOKS, HOIST HOOKS, AND MISCELLANEOUS HOOKS

When hooks are to be used at temperatures above 400°F or below −40°F, the hook manufacturer or a qualified engineer should be consulted.
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6.0 SCOPE

This chapter specifies operation, inspection, testing, and maintenance requirements for forklift trucks (also referred to in this chapter as “truck” and “forklift”) powered by internal combustion engines or electric motors. This includes manually propelled high-lift trucks controlled by a walking operator. (See Attachment 6-1, Classes of Commonly Used Powered Industrial Trucks) This chapter includes only ANSI/ITSDF B56 requirements for forklift trucks. Other B56 standards should be implemented as required by site-specific policies. This chapter excludes vehicles used for moving earth.

Guidelines may be taken from this chapter regarding pallet trucks and other small miscellaneous non-powered lift trucks (see Attachment 6-2, Manually Operated Pallet Trucks, for examples). Operating, maintenance, and testing requirements for non-powered equipment are based on the manufacturer’s instructions and recommendations.

Each B56 Standard is available free of charge from ITSDF. Each standard is copyrighted by ITSDF and may not be published, reproduced, distributed or otherwise made publicly available without the prior written consent of ITSDF. Please visit www.ITSDF.org to ensure that you have the most recent version.

Safety standards applicable to this chapter include the following:

- B56.1 Low Lift and High Lift Trucks
- B56.6 Rough Terrain Forklift Trucks
- B56.9 Operator Controlled Industrial Tow Trucks
- B56.10 Manually Propelled High Lift Industrial Trucks

To access the applicable OSHA standard, go to the following link:

- 29 CFR 1910.178, Powered Industrial Trucks

6.1 OPERATOR TRAINING AND QUALIFICATION

According to the ANSI/ITSDF B56 series of standards: “The use of powered industrial trucks is subject to certain hazards that cannot be completely eliminated by mechanical means, but their risks can be minimized by the exercise of intelligence, care, and common sense. It is therefore essential to have competent and careful operators, physically and mentally fit, and thoroughly trained in the safe operation of the equipment and handling of the loads. Serious hazards are overloading, instability of the load, obstruction to the free passage of the load, collision with objects or pedestrians, poor maintenance, and use of equipment for a purpose for which it was not intended or designed.”

The employer shall ensure that each forklift truck operator is competent to operate the equipment safely, as demonstrated by successfully completing training and an on-the-job evaluation (OJE) and as specified in Chapter 4, Personnel Qualifications and Training Requirements.

6.1.1 Substance Abuse Testing for Commercial Motor Vehicle Operators

The commercial motor vehicle (CMV) definition found in 49 CFR 383.5, Definitions, (See Appendix A, Commercial Motor Vehicle) shall apply to forklifts designed for highway use with a gross vehicle weight rating of 26,001 pounds or more. CMV drivers shall pass, with a negative result, a substance abuse test performed by a recognized laboratory initially, and every 36 months thereafter.
6.1.2 Training

6.1.2.1 Operator Training
Training for operators of forklift trucks will be provided in the following manner:

a. Operators of forklift trucks shall be trained and qualified as prescribed in Chapter 4, Personnel Qualification and Training Requirements. Operators of manually propelled pallet trucks and small miscellaneous trucks do not require training in accordance with Chapter 4. For the operation of non-powered and miscellaneous trucks, operators shall follow the manufacturer’s operating instructions.

b. The forklift truck operator training program shall be successfully completed by all new operators at the Hanford Site regardless of previous experience. Chapter 4, Personnel Qualifications and Training Requirements, includes provisions for crediting previous training and experience under the Hanford Training Program.

6.1.2.2 Retraining
Retraining requirements are outlined in Chapter 4, Section 4.4, Retraining. Assignment to a forklift truck having a classification for which the operator is not qualified requires retraining and/or on-the-job training (OJT) and passing an OJE for that class of forklift truck (see Attachment 6-1, Classes of Commonly Used Powered Industrial Trucks).

6.2 RESPONSIBILITIES

6.2.1 Management at the Using Organization

a. Classify hazardous locations and post appropriate building signs before a forklift truck is assigned to work in the area (see Attachment 6-5, Building Signs for Posting at Entrances to Hazardous Areas).

b. Ensure that the proper forklift truck is assigned to hazardous areas (see Attachment 6-7, Forklift Trucks in Hazardous (Explosive) Atmospheres).

c. Coordinate with and acquire concurrence from the responsible industrial safety representative before using forklift trucks in a hazardous area.

d. Ensure that forklift truck operators are trained and qualified in accordance with Chapter 4, Personnel Qualifications and Training Requirements, and ensure that retraining is implemented in accordance with Chapter 4, Section 4.3.6, Requalification.

e. If battery-powered forklift trucks are used, designate an area for charging batteries.

f. If LP-gas-powered forklift trucks are used, ensure that personnel are assigned and trained to exchange LP-gas containers.

g. Ensure that each forklift truck has been assigned a custodian.

h. Be sure the selected forklift truck has adequate capacity for the planned work. (This requires special attention if the load’s center of gravity will be beyond the truck’s load center.) See Section 6.12, Conduct of Operator, Item d.

i. Do not allow forklift trucks designed for indoor use to be used in wet outdoor locations without the manufacturer’s approval.
j. Before purchasing, leasing, or renting any forklift truck, consult with the responsible occupational safety and health organization to ensure that the equipment selected is appropriate for its intended work environment and will not introduce any unacceptable safety risk.

k. Normal forklift truck material handling operations are not considered hoisting and rigging activities and do not require a Designated Leader. A Designated Leader is required for forklift operations involving a critical lift or where rigging is being used with the lift.

l. Ensure all sit down model forklift trucks are equipped with a functioning and approved seat belt or active operator protection device.

6.2.2 Forklift Truck Custodian

The forklift truck custodian has the following responsibilities:

a. Acts as “owner” of the assigned forklift truck

b. Ensures that frequent (pre-use) inspection instructions are readily available to operators (see Attachment 6-6, Typical Pre-use Inspection Procedures)

c. Ensures that the forklift truck manufacturer’s approval is obtained before using an attachment

d. Ensures that nameplates and caution and instruction markings (see Section 6.3, Nameplates and Markings) are in place and legible. This includes markings required on trucks using attachments

e. Ensures that a planned maintenance and inspection program is implemented for each forklift truck and for any attachments used with it

f. Ensures that, if the truck is obtained on a rental agreement, it is inspected and found suitable for its intended function before putting it in service

g. Ensures that initial inspections are performed (see Section 6.10.1, Inspection of New and Rented Equipment) and maintenance files are maintained.

6.2.3 Forklift Truck Operator

The forklift truck operator has the following responsibilities:

a. Operates the truck in a safe responsible manner

b. Is familiar with information provided on the forklift truck data plate

c. Is knowledgeable with the forklift truck pre-use inspection criteria and performs inspections accordingly

d. Notifies the responsible supervisor when a problem is detected during either inspection or operation of the truck

e. Ensures that the truck is taken out of service if a problem is detected that would compromise safe operation of the truck.

6.2.4 Industrial Safety Representative

The industrial safety representative has the following responsibilities:

a. Ensures that the entrances to hazardous areas are properly posted to identify which trucks are permitted in the area. (See Attachments 6-5, Building Signs for Posting at Entrance to Hazardous Areas, and 6-7, Forklift Trucks in Hazardous (Explosive) Atmospheres)
b. Approves the use of forklift trucks assigned to operate in hazardous areas

c. Assists management at user facilities with safety issues regarding forklift truck selection and issues regarding areas for LP-gas refueling and battery charging.

d. Where internal combustion-powered forklift trucks are proposed for use indoors, assist management at user facilities in establishing precautions to preclude the buildup of carbon monoxide in the work atmosphere. (See Section 6.8, Work Atmosphere)

e. Provide safety- and health-related information to managers and supervisors to assist them in selecting or procuring the proper class and type of vehicle for the planned work activity. (See Sections 6.7, Fire Hazard Areas, and 6.8, Work Atmosphere)

6.3 NAMEPLATE(S) AND MARKING

6.3.1 Truck Marking by the Manufacturer

Every truck shall have a durable, corrosion-resistant nameplate, legibly inscribed with the following information:

a. Truck model and serial number
b. Truck weight
c. Designation of compliance with the mandatory requirements of ANSI/ITSDF B56.1, Safety Standard for Low and High Lift Trucks, applicable to the manufacturer
d. Type designation to show conformance with the requirements, such as those prescribed by Underwriters Laboratories, Inc., and Factory Mutual Research Corporation
e. Rated capacity.

In addition to these requirements, additional information is required (and allowed) on nameplates on high-lift trucks, electric trucks, and trucks intended for use in hazardous locations (see ANSI/ITSDF B56.1, Section 7.5, Nameplates and Markings).

6.3.2 Fork Arm Stamping by the Manufacturer

For forklift trucks purchased after December 1984, each fork arm shall be clearly stamped with its rated capacity in an area readily visible and not subject to wear. For example, the designation “1520 x 24” means 1,520-lb (680-kg) capacity at 24-in. (600 mm) load center.

6.3.3 Attachment Marking

On every removable attachment (excluding fork extensions), a nameplate with the following information is required:

a. Model number
b. Serial number on hydraulically actuated attachments
c. Maximum hydraulic pressure (on hydraulically actuated attachments)
d. Weight
e. Capacity
f. The following instructions (or equivalent): “Capacity of truck and attachment combination may be less than capacity shown on attachment. Consult truck nameplate.”

NOTE: This information should be provided by the attachment manufacturer.

6.3.4 User’s Obligation for Truck Marking

The using organization shall ensure that trucks using attachments (including fork extensions) are marked to identify the attachment(s), show the approximate 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. The using organization shall see that nameplates and caution and instruction markings are in place and legible.

6.3.5 Maintain Tags

The forklift truck manufacturer’s capacity, operating, and maintenance instruction plates, tags, or decals shall be maintained in legible condition.

6.4 ATTACHMENTS, MODIFICATIONS, AND FREE RIGGING FROM TINES

6.4.1 Attachments

a. Attachments almost always affect the 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.

CAUTION: Use of after-market attachments requires written approval from the truck manufacturer.

b. The rated capacity of an attachment-truck combination shall not be exceeded.

c. Attachments shall be maintained and lubricated based upon the recommendations of the manufacturer or a qualified person.

d. Attachments shall be inspected no less than annually. The inspection shall be documented:

e. Hooks included as part of attachments shall be inspected as specified for hooks on cranes and hoists (see Chapter 5.0, Hooks).

f. Load-bearing components shall be examined for deformation, and load-bearing welds shall be visually examined for cracks.

g. Load capacity of an attachment shall be verified by the manufacturer or by a load test at 100-percent capacity. The load test shall be performed on site. Load tests are not routinely required because a catalog cut, user’s manual, decals on attachment, or other manufacturer’s data serves as capacity verification.

6.4.2 Modifications

Modifications or additions that affect capacity or safe operation shall not be performed by the customer or user without the manufacturers’ prior written approval. Employers must seek written approval from powered industrial truck manufacturers when modifications and additions affect the capacity and safe operation of powered industrial trucks. When approval has been granted, the capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.
However, if no response or a negative response is received from the manufacturer, OSHA will accept a written approval of the modification/addition from a qualified Registered Professional Engineer. A qualified Registered Professional Engineer must perform a safety analysis and address any safety or structural issues contained in the manufacturer’s negative response prior to granting approval. When approval has been granted, machine data plates must be changed accordingly. Click to see OSHA’s Letter of Interpretation.

### 6.4.3 Free Rigging From Tines

Free rigging is the direct attachment to or placement of rigging equipment (slings, shackles, rings, etc.) onto the tines of a powered industrial truck for a below-the-tines lift. This type of lift does not use an approved lifting attachment and could affect the capacity and safe operation of a powered industrial truck. 29 CFR 1910.178 (o)(1) requires that: “Only stable or safely arranged loads shall be handled. Caution shall be exercised when handling off-center loads which cannot be centered.” Free rigging from the tines shall be treated as a modification and would only be allowed if approved as identified in Section 6.4.2, Modifications. Click to see OSHA’s Letter of Interpretation.

### 6.5 OVERHEAD GUARDS

High-lift rider trucks, order-picker trucks, and rough-terrain forklift trucks shall be equipped with an overhead guard that is manufactured in accordance with ANSI/ITSDF B56.1, *Safety Standard for Low and High Lift Trucks*, unless an exception is approved in writing by the responsible industrial safety organization. Rough-terrain forklift trucks shall be fitted with an overhead guard manufactured in accordance with ANSI/ITSDF B56.6, *Safety Standard for Rough Terrain Forklift Trucks*.

### 6.6 WARNING DEVICES

a. Every power-propelled truck shall be equipped with an operator-controlled horn, whistle, gong, or other sound-producing device. For manually propelled trucks, the using organization shall determine if operating conditions require the truck to be equipped with sound-producing or visual warning devices and be responsible for providing and maintaining them.

b. 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.

### 6.7 FIRE HAZARD AREAS

Powered forklift trucks for operation in fire hazard areas shall be of the type that is recommended in NFPA 505, *Powered Industrial Trucks, Type Designation and Areas of Use*. (See Attachment 6-7, *Forklift Trucks in Hazardous (Explosive) Atmospheres*).

### 6.7.1 Adverse Weather

Adverse weather conditions such as but not limited to wind, wind gusts, rain, snow and extreme temperatures, etc., that may inhibit the operator’s or the equipment’s ability to safely handle loads, shall be evaluated by supervision and forklift operator prior to any outdoor lifting operation. Limitations and conditions imposed by equipment manufacture for adverse weather shall be implemented. Outdoor forklift operations shall be suspended when lightning is within 50 miles of the work location, as
determined by the Hanford Meteorological Station. The Hanford Meteorological station can be contacted @ (509) 373-2716.

6.8 WORK ATMOSPHERE

The operation of forklift trucks affects the concentrations of carbon monoxide and oxygen at indoor work locations. The atmosphere in the work locations must meet the requirements of 29 CFR 1910, Occupational Safety and Health Standards for General Industry. Contact your industrial safety representative if guidance is needed or if questions arise (see Attachment 6-7, Forklift Trucks in Hazardous (Explosive) Atmospheres).

6.8.1 Operating Near Electric Power Lines

Requirements for operating fork trucks near electric power lines can be found in DOE-0359, Section 5.11, Performing Work Within 20 Feet of Overhead Lines.

6.9 OPERATOR CARE OF THE TRUCK

6.9.1 Frequent (Pre-use) Inspection

6.9.1.1 Frequent Inspection Instructions

Frequent inspection instructions that list inspection steps 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.

6.9.1.2 Results of Frequent Inspection

The operator shall report any deficiencies or unusual conditions to the responsible supervisor. Conditions adversely affecting safety shall be corrected before the forklift truck is placed into service.

6.9.2 Key Steps in a Pre-Use Inspections

At the beginning of each shift and before operating the truck, check its condition, giving special attention to the following:

a. Periodic maintenance and inspections have been performed and are current
b. Condition of tires (proper inflation pressure, if pneumatic tires)
c. Warning and safety devices
d. Lights
e. Battery
f. Controls
g. Lift and tilt systems – Ensure interlocks & safety devices are in-place for lifts that are capable of tilting forward for transportation
h. Forks or other load-engaging means
i. Chains and cables
j. Limit switches

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k. Brakes hold in forward and reverse directions
l. Steering mechanism
m. Fuel system(s)
n. Additional items as specified by the manufacturer or that are unique to the facility at which the truck is operated.
o. Ensure forklift and forklift attachment inspections are current via inspection stickers, other documentation or verbal confirmation from the equipment custodian.

See Attachment 6-6, Typical Pre-use Inspection Procedures, for typical pre-use inspection forms.

6.9.3 Truck Unsafe or Needs Repair

If during pre-use inspection or during operation the truck is found to need repair or is in any way unsafe, the operator shall immediately report the matter to his or her supervisor. The truck shall not be operated until it has been restored to safe operating condition.

6.9.4 No Repair by Operator

Do not make repairs or adjustments unless specifically authorized to do so.

6.9.5 Forklift Out of Service

Where the employer has taken the equipment out of service, a tag shall be placed in the cab stating that the equipment is out of service and is not to be used. Where the employer has taken a function(s) out of service, a tag shall be placed in a conspicuous position stating that the function is out of service and is not to be used.

6.9.6 Refueling

When refueling the truck, move to the refueling area, if one is designated at your facility, and always stop the engine before refueling. Always follow company- and facility-specific refueling and spill prevention and response procedures.

6.10 MAINTENANCE AND INSPECTION

Maintenance and inspection of powered forklift trucks shall be performed in conformance with the following practices:

a. A scheduled planned maintenance, lubrication, and inspection program shall be followed; consult the manufacturer’s recommendations.

b. Only trained and authorized personnel shall be permitted to maintain, repair, adjust, and inspect forklift trucks; these services shall be provided in accordance with manufacturer’s specifications.

c. No repairs shall be made while the truck is in a hazardous (explosive/classified) area.

6.10.1 Inspection of New and Rented Equipment

For newly purchased equipment or newly arrived rental 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. Receipt inspection shall include a review to verify that the tire ply rating is consistent
with the Manufacturer data plates or other manufacture specification. This inspection shall be documented and retained in the forklift truck’s maintenance file. (NOTE: The custodian shall retain the initial inspection report while the unit is on Site.)

| CAUTION: For forklift trucks on rental, ensure that a suitable maintenance and inspection program is established for the duration of the rental period. |

6.10.2 Modified or Extensively Repaired Equipment

For modified or repaired equipment, an inspection shall ensure that the equipment is in good condition and suitable for its intended use.

6.10.3 Replacement Parts

All parts that require replacement shall be replaced only with parts that meet the safety standards of those used in the original design.

6.10.4 Inspection of Forks

6.10.4.1 Fork Inspection Frequency

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 applications require more frequent inspection at an interval set by facility management.

6.10.4.2 Fork Load Rating

Forks used in pairs (the normal arrangement) have a rated capacity for each fork that is at least half the manufacturer’s truck rated capacity at the center distance shown on the forklift truck nameplate.

6.10.4.3 Fork Inspection Procedures

Fork inspection shall be carefully conducted by trained personnel 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:

a. **Surface Cracks.** The forks shall be thoroughly examined visually for cracks and, if their condition warrants, subjected to nondestructive crack detection, paying 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.

b. **Straightness of Blade and Shank.** Straightness of the upper face of the blade and the front face of the shank shall be checked. If deviation from straightness exceeds 0.5 percent of the length of the blade and/or the height of the shank, respectively, the fork shall not be returned to service until it has been repaired in accordance with Section 6.10.5, *Fork Repair.*

c. **Fork Angle (Upper Face of Blade to Load Face of the Shank).** Any fork with a deviation greater than 3 percent from the original specification shall not be returned to service. The rejected fork shall be reset and tested in accordance with Section 6.10.5, *Fork Repair.*
d. **Difference in Height of Fork Tips.** If the difference in height between forks in a set when mounted on the fork carrier exceeds 3 percent of the length of the blade, the set of forks shall not be returned to service until repaired in accordance with Section 6.10.5, *Fork Repair.*

e. **Positioning Lock (When Provided).** It shall be confirmed that the positioning lock 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.

f. **Fork Blade and Shank Wear.** The fork blade and shank shall be thoroughly checked for wear, with special attention to the vicinity of the heel. If thickness is reduced to 90 percent of the original thickness, the fork shall not be returned to service.

g. **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 Section 6.10.5, *Fork Repair.*

h. **Legibility of Fork Marking.** When fork marking in accordance with Section 6.2.2, *Forklift Truck Custodian,* is not clearly legible, it shall be renewed. Marking shall be renewed per instructions from the original fork supplier.

### 6.10.5 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.

### 6.10.6 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 ANSI/ITSDF B56.1, Section 7.27, *Forks,* which lists loading and method of test for forks; except for the test load, which shall correspond to 2.5 times the rated capacity marked on the fork.

### 6.11 FORKLIFT TRUCK LOAD TEST

Forklift truck load tests are not routinely required. Load tests shall be performed after major repair or modification to components that affect the load-carrying ability of the truck. The manufacturer should be consulted if questions arise as to whether a load test is appropriate. Forklift trucks shall be load tested by or under the direction of a qualified person and in accordance with the manufacturer’s recommendations.

#### 6.11.1 Verify Maintenance/Inspection is Current

Load tests shall be conducted only after confirmation that inspection and maintenance is up to date.

#### 6.11.2 Test Weight Accuracy

Test weights shall be accurate within -5 percent to +0 percent of stipulated values.
6.11.3 Load Test Report

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 maintenance file.

6.12 CONDUCT OF OPERATOR

The operator has the following responsibilities while operating a forklift truck:

a. Be certain the truck has been subjected to pre-use inspection and a workplace hazard evaluation has been performed.

b. A seatbelt or other active operator protection device shall be used at all times when operating any sit down model forklift truck.

c. Never exceed rated capacity. In determining total weight of the load to be handled, account for added weight that may be present as a result of field modifications, rigging hardware, shipping containers, and vessel or container contents.

**NOTE:** Rated capacity is the weight established by the manufacturer at a required load center at an established height. For large or unusually configured loads, the position of the load’s center of gravity relative to the truck’s load center must be considered when determining the truck’s ability to carry the load.

d. When handling large or unusually configured loads outside the truck’s load center, the forklift manufacturer’s instructions must be consulted. If applicable manufacturer’s instructions are not available, for a counterbalance-type truck, field calculations may be used to estimate the reduced lifting capacity.

**Example:** A 5,000-lb (2268 kg)-capacity forklift truck having a 24 in. (61 cm) load center must handle a load with the load’s center of gravity (c. g.) 28 in. (71 cm) from the front face of the forks. In this configuration, with the load’s c. g. 4 in. (10 cm) beyond the fork load center, estimate the truck’s safe load capacity.

\[
\begin{align*}
24 \text{ in} / 28 \text{ in} & \times 5,000 \text{ lb} = 4,285 \text{ lb} \text{ (approximate safe load capacity)} \\
61 \text{ cm} / 71 \text{ cm} & \times 2268 \text{ kg} = 1949 \text{ kg} \text{ (approximate safe load capacity)}
\end{align*}
\]

This calculation method will not produce exact load reduction figures. Use this method only as a rule of thumb. The forklift truck manufacturer is the source of more precise information.

e. “Free rigging” from tines is considered a modification and requires approval in accordance with Section 6.4.2, *Modifications*.

f. Prohibit riders on forklift trucks, unless the truck is built with passenger seating.

g. To avoid personal injury, keep head, arms, and legs inside the operator’s area of the machine.

h. 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: Inside plant buildings, drive no more than 5 mi (8 km) per hour; on in-plant roads, drive no more than 15 mi (24 km) per hour. Go slowly around curves.

i. Stop and sound the horn at blind intersections and doorways. Watch out for blind corners; stop and/or sound horn if appropriate.
j. Use low gear or slowest speed control when descending ramps.

k. Always spread the forks to suit the load width.

l. Prohibit any person from standing or passing under the elevated portion of any forklift truck, whether loaded or empty.

m. Lift, lower, and carry loads with the mast vertical or tilted back; never forward.

n. Avoid reaching through the mast for any purpose.

o. Lower and raise the load slowly, and only while the vehicle is stopped. Make smooth gradual stops.

p. Use special care when high-tiering. Return the mast to a vertical position before lowering load.

q. Avoid sudden stops and starts.

r. Watch overhead clearance. If in doubt, measure.

s. Never travel with forks raised to unnecessary heights.

t. Drive slowly over railroad tracks and rough surfaces. Cross tracks at an angle whenever possible.

CAUTION: Parking closer than 8 ft (2.4 m) from the center of railroad tracks is prohibited.

u. Consider both the truck and load weight when operating in railcars and semitrailers.

v. When loading trucks or trailers, ensure that the wheels are chocked and the brakes are set. Operate in front end of the semitrailer only if the tractor is attached, or if adequate trailer jacks are in place.

CAUTION: Semitrailers not coupled to a tractor may require supports (e.g., fixed jacks) to prevent upending or corner dipping.

w. Inspect floors on trucks, boxcars, unfamiliar ramps, or platforms before beginning operation.

x. Ensure that dockboards and bridge plates into trucks or freight cars are sufficiently wide, strong, and secure. Check them frequently. Portable or powered dockboards and bridge plates must be marked to show their carrying capacity. The carrying capacity indicated shall not be exceeded.

y. While turning, be cautious of rear-end swing and keep clear of the edge of loading docks.

z. If the load being carried obstructs the forward view, travel with the load trailing, except when ascending a ramp or incline.

aa. When ascending or descending grades in excess of 5 percent, drive a loaded rider truck with the load upgrade.

bb. Operate unloaded forklift trucks on grades with the forks downgrade.

cc. Avoid turning, if possible, and use extreme caution on grades, ramps, or inclines; normally travel straight up and down.

dd. 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.

e. Never butt loads with forks or rear end of truck.
ff. Split-forked or bulldozing a load into position using the forks is an accepted practice with administrative controls in place. The operators shall not push loads with forks or “bulldoze” a load when it exposes personnel to risk of injury, compromises the forklift’s capacity, could cause the load, or part of the load to tip, could result in damage to the forks, interferes with the maneuverability of the forklift, or reduce the operator’s control of the load. NOTE: Administrative controls may be addressed in a job hazard analysis, procedure, or in the work package/record.

gg. Do not drive forklift trucks onto any elevator unless specifically authorized and instructed to do so by a written, approved procedure.

hh. Safeguard pedestrians at all times. Do not drive a truck up to anyone standing in front of a fixed object. All trucks must yield the right of way to pedestrians and emergency vehicles. Manually powered trucks must yield the right of way to power propelled trucks. Before leaving a forklift truck unattended, fully lower the forks, neutralize the controls, shut off the power, and set the brakes. If parked on an incline, block the wheels. (A forklift truck is unattended when the operator is 25 ft (7.6 m) or more away from the truck, or whenever the truck cannot be viewed directly by the operator.) Before leaving an LPG-fueled forklift parked indoors, ensure the service valve of the fuel (LPG) container is closed.

ii. If the operator is dismounted, less than 25 ft (7.6 m) away, and within view of the truck, before dismounting, fully lower the forks, neutralize the controls, and set the brakes.

jj. At the end of the operator’s shift, return the forklift truck to its assigned parking place, set the brakes, lower forks flat on the floor, place controls in neutral position, turn ignition off, secure the key, and when the forklift is LPG fueled, ensure the service valve of the fuel (LPG) container is closed.

kk. Report all accidents and “near misses” promptly to the operator’s supervisor.

ll. Do not attach or operate any attachment that has not been approved for use on that forklift truck.

mm. Never lift with only one fork without an engineering analysis and approval.

nn. Request a trained spotter(s) whenever vision is obstructed in direction of travel or when needed to provide a warning or stop signal during forklift operation prior to violation of proximity restrictions or pre-determined distance limitations to structures or hazards such as power and communication lines, overhead obstructions, buildings, telephone poles, ground penetrations and etc.

oo. Exercise extra caution when handling loads that cause the truck to approach its maximum design characteristics. For example, when handling a maximum load, the load should be carried at the lowest position possible, the truck should be accelerated slowly and evenly, and the forks should be tilted forward cautiously. However, no precise rules can be formulated to cover all eventualities. The final responsibility for the handling of a truck remains with the operator.

pp. When lifting Freight Containers/Conex boxes, follow direction provided in Attachment 1, Freight Container Lifting Standard.

### 6.12.1 Load Securing and Stability

Only stable, safely arranged or secured loads shall be handled. Caution shall be exercised when handling off-balanced or loads that cannot be centered (See Section 6.12.d, Conductor of Operator). Methods of securing and stabilizing loads and materials moved on forklift trucks must be specific to the load (s) and...
forklift. The forklift manufacturer or a qualified person should be contacted for guidance if the forklift’s stability or structural integrity could be affected by securing a specific load or material to the forklift.

The forklift truck operator shall:

1. Ensure the load’s weight and center of gravity is within the lift’s capacity ratings.
2. Ensure loads and materials are stable and will remain stable during forklift movements and travel.
3. Secure loads and materials that are or may become unstable before movements or travel.
4. Ensure placed or stacked loads and materials are stable.
5. Adjust speed of travel and forklift movements for terrain and surface conditions.

6.13 LIFTING OF PERSONNEL

6.13.1 Special Provisions Prior to Lifting Personnel

Only operator-up high-lift trucks have been designed to lift personnel. If a personnel lifting platform is used on trucks designed and intended for handling materials, the manager who is specifically responsible for the work to be performed shall determine that there is no practical alternative way to perform the needed work.

For each platform lifting operation, the manager who is responsible for the task shall issue a written statement describing the procedure and its time frame. The statement shall be signed by the authorizing manager and, when approved, the statement also shall be signed by the responsible industrial safety representative. The statement shall be readily available at the job site when personnel lifting is in progress.

6.13.2 Qualification of Trucks Used for Lifting Personnel

Hydraulic or pneumatic hoisting systems shall include means to prevent unintended descent in excess of 120 ft/min (0.6 m/s) in the event of a hose failure. 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.

6.13.3 Standard Precautions – Lifting Personnel with Forklift Trucks

a. Be certain the truck is set on a firm and level surface.
b. Use only work platforms that are manufactured for the purpose of lifting personnel. Platforms shall be in conformance with ANSI/ITSDF B56.1, Section 7.37, Platforms-Elevating.
c. Be certain that the platform is securely attached to the lifting carriage or forks. When being supported by a forklift, the personnel platform shall be attached in such a manner that it cannot slide or bounce off the forks.
d. Be certain the platform is horizontal and is never tilted forward or rearward when elevated.
e. The operator shall remain in the control position of the forklift truck.
f. Overhead protection, as necessary by operating conditions, shall be provided.
g. 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.
h. Do not transport personnel from one location to another while they are on the personnel lifting platform.

i. Whenever a truck (except for high-lift order-picker trucks) is equipped with vertical hoisting controls that can be elevated with the lifting carriage or forks, take the following additional precautions to protect personnel:
   1. Provide means for personnel on the platform to shut off power to the truck.
   2. Provide means to render inoperative all operating controls, other than those 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.
   3. Ensure that emergency-lowering means are available at ground level and are protected against misuse.

j. A forklift truck is not permitted to be used as an anchorage point per DOE-0346, Hanford Site Fall Protection Program.

6.14 HAND SIGNALS

a. Two types of hand signals are shown in Attachment 6.3, Hand Signals.

b. The operator should respond to signals only from the designated signaler, but obey a STOP signal no matter who gives it.

c. 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 they should not conflict with the standard signals.

6.15 DESIGNATED LEADER

Operations that involve more than one person for hoisting and rigging activities require a designated leader (DL)/lift director. See Chapter 2.0, Sections 2.2.4, Designated Leader/Lift Director for Critical Lifts, and 2.2.5, Designated Leader.

6.16 CRITICAL LIFTS

Critical lifts require approved procedures (see Chapter 3, Critical Lifts).

6.17 MAINTENANCE FILES

The forklift truck maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluating, and repair of the equipment. The file may be centrally located or proportioned into satellite holding areas. The methods selected for establishing adequate information retention and retrieval shall be determined by the equipment custodian, who is the responsible person for ensuring that a safe and reliable maintenance program is in place.

6.17.1 Contents of Maintenance Files

The 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. Inspection records should be retained in an easily accessible format and location. Maintenance file information should provide a source for comparing present and past equipment conditions. This comparison will help determine whether existing conditions show a trending pattern of wear,
deterioration, or other conditions that may compromise continued safe use of the equipment. Length of record retention shall be determined by the equipment custodian’s established maintenance program.

A typical maintenance file should contain the following types of documentation, as applicable:

a. Waivers applicable to the forklift truck
b. Documentation for replacement forks or other altered, replaced, or repaired load-sustaining parts
c. Records of documented inspection, repair, modification, and overhaul:
   1. The most recent periodic inspection records
   2. Load test reports
   3. Initial inspection records for procured or newly arrived rental equipment
   4. The forklift truck manufacturer’s written approval for any modifications or additions

6.18 EQUIPMENT QUALIFICATION

To qualify for operation, a forklift truck shall have the following:

a. A record of successful inspection and maintenance
b. A frequent (pre-use) inspection instruction available to the operator
c. A qualified operator
d. The proper type designation for working in a classified hazardous area, if applicable

(See Attachment 6-7, Forklift Trucks in Hazardous (Explosive) Atmospheres).
ATTACHMENT 6-1.
CLASSES OF COMMONLY USED POWERED INDUSTRIAL TRUCKS *
(sheet 1 of 14)

For training purposes, powered industrial trucks are divided into the following eight classes as determined by the Industrial Truck Association:

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electric motor, sit-down or stand-up rider, counter-balanced trucks, solid and pneumatic tires</td>
</tr>
<tr>
<td>2</td>
<td>Electric motor, narrow-aisle trucks, solid tires</td>
</tr>
<tr>
<td>3</td>
<td>Electric motor, hand trucks or hand/rider trucks, solid tires</td>
</tr>
<tr>
<td>4</td>
<td>Internal combustion engine trucks, solid tires</td>
</tr>
<tr>
<td>5</td>
<td>Internal combustion engine trucks, pneumatic tires</td>
</tr>
<tr>
<td>6</td>
<td>Electric and internal combustion engine tractors, solid and pneumatic tires</td>
</tr>
<tr>
<td>7</td>
<td>Rough-terrain forklift trucks, pneumatic tires</td>
</tr>
<tr>
<td>8</td>
<td>Rough Terrain Telescopic Boom Forklift Truck</td>
</tr>
</tbody>
</table>

*See Chapter 4, Section 4.3.4.1, Powered Industrial Trucks.
ATTACHMENT 6-1
(sheet 2 of 14)

Class 1 - Electric Motor, Sit-Down or Stand-Up Rider, Counter-Balanced Trucks,
Solid and Pneumatic Tires

Electric Motor,
Sit-Down Rider Truck
ATTACHMENT 6-1
(sheet 3 of 14)

Class 1 - Electric Motor, Sit-Down or Stand-Up Rider, Counter-Balanced Trucks,
Solid and Pneumatic Tires

Counterbalanced Stand-Up Rider
Class 2 - Electric Motor Narrow-Aisle Trucks, Solid Tires

Order Picker

Turret Truck

Reach-Type Outrigger
ATTACHMENT 6-1
(sheet 5 of 14)
Class 2 - Electric Motor Narrow-Aisle Trucks, Solid Tires

Rider Reach Truck
ATTACHMENT 6-1
(sheet 6 of 14)

Class 2 - Electric Motor, Narrow-Aisle Trucks, Solid Tires

Order Picker
ATTACHMENT 6-1
(sheet 7 of 14)

Class 3 - Electric Motor. Hand Trucks or Hand/Rider Trucks, Solid Tires

Low Lift Platform

Low Lift Walkie Pallet

High Lift Counterbalanced

Manually Propelled High-Lift Industrial Truck
Class 3 – Electric Motor, hand Trucks or Hand/Rider Trucks, Solid Tires

Walkie Powered Pallet Truck

Walkie/Rider Powered Pallet Truck
ATTACHMENT 6-1
(sheet 9 of 14)

Class 4 - Internal Combustion Engine Trucks, Solid Tires

Counterbalanced, solid tires
ATTACHMENT 6-1
(sheet 10 of 14)

Class 4 - Internal Combustion Engine Trucks, Solid Tires

Sit-Down Rider Forklift Truck - LPG
ATTACHMENT 6-1
(sheet 11 of 14)

Class 5 - Internal Combustion Engine Trucks, Pneumatic Tires
ATTACHMENT 6-1
(sheet 12 of 14)

Class 6 - Electric and Internal Combustion Engine Tractors, Solid and Pneumatic Tires
ATTACHMENT 6-1
(sheet 13 of 14)

Class 6 - Electric and Internal Combustion Engine Tractors, Solid and Pneumatic Tires

NOTE: This Manual does not specifically include requirements for tractors. However, OSHA and general industry administer training programs for powered industrial trucks (Classification 6) under the same classification program as forklift trucks. Thus, powered industrial trucks (tractors) are shown here for clarification. See Chapter 4, paragraph 4.3.4.1, *Powered Industrial Trucks*. 
Class 7 – Rough-Terrain Forklift Trucks, Pneumatic Tires

- Straight-mast forklift
- Extended-reach forklift

Class 8 Rough Terrain Telescopic Boom Forklift Truck
ATTACHMENT 6-2. MANUALLY OPERATED PALLET TRUCKS

- Small Miscellaneous Truck
ATTACHMENT 6-3. HAND SIGNALS

Standard Hand Signals for Controlling Forklift Operations

RAISE THE TINES. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.

LOWER THE TINES. With arm extended, palm down, lower arm vertically.

TILT MAST BACK. With forearm vertical, thumb extended, jerk thumb over shoulder.

TILT MAST FORWARD. With arm extended, thumb down, lower arm vertically.

MOVE TINES IN DIRECTION FINGER POINTS. With arm extended, palm down, point forefinger in direction of movement.

DOG EVERYTHING. Clasp hands in front of body.

STOP. Extend both arms, palms down.
Standard Hand Signals for Telescopic Boom Forklift Operations

<table>
<thead>
<tr>
<th>Retract Boom</th>
<th>Raise Boom</th>
<th>Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extend Boom</td>
<td>Lower Boom</td>
<td>Shift Fork Left</td>
</tr>
<tr>
<td>Tilt Forks Left</td>
<td></td>
<td>Shift Fork Right</td>
</tr>
<tr>
<td>Tilt Forks Right</td>
<td></td>
<td>Tilt Forks Up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tilt Forks Down</td>
</tr>
</tbody>
</table>
ATTACHMENT 6-4. MARKERS TO IDENTIFY TYPE OF INDUSTRIAL TRUCK

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. For Marker definitions see Attachment 6-7, paragraph 6-7.6, *Hazardous Areas.*
ATTACHMENT 6-5. BUILDING SIGNS FOR POSTING AT ENTRANCE TO HAZARDOUS AREAS

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 Attachment 6-4, *Markers to Identify Type of Industrial Truck*, shall be installed on the sign.
### TYPICAL OPERATOR PRE-USE INSPECTION CHECKLIST

**DATE_____________________  VEHICLE NO._____________________________  SHIFT _______________**  

**TYPE AND MODEL___________________________________________________  HOUR METER _________**

<table>
<thead>
<tr>
<th>OK</th>
<th>VISUAL CHECKS</th>
<th>Maintenance Needed-Reported to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Periodic maintenance and inspections are current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leaks - Hydraulic Oil, Battery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tires - Condition and pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forks, Top Clip retaining pin and heel - Condition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load Backrest Extension - solid attachment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydraulic hoses, Mast chains &amp; Stops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finger guards - attached</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety warnings - attached and legible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operators manual - Located on truck and legible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity Plate – attached, information matches Model &amp; Serial Nos. and attachements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seat Belt - Buckle and retractor working smoothly</td>
<td></td>
</tr>
</tbody>
</table>

**OPERATIONAL CHECKS - Unusual Noises Must be Reported Immediately**

- Accelerator Linkage
- Parking Brake/Deadman – Forward and Reverse
- Steering
- Drive Control - Forward and Reverse
- Tilt Control - Forward and Back – Ensure interlocks & safety devices are in-place for lifts capable of tilting forward for transportation purposes
- Hoist & Lowering Control
- Attachment Control
- Horn
- Lights
- Back-Up Alarm
- Hour Meter
- Battery Discharge Gauge

**Inspected by:___________________________________**  

**Custodian:_______________________________________**

---

**Daily Pre-Shift Inspections are an OSHA requirement. It is recommended that you document that these inspections have been made.**

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ATTACHMENT 6-6. TYPICAL OPERATOR PRE-USE INSPECTION CHECKLIST
(sheet 2 of 2).

(GAS, LP, or DIESEL FORKLIFT)

<table>
<thead>
<tr>
<th>OK</th>
<th>VISUAL CHECKS</th>
<th>Maintenance Needed- Reported to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Periodic maintenance and inspections are current</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fluid Levels -Oil, Radiator, Hydraulic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leaks - Hydraulic Oil, Battery, Fuel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tires - Condition and pressure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forks, Top Clip retaining pin and heel - Condition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Load Backrest Extension - solid attachment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydraulic hoses, Mast chains &amp; Stops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finger guards - attached</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>Operators manual - Located on truck and legible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity Plate – attached, information matches Model &amp; Serial Nos. and attachments.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seat Belt - Buckle and retractor working smoothly</td>
<td></td>
</tr>
</tbody>
</table>

OPERATIONAL CHECKS - Unusual Noises Must be Reported Immediately

| Accelerator Linkage |                                      |
| Parking Brake – Forward and Reverse |                                      |
| Steering |                                      |
| Drive Control - Forward and Reverse |                                      |
| Tilt Control - Forward and Back – Ensure interlocks & safety devices are in-place for lifts capable of tilting forward for transportation purposes |                                      |
| Hoist & Lowering Control |                                      |
| Attachment Control |                                      |
| Horn |                                      |
| Lights |                                      |
| Back-Up Alarm |                                      |
| Hour Meter |                                      |

Inspected by: ___________________________________________

Custodian: ___________________________________________

Daily Pre-Shift Inspections are an OSHA requirement. It is recommended that you document that these inspections have been made.
ATTACHMENT 6-7. FORKLIFT TRUCKS IN HAZARDOUS (EXPLOSIVE) ATMOSPHERES

6-7.1 Hazardous Area Equipment. 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 some other identifying mark indicating approval for the intended use by a recognized national testing laboratory [e.g., Underwriters Laboratories (UL) or Factory Mutual (FM)].

6-7.2 Truck Designation. 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 Attachment 6-4, Markers to Identify Type of Industrial Truck.

6-7.3 Hazardous-Area Signs. The entrance to hazardous areas shall be posted with a sign to identify the type of forklift truck permitted (see Attachment 6-5, Building Signs for Posting at Entrance to Hazardous Areas).

6-7.4 Hazardous Area Classification. The responsible industrial safety organization shall classify hazardous locations where a powered forklift truck is to be used. Location classifications are described as follows:

   a. 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
   b. Class II—locations that are hazardous because of the presence of combustible dust
   c. 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
   d. Unclassified—locations not possessing atmospheres defined as Class I, II, or III locations.

6-7.5 Non-Hazardous Areas. The following units are not suitable for use in hazardous areas because they include only minimum safeguards against inherent fire hazards:

   a. Type D Forklifts—diesel-powered units having minimum acceptable safeguards against inherent fire hazards
   b. Type E Forklifts—electrically powered units having minimum acceptable safeguards against inherent fire and electrical shock hazards
   c. Type G Forklifts—gasoline-powered units having minimum acceptable safeguards against inherent fire hazards
   d. Type LP Forklifts—liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards
   e. Type G/LP Forklifts—gasoline- or liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards.
6-7.6 Hazardous Areas. The following units are suitable for use in hazardous areas because they are equipped with additional safeguards (i.e., special exhaust, fuel, or electrical systems) or other modifications against inherent fire hazards:

a. Type DS Forklifts—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.

b. Type DY Forklifts—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.

c. Type ES Forklifts—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.

d. Type EE Forklifts—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.

e. Type EX Forklifts—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, National Electrical Code.

f. Type GS Forklifts—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.

g. Type GS/LPS Forklifts—gasoline- or liquefied-petroleum-gas-powered units that, in addition to all the requirements for the type G/LP units, are provided with additional safeguards to the exhaust, fuel, and electrical systems.

h. Type LPS Forklifts—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.
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7.0 SHOP CRANES

7.1 SCOPE
This section applies to the construction, installation, operation, inspection, testing, maintenance, and the safe use of self-contained hydraulic and pneumatic-hydraulic shop cranes as prescribed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. Shop cranes are characterized by a pair of laterally spaced legs, an upright mast, a pivoting boom with a boom extension and hook, and a hydraulic unit. This section implements required criteria from DOE/RL-92-36, OSHA 29 CFR 1926 Subpart CC, and the following ASME Portable Automotive Service Equipment (PASE) standard.

The following criteria and the applicable national standard and/or federal specification identify the mandatory requirements for each item.

ASME PASE-Part 2 - General Requirements
  2-1 Scope and Definitions
  2-2 Design
  2-3 Product Marking and Identification
  2-4 Product Instructions and Safety Messages
  2-5 Quality Assurance
  2-6 Operation, Maintenance, and Inspection
  2-7 Related Standards
  2-8 Effective Date

Part 12 – Shop Cranes
  12.1 Scope, Classification, and Illustrations
  12.2 Design
  12.3 Safety Markings and Messages
  12.4 Design Qualification Testing
  12.5 Attachment and Adapters

7.2 GENERAL REQUIREMENTS
Contractors should access ASME via one of the following options:

- IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. To print IHS file go to http://www.ihs.com/
- Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.
- To purchase directly from ASME go to http://www.asme.org
- To view read only ASME file go to: ASME Portable Automotive Service Equipment-2014 (PASE)
- Chapter 19, OSHA 29 CFR 1926 Subpart CC
7.3 IMPLEMENTATION

Contractors shall be compliant to DOE/RL-92-36, OSHA, and the ASME PASE manufacturers’ requirements. It is the responsibility of the user of this Manual to implement all of the requirements. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Hoisting and Rigging Committee (HHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0, Interpretations, for the process to be followed when requesting an interpretation. Notify the HHRC if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current Manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user).

7.4 INCONSISTENT STANDARDS

No inconsistencies between standards have currently been identified.

7.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

Follow ASME PASE standard.

A periodic inspection tag (like the example shown below) is required in addition to the other identification requirements for each PASE.

Proof test shall never be less than minimum requirements defined in ASME PASE. A tag indicating date of load test may be affixed to the device for filed verification. See example below.

Figure 7-1 Example of Periodic Inspection Tag

![Figure 7-1 Example of Periodic Inspection Tag]

Figure 7-2 Example of a Load Test Tag

![Figure 7-2 Example of a Load Test Tag]
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8.0 WIRE ROPE

8.1 SCOPE

This section specifies inspection and replacement requirements and acceptance criteria for wire rope on mobile cranes, overhead cranes, monorail cranes, jib cranes, and hoists that are used in lifting service.

Wire rope slings are not included in this section. For wire rope slings, see Section 9.0. Wire rope that has been removed from a crane or hoist shall not be used to fabricate slings.

8.2 GENERAL REQUIREMENTS

8.2.1 Design Factors For Wire Ropes

The design factor (safety factor) is the nominal strength of the rope divided by the rated load.

8.2.1.1 Hoists and Overhead Crane Wire Ropes. On hoists and overhead cranes, the wire rope design factor is 5:1.

8.2.1.2 Mobile Crane Wire Rope. Mobile crane wire ropes have different design factors for the various ropes under both operating and boom erection conditions:

1. Operating Conditions
   a. 3.5:1 for live or running ropes (including hoist rope) that wind on drums or travel over sheaves.
   b. If rotation-resistant\(^1\) rope is used, the design factor shall be no less than 5:1. If the crane manufacturer recommends a higher design factor (example 7:1) the crane manufacturer’s recommendation shall be followed.
   c. 3:1 for boom pendants or standing ropes.

2. Under Boom Erection Conditions
   a. 3:1 for live or running ropes
   b. 2.5:1 for boom pendants or standing ropes.

8.2.2 Rotation-Resistant Rope

Use of rotation-resistant rope shall be approved by the manufacturer of the equipment on which it is used. Application of rotation-resistant rope requires special installation procedures, higher design factors, and special inspection and maintenance procedures.

---

\(^1\) The term “nonrotating” wire rope, originally referred to 19 x 7 or 18 x 7 rope. “Nonrotating” has been replaced by the term “rotation-resistant” wire rope. Many other rotation-resistant ropes, besides 19 x 7 and 18 x 7, are currently available.
8.2.3 Requirement for Independent Wire Rope Core

Overhead cranes and hoists exposed to ambient temperatures at the rope in excess of 180 °F shall use rope with independent wire rope core (IWRC). Mobile cranes shall use IWRC rope regardless of temperature.

8.3 INSPECTION REQUIREMENTS

Only inspection can determine whether or not rope must be replaced (see Table 8-1). Based on experience, and in accordance with wire rope inspection criteria in this section, a qualified rope inspector must determine the following:

1. If the rope’s existing condition presents a likelihood of failure
2. If the rate of deterioration of the rope is such that it will remain in safe condition until the next scheduled inspection by a qualified wire rope inspector.

**CAUTION:** Proper maintenance of the drums and sheaves over which ropes operate is important to rope life (e.g., worn grooves or poorly aligned sheaves can cause short service life for wire rope). If, during wire rope inspection, equipment maintenance problems are found, the inspector shall promptly notify the equipment custodian.

<table>
<thead>
<tr>
<th>Inspection type</th>
<th>Equipment type</th>
<th>Reference paragraph</th>
<th>Frequency</th>
<th>Performed by</th>
<th>Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>All</td>
<td>8.3.1</td>
<td>Each day of use</td>
<td>Operator</td>
<td>Not required</td>
</tr>
<tr>
<td>Monthly</td>
<td>Overhead and gantry, crawler locomotive and truck crane</td>
<td>8.3.2</td>
<td>Monthly</td>
<td>Wire rope inspector</td>
<td>Checklist or inspection report. Signed and dated.</td>
</tr>
<tr>
<td>Periodic</td>
<td>All</td>
<td>8.3.3</td>
<td>To meet conditions, but no less than annually. When returning to lift service</td>
<td>Wire rope inspector</td>
<td>Inspection report. Signed and dated.</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>8.3.4</td>
<td>Before service</td>
<td>Wire rope inspector</td>
<td>Inspection report. Signed and dated.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.3.1 Frequent Inspection

Running ropes should be visually inspected once each working day by the equipment operator. This visual inspection shall consist of observing any rope that can reasonably be expected to be in use during the day’s operations. These visual observations should be concerned with discovering gross damage that may be an immediate hazard, such as the following:

1. Rope distortion such as kinking, crushing, unstranding, birdcaging, main strand displacement, or core protrusion
2. Corrosion
3. Broken or cut strands.
8.3.2 Monthly Inspection

For crawler locomotive and truck cranes and for overhead and gantry cranes, a monthly inspection of running ropes shall be performed and documented by a qualified wire rope inspector. Documentation shall include the date of inspection, the signature of the person who performed the inspection and the identity of the ropes that were inspected. This documentation shall be kept readily available. A checklist near the operator’s station is recommended. This inspection does not necessitate a breakdown of the crane. For overhead and gantry cranes, lower the hook block(s) to the floor or lowest attainable position. Inspect the rope(s) from the floor and bridge walkway or trolley floor where there is a means of access. For crawler locomotive and truck cranes, position the boom and load block(s) for good access to length(s) of running rope(s) that can reasonably be expected to be used in the existing boom/jib configuration. Hydraulic booms should be fully extended.

Visually inspect running ropes for any condition that could result in an appreciable loss of strength and thus constitute a safety hazard. Some conditions that could result in an appreciable loss of strength are the following:

1. Reduction of rope diameter below nominal diameter as a result of loss of core support, internal or external corrosion, or wear of outside wires
2. A number of broken outside wires and the degree of distribution or concentration of such broken wires
3. Worn outside wires
4. Corroded or broken wires at end connections
5. Corroded, cracked, bent, worn, or improperly applied end connections
6. Severe kinking, crushing, cutting, or unstranding.

NOTE: A monthly inspection of running rope is not required if a periodic inspection of running and standing rope is accomplished during that month.

8.3.3 Periodic Wire Rope Inspection (Active Cranes and Hoists)

8.3.3.1 Periodic Inspection Intervals. A thorough inspection of running rope and standing rope shall be made at least annually or more frequently as determined by a qualified person. The inspection frequency shall be based on such factors as expected rope life, determined by experience on the particular equipment or similar equipment, severity of environment, percentage of capacity lifts, frequency of operation, and exposure to shock loads. Inspections need not be at equal calendar intervals and should be more frequent as the rope approaches the end of its useful life.

---

3 Commonly called mobile cranes, this equipment type includes crawler cranes, locomotive cranes, wheel-mounted cranes of both truck and self-propelled wheel type, and any variations thereof which retain the same fundamental characteristics.
4 The overhead and gantry crane equipment classification includes semigantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics. These cranes have trolleys and similar travel characteristics. This classification does not include hoists, monorail hoists, or jib cranes.
8.3.3.2 Inspector. Periodic wire rope inspections shall be performed by a qualified wire rope inspector (see Section 4, “Personnel Qualifications and Training Requirements”).

8.3.3.3 Inspection Area. The inspection shall cover the entire length of each rope. Only the surface wires of the rope must be inspected. No attempt should be made to open the rope. Any deterioration resulting in loss of original strength shall be documented and a determination made as to whether further use of the rope would constitute a hazard. As a minimum, ropes shall be inspected for the following:

1. Items listed for frequent wire rope inspection
2. Reduction of rope diameter below nominal diameter resulting from loss of core support, internal or external corrosion, or wear of outside wires
3. Severely corroded or broken wires at end connections
4. Severely corroded, cracked, bent, worn, or improperly applied end connections
5. Improper and insufficient rope lubrication
6. Evidence of heat damage from any source.

8.3.3.4 Sections of Rapid Deterioration. Additional care shall be taken when inspecting sections of rapid deterioration, such as the following:

1. Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited
2. Sections of the rope at or near terminal ends where corroded or broken wires may protrude.

8.3.4 Inspection of Ropes Not in Regular Use

Rope that has been idle for a period of 1 month or more due to shutdown or storage of the hoist or crane on which it is installed shall be given a thorough inspection by a qualified wire rope inspector, which shall include running and standing ropes, and be equal to a periodic inspection, as described previously. (The condition of wire rope lubricant is a key concern.) This inspection shall be completed before the equipment is returned to service.

8.3.5 Inspection of Ropes Before Returning to Lift Service

Cranes that have been used for excavation or demolition work shall have a periodic wire rope inspection before being returned to lifting service.
8.4 WIRE ROPE REPLACEMENT CRITERIA

8.4.1 Wire Rope Replacement Criteria – Overhead and Gantry Cranes, Monorail Cranes and Hoists, Overhead Hoists and Mobile Cranes

No precise rules can be given for determination of the exact time for rope replacement since many variable factors are involved. Once a rope reaches any one of the specified removal criteria, it may be allowed to operate to the end of the work shift, based on the judgment of a qualified person. The rope shall be replaced after that work shift, at the end of the day, or at the latest time prior to the equipment being used by the next work shift.

8.4.2 Wire Rope Replacement Criteria – ASME Standards

Follow the criteria in the ASME Standard for Rope Replacement.

- ASME B30.2 Overhead and Gantry Cranes
- ASME B30.4 Portal and Pedestal Cranes
- ASME B30.5 Mobile and Locomotive Cranes
- ASME B30.6 Derricks
- ASME B30.7 Base Mounted Drum Hoists
- ASME B30.8 Floating Cranes and Floating Derricks
- ASME B30.16 Overhead Hoists (Underhung)
- ASME B30.21 Lever Hoists
## 8.4.3 Wire Rope Replacement Criteria – Table

<table>
<thead>
<tr>
<th>Pertinent ASME Standard</th>
<th>Number of Broken Wires in Running Ropes</th>
<th>Number of Broken Wires in Running Ropes</th>
<th>Rotation Resistant Ropes Broken Wires</th>
<th>Standing Ropes</th>
<th>Reduction in Nominal Rope Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>B30.2</td>
<td>12 In one rope lay</td>
<td>4 In one strand of one lay</td>
<td>N/A</td>
<td>N/A</td>
<td>5%</td>
</tr>
<tr>
<td>Overhead and Gantry Cranes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B30.5</td>
<td>6 In one rope lay</td>
<td>3 In one strand of one lay</td>
<td>2 in 6 rope diameters</td>
<td>3 or more in one rope lay</td>
<td>5%</td>
</tr>
<tr>
<td>Mobile and Locomotive Cranes</td>
<td></td>
<td></td>
<td>4 in 30 rope diameters</td>
<td>2 at end connections</td>
<td></td>
</tr>
<tr>
<td>B30.16</td>
<td>6 In 6 rope diameters</td>
<td>3 in 1 strand in 6 rope diameters</td>
<td>2 in 6 rope diameters</td>
<td>N/A</td>
<td>5%</td>
</tr>
<tr>
<td>Overhead Hoists/ Underhung Hoists</td>
<td></td>
<td></td>
<td>4 in 30 rope diameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B30.21</td>
<td>6 In 6 rope diameters</td>
<td>3 in 1 strand in 6 rope diameters</td>
<td>2 in 6 rope diameters</td>
<td>N/A</td>
<td>5%</td>
</tr>
<tr>
<td>Lever Hoists</td>
<td></td>
<td></td>
<td>4 in 30 rope diameters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attention shall be given to end connections. Upon development of two broken wires adjacent to socket end connections, the rope shall be resocketed or replaced. Resocketing shall not be attempted if the resulting rope length will be insufficient for proper operation.
8.5 WIRE ROPE RECEIVING, STORAGE, AND MAINTENANCE

8.5.1 Receiving at the Work Site

When rope is received at the rigging loft, shop, or other work site it should be carefully checked for size, construction and core, to ensure that it matches the description on the tags, requisition, packing slips, purchase order, or invoice.

8.5.2 Rope Storage

If the rope is to be held for a considerable length of time (longer than 3 months) it must be protected from the elements. A dry, well-ventilated building is the proper storage place. Avoid closed, unheated, tightly sealed places. Wire rope shall not be stored in areas subject to elevated temperatures or subject to dust, grit, or a chemically laden atmosphere. If the delivery site precludes inside storage and the rope must be kept outside, the rope shall be covered with a waterproof tarp. The reel should be on a platform so as to keep it from direct contact with the ground.

8.5.3 Unreeling, Cutting, and Seizing

8.5.3.1 Unreeling. Unreeling or uncoiling of rope shall be done in a manner to avoid kinking or inducing a twist. (A rigging specialist should be consulted, if necessary.)

8.5.3.2 Cutting. Before cutting a rope, seizing should be placed on each side of the place where the rope is to be cut to prevent unlaying of the strands. (For preformed rope, one seizing each side of the cut. For nonpreformed rope, 7/8-inch diameter or smaller, two seizings on each side of cut; for larger diameter, three seizings each side of cut.)

8.5.4 Wire Rope Lubrication

8.5.4.1 Lubrication by the Rope Manufacturer. The lubrication ropes receive during manufacture is adequate only for initial storage and the early stages of the rope’s service life.

8.5.4.2 Rope Lubrication on Active Cranes and Hoists. Rope on active hoists and cranes shall be maintained in a well-lubricated condition. It is important that lubricant be applied as part of the maintenance program. The lubricant must be compatible with the original lubricant, so the rope manufacturer should be consulted. The lubricant applied shall be of the type that does not hinder visual inspection. Rope sections that are located over sheaves, or otherwise hidden during inspection and maintenance procedures, require special attention when lubricating rope.

8.5.4.3 Lubrication Frequency. This manual does not specify the time interval between lubrications. A thorough periodic inspection will indicate when lubrication is required and whether lubrication frequencies, as part of the maintenance program, must be adjusted.

8.6 REPLACEMENT ROPE

8.6.1 Rope Replacement Frequency (Recommended)

Where equipment is consistently in use, it is recommended that wire rope be given a certain length of service (e.g., several hundred operating hours or a certain number of months) and then the rope replaced regardless of its condition. This method will eliminate the risk of fatigue causing rope failure.
8.6.2 Extra-Long Rope

If a longer rope than necessary can be installed, well-defined, localized abrasion and fatigue may be dealt with without discarding the whole rope. In such a case, one end shall be cut to expose a different section of rope to the place where the deterioration occurs. (This method is most applicable to running ropes on mobile cranes.)

8.6.3 Replacement Rope as Recommended by Equipment Manufacturer

Replacement ropes shall be of a construction recommended by the rope manufacturer or the crane or hoist manufacturer (see paragraph 8.2.2, “Rotation-Resistant Rope”). Replacement rope shall be the same size, grade and construction, and have a strength rating equal to the original rope furnished or recommended by the crane or hoist manufacturer. Replacement ropes shall be manufactured by a member of the Wire Rope Technical Board or acquired from the crane or hoist manufacturer by part number. Replacement ropes shall be acquired with signed test certification indicating actual breaking strength and origin of rope. Current wire rope test reports shall be kept in the equipment history/maintenance file.

8.6.4 Terminal Ends

Terminal ends shall be prepared and socketed in the manner specified by the manufacturer of the wire rope or fitting.

8.7 REPLACEMENT ROPE INSTALLATION

8.7.1 Before Initial Load Cycle

After wire rope replacement, and before the initial load cycle, a qualified inspector shall verify the following conditions.

1. The rope attachment points to the hoist drum and dead end (if applicable) are properly installed.
2. Fasteners are properly torqued.
3. Overhead cranes and hoists will have no less than two full wraps of rope on the drum when the hoist is at the lower limit. Mobile cranes will have an adequate rope length so that neither the load nor the boom lowering will result in less than two full wraps of rope on respective drums.
4. Reeving is in accordance with the manufacturer's recommendations.

8.7.2 Initial Cycle

After rope replacement and before returning the equipment to service, it is recommended that the hoist unit be cycled from maximum down position to maximum up position eight to ten times with 10 percent to 20 percent of rated load.

8.7.3 New Rope Stretch

On equipment having multiple part lines (other than rotation-resistant wire rope) a new rope will stretch and unlay slightly, causing turns to appear in the load block. The anchorage, if not fitted to a swivel, may be disconnected, the turns removed and reconnected.
8.7.4 Verification of Fasteners

After the initial load cycle has been completed, a qualified inspector shall verify that the fasteners on drum and/or dead end have been re-torqued.

8.7.5 Documentation of Rope Replacement

A wire rope replacement checklist (Attachment 8-1 or equivalent), signed and dated by a qualified inspector, shall document proper installation of replacement rope.

8.8 QUALIFICATION OF WIRE ROPE

8.8.1 Qualification of Original Rope Supplied with New Equipment

Original rope, supplied with new equipment, is qualified for service by the inspection performed on the new equipment.

8.8.2 Qualification of Replacement Rope

A completed wire rope replacement checklist, documenting the most recently installed replacement rope (Attachment 8-1 or equivalent), signed and dated by a qualified inspector, shall be in the equipment maintenance file. In addition to inspection records in the equipment maintenance file, replacement rope shall have certification from the rope manufacturer. The manufacturer’s certification shall contain adequate information to identify the rope and should contain the following information:

1. Rope diameter (e.g., 1/2 inch)
2. Rope classification (number of strands X wires per strand) (e.g., 6 x 37)
3. Lay (e.g., right regular lay, or left lang lay)
4. Grade of wire (e.g., Improved Plow Steel, or Extra Improved Plow Steel)
5. Type of core (e.g., Independent Wire Rope Core, or Fiber Core)
6. Nominal strength (e.g., 10.7 tons)
7. Rope’s purchase order number, if known.
**ATTACHMENT 8.1 WIRE ROPE REPLACEMENT CHECKLIST - EXAMPLE**

**WIRE ROPE REPLACEMENT CHECKLIST**

<table>
<thead>
<tr>
<th>Equipment Identification and Location:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of replacement rope installation:</td>
<td></td>
</tr>
<tr>
<td>Rope Manufacturer:</td>
<td></td>
</tr>
<tr>
<td>Diameter: ____  Strands: ____  Wires/strand: ____  Lay: ____</td>
<td></td>
</tr>
<tr>
<td>Wire rope purchase order number:</td>
<td></td>
</tr>
<tr>
<td>Grade of wire: __________  Type of core: _________  Nominal strength: _________</td>
<td></td>
</tr>
</tbody>
</table>

**PRIOR TO INITIAL LOAD CYCLE**

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rope attachment points properly installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fasteners properly torqued</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record torque value applied at drum attachment: ____________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record torque value applied at dead end:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhead crane or hoist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No less than two full wraps on drum with hook at lower limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile crane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neither load nor boom lowering will result in less than two full wraps on the respective drum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reeving in accordance with manufacturer’s recommendation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INITIAL LOAD CYCLE**

| Initial load cycle performed (maximum down to maximum up position 8 to 10 times with 10% to 20% of rated load | |
| After Initial Load Cycle, re-torque impact rope attachment points (drum and dead end) | |
| Rope manufacturer’s certification placed in equipment maintenance file | |

**Comments:**

Qualified Inspector

(print name)  (signature)

Place the most recently completed form in the equipment maintenance file.
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<th>Title</th>
<th>Page</th>
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</thead>
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<td>9.5.2</td>
<td>Inspection and Testing Documentation</td>
<td>6</td>
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<td>9.5.3</td>
<td>Periodic Inspections</td>
<td>7</td>
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<tr>
<td>9.5.4</td>
<td>Periodic Inspection Record Tags</td>
<td>7</td>
</tr>
</tbody>
</table>

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- Figure 9.2 – Example of Periodic Inspection Tag ....................................................... 7
9.0 SLINGS

9.1 SCOPE

This chapter applies to the fabrication, attachment, use, inspection, and maintenance of slings used for lifting purposes. The proper and safe use of slings is governed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. This section implements required criteria from DOE/RL-92-36, and the following standards: ASME B30.9-Slings, OSHA 29 CFR-1910.184 Slings, and OSHA 29 CFR-1926.251 Rigging Equipment for Material Handling. Slings are used in conjunction with lifting equipment described in other sections of this manual. This chapter implements the following criteria and the applicable national standards and/or federal specifications that are mandatory per ASME B30.9-Slings as follows:

- Chapter 9-1 Alloy Steel Chain Slings
- Chapter 9-2 Wire Rope Slings
- Chapter 9-3 Metal Mesh Slings
- Chapter 9-4 Synthetic Rope Slings
- Chapter 9-5 Synthetic Webbing Slings
- Chapter 9-6 Polyester Round Slings

Each chapter above includes the following sections:
- Scope
- Training
- Components
- Fabrication and Configurations
- Design Factor
- Rated Load
- Proof Test Requirements
- Sling Identification
- Effects of Environment
- Inspection, Removal and Repair
- Operating Practices

9.2 GENERAL REQUIREMENTS

Contractors should access ASME via one of the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. For access contact The Hanford Technical Library, 277 University Dr, Richland, WA (372-7430). To print IHS file go to http://www.ihs.com/

2. Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.
3. To purchase standards directly from ASME go to http://www.asme.org

4. To access OSHA standards go to the following links:
   - 29 CFR-1910.184 Slings
   - 29 CFR-1926.251 Rigging Equipment for Material Handling

5. To view read only ASME file go to: ASME B30.9-2014-Slings

9.3 IMPLEMENTATION

Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36 and the Slings manufacturers’ requirements. It is the responsibility of the user of this manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Hoisting Rigging Committee (HHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0 for process to be followed when requesting an interpretation. Notify the Hanford Site Hoisting and Rigging Committee if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user).

9.4 INCONSISTENT STANDARDS

OSHA 29 CFR 1910.184 Table N-184-4 specifies deductions from capacities shall be taken if a D/d ratio of 20:1 or greater for 6 x 36 and 6 x 19 Improved Plow Steel Grade Wire Rope with an IWRC is not maintained. ASME B30.9 specifies deductions from capacities shall be taken on a mechanical spliced sling if a D/d ratio of 25:1 or less is obtained for 6 x 36 and 6 x 19 Extra Improved Plow Steel Grade Wire Rope with an IWRC.

Therefore, the requirements of the more restrictive ASME B30.9 shall be followed, but in no case shall wire rope slings be subjected to a D/d ratio of less than 1:1.
9.4.1 D/d Ratio

When a wire rope is bent around any sheave or other object there is a loss of strength due to this bending action. As the D/d ratio becomes smaller this loss of strength becomes greater and the rope becomes less efficient. This curve relates the efficiency of a rope diameter to different D/d ratios. This curve is based on static loads and applies to 6-strand class 6x19 and 6x37 wire rope.

**Effects on Wire Rope Slings**

The D/d Ratio is the ratio of the diameter around which the sling is bent divided by the body diameter of the sling. Example: A 1/2" diameter wire rope is bent around a 10" diameter pipe; the D/d Ratio is 10" divided by 1/2" = D/d Ratio of 20:1. This ratio has an effect on the rated capacity of slings.

Reference ASME B30.9 for Sling D/d Ratio (Alloy Steel Chain, Wire Rope, Synthetic Rope)

9.4.2 Temperature Limitations

The working temperature limits listed below shall not be exceeded without the manufacturer’s written approval.
### SLING TYPE

<table>
<thead>
<tr>
<th>SLING TYPE</th>
<th>TEMPERATURE LIMIT</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synthetic Rope Slings</td>
<td>-40°F to 194°F</td>
<td>ASME B30.9</td>
</tr>
<tr>
<td>Synthetic web and round slings</td>
<td>-40°F to 194°F</td>
<td>ASME B30.9</td>
</tr>
<tr>
<td>Wire rope slings</td>
<td>Fiber core -40°F to +180°F</td>
<td>ASME B30.9</td>
</tr>
<tr>
<td></td>
<td>IWRC -40°F to +400°F</td>
<td>ASME B30.9</td>
</tr>
<tr>
<td>Alloy steel chain slings</td>
<td>-40°F to +400°F</td>
<td>ASME B30.9</td>
</tr>
<tr>
<td>Metal mesh slings</td>
<td>-20°F to +550°F</td>
<td>ASME B30.9</td>
</tr>
<tr>
<td>Elastometer coated Slings</td>
<td>0°F to 200°F</td>
<td>ASME B30.9</td>
</tr>
</tbody>
</table>

Note: Some synthetic yarns do not retain their published breaking strength above 140°F. The manufacturer should be consulted for the temperature range of slings made from other than yarns identified in ASME B30.9.

### 9.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

#### 9.5.1 Prohibited Sling Applications

Slings 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.

#### 9.5.1.1 Pre-Use Inspections

Prior to use, slings shall be inspected and verified that the periodic inspection is current.

#### 9.5.1.2 Sling Identification

Slings used at Hanford shall have permanently affixed and legible identification markings as prescribed by the manufacturer and that indicate the recommended safe working load for the type(s) of hitch (s) used the angle upon which it is based, and the number of legs if more than one.

#### 9.5.2 Inspection and Testing Documentation

##### 9.5.2.1 Proof Testing

All slings shall be proof tested (load tested) prior to initial use by the manufacturer or user. Proof test date shall be marked on the sling. Proof test shall never be less than minimum requirements defined in ASME B30.9. A tag indicating date of load test may be affixed to the device for filed verification. See example in Figure 9-1.
9.5.3 Periodic Inspections

The periodic inspection for all sling types used at Hanford shall be documented by any one of the following methods:

1. Mark a serial number on the sling and maintain inspection records by serial numbers.
2. Institute a comprehensive marking program (such as color coding) to indicate when the next inspection is required.
3. Mark each sling with a tag that indicates when the next periodic inspection is required. This tag becomes the record.

9.5.4 Periodic Inspection Record Tags

A periodic inspection tag (like the example shown below) is required in addition to the other sling identification requirements for each sling type prescribed by the applicable ASME B30.9 chapter.
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10.0 RIGGING HARDWARE

10.1 SCOPE

This chapter provides requirements that apply to the construction, installation, operation, inspection, and maintenance of detachable rigging hardware used for lifting purposes in conjunction with equipment described in other sections of this manual. This hardware includes shackles, links, rings, swivels, turnbuckles, eyebolts, hoist rings, wire rope clips, wedge sockets, and rigging blocks. The proper and safe use of rigging hardware is governed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. This section implements required criteria from DOE/RL-92-36 and the following standards: ASME B30.26-Rigging Hardware and OSHA 29 CFR 1926.251-Rigging Equipment for Material Handling.

This chapter implements the following criteria and the applicable national standards and/or federal specifications that are mandatory per ASME B30.26-Rigging Hardware:

- Chapter 26.1 Shackles – Selection, Use, and Maintenance
- Chapter 26.2 Adjustable Hardware – Selection, Use, and Maintenance
- Chapter 26.3 Compression Hardware – Selection, Use, and Maintenance
- Chapter 26.4 Links, Master Link Subassemblies, Rings, and Swivels
- Chapter 26.5 Rigging Blocks – Selection, Use, and Maintenance
- Chapter 26.6 Detachable Load-Indicating Devices – Selection, Use, and Maintenance

Each chapter above includes the following sections:
- Scope
- Types, Materials, and Assembly (26.3)
- Design Factor
- Rated Loads
- Proof Test
- Identification
- Effects of Environment
- Training
- Inspection, Repair, and Removal, Calibration (26.6)
- Operating Practices

10.2 GENERAL REQUIREMENTS

Contractors should access ASME via one of the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. For access contact The Hanford Technical Library, 277 University Dr, Richland, WA (372-7430). To print IHS file go to http://www.ihs.com/

2. Thomson Rueters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.
3. To purchase standards directly from ASME go to http://www.asme.org

4. To access the OSHA standard go to the following link:

- 29 CFR 1926.251 Rigging Equipment for Material Handling

- To view read only ASME file go to: ASME B30.26-2015-Rigging Hardware

10.3 IMPLEMENTATION

Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36 and the Rigging Hardware manufacturers’ requirements. It is the responsibility of the user of this manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Site Hoisting Rigging Committee (HSHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0 for process to be followed when requesting an interpretation. Notify the Hanford Site Hoisting and Rigging Committee if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user).

10.4 INCONSISTENT STANDARDS

1. ASME B30-26-1.5.2 Shackle Pin Identification specifies each shackle pin shall have durable markings by the manufacturer to show the name or trademark of manufacturer and the grade, material type, or load rating.

2. OSHA does not address stamped identification of shackle pins.

Therefore, follow the requirements of ASME B30-26-1.5.2.
10.5 TEMPERATURE LIMITATIONS

The working temperature limits listed for carbon steel shall not be exceeded without the manufacturer’s written approval. For hardware manufactured from other materials consult manufacturer.

<table>
<thead>
<tr>
<th>HARDWARE TYPE</th>
<th>TEMPERATURE LIMIT</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Rope Clips</td>
<td>-40°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Wedge Sockets</td>
<td>-4°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Shackles</td>
<td>-40°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Turnbuckles</td>
<td>-40°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Eyebolts</td>
<td>+30°F to +275°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Eye Nuts</td>
<td>-40°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Swivel Hoist Rigs</td>
<td>-20°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Detachable Load Indicating Devices</td>
<td>+14°F to +104°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Links, Rings and Swivels</td>
<td>-40°F to +400°F</td>
<td>ASME B30.26</td>
</tr>
<tr>
<td>Rigging Blocks</td>
<td>0°F to +150°F</td>
<td>ASME B30.26</td>
</tr>
</tbody>
</table>

10.6 HANFORD SPECIFIC REQUIREMENTS

10.6.1 Manufacturer-Installed Lift Points

All manufacturer-installed lift points shall be inspected and evaluated by a qualified person before use for cracks, deformation, excessive wear, or damage. When questions arise regarding the use of manufacturer-installed lift points, the equipment custodian or cognizant engineer shall be consulted.

10.6.2 Proof Testing

Rigging hardware used in critical lifts shall be proof tested (load tested) in accordance with the requirements of ASME B30.26, and tagged or marked with proof test date. Proof test shall never be less than minimum requirements defined in ASME B30.26. See Figure 10.1 example.

Dynamometers and Precision Load-Position Devices (hydro-set) shall have the following requirements.

a. Load test at maximum capacity.

b. Shall have a minimum design factor of 4:1 based on yield of strength of materials.

c. Shall be load tested to 100% of rated capacity

d. Shall be calibrated per the contractor’s requirements at least annually.
Figure 10.1 Load test tag used for date record
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11.0 BELOW-THE-HOOK LIFTING DEVICES

11.1 SCOPE

This chapter provides requirements that apply to the marking, construction, installation, inspection, testing, maintenance, and operation of Below-the-Hook (BTH) Lifting Devices for attaching loads to various hoists. The proper and safe use of Below-the-Hook Lifting Devices is governed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. This section implements required criteria from DOE/RL-92-36 and the following standards: ASME B30.20-Below-the-Hook Lifting Devices, ASME BTH-1-Design of Below-the-Hook Lifting Devices, ANSI N14.6 Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More, and OSHA 29 CFR 1926.251 Rigging Equipment for Material Handling.

This chapter implements the following criteria and the applicable national standards and/or federal specifications that are mandatory per ASME B30.20-Below-the-Hook Lifting Devices, ASME BTH-1-Design of Below-the-Hook Lifting Devices, and ANSI N14.6:

ASME B30.20-Below-the-Hook Lifting Devices

- Chapter 20-0 Scope, Definitions, Personnel Competence, Translations and References
- Chapter 20-1 Structural and Mechanical Lifting Devices
- Chapter 20-2 Vacuum Lifting Devices
- Chapter 20-3 Close Proximity Operated Lifting Magnets
- Chapter 20-4 Remotely Operated Lifting Magnets
- Chapter 20-5 Scrap and Material Handling Grapples

Each ASME B30.20 chapter above includes the following sections:

- Scope
- Marking, Construction, and Installation
- Inspection, Testing, and Maintenance
- Operation
- Instruction Manuals

ASME BTH-1-Design of Below-the-Hook Lifting Devices

- Chapter 1 Scope, Definitions, and References
- Chapter 2 Lifter Classifications
- Chapter 3 Structural Design
- Chapter 4 Mechanical Design
- Chapter 5 Electrical Components

ANSI N14.6-Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More.

1. Scope
2. Normative References
3. Definitions
4. Design
5. Fabrication
6. Acceptance Testing, Maintenance, and Assurance of Continuing Compliance
7. Quality Assurance
11.2 GENERAL REQUIREMENTS
Contractors should access ASME via one of the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/The contractor must have paid for access to the specific standard. To print IHS files go to http://www.ihs.com/
2. Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.
3. To purchase standards directly from ASME go to http://www.asme.org/
4. To access OSHA standards go to the following links
5. To view read only ASME files go to:
   - ASME B30.20-2013-Below-the-Hook Lifting Devices
   - ASME BTH-1-2014-Design of Below-the-Hook Lifting Devices

11.3 IMPLEMENTATION
Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36 and the Below-the-Hook Lifting Device manufacturers’ requirements. It is the responsibility of the user of this manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Hoisting Rigging Committee (HHRC) representative or send an email to ^Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0 for process to be followed when requesting an interpretation. Notify the Hanford Site Hoisting and Rigging Committee if any inconsistent standards are identified.

In accordance with design requirements, the responsible engineer may invoke ANSI N14.6 to a below the-hook device. ANSI N14.6 invokes criteria similar to, but not identical to ASME B30.20 and ASME BTH-1.

11.4 INCONSISTENT STANDARDS
No inconsistencies between standards currently identified.

11.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES
Below-the-hook lifting devices used at Hanford shall be tagged by any one of the following methods to indicate next periodic inspection due date.

a. Institute a comprehensive marking program (such as color coding) to indicate when the next inspection is required.

b. Mark each below-the-hook lifting device with a tag that indicates when the next periodic inspection is required.
11.5.1 Load Testing
ASME B30.20 states load testing should be performed for Below-the-hook lifting devices. All new, repaired or altered Below-the-hook (BTH) lifting devices used at Hanford shall be load and operational tested to the provisions of ASME B30.20. The testing shall be documented as defined in ASME B30.20 and the BTH device tagged with the test date (for manufacturer load tested BTH devices use in-service date).

11.5.2 Load-Test Weight
The load-test weight or testing device should be within a tolerance of (+0 percent, -5 percent) and shall be traceable to a recognized standard or verified by engineering calculations. Load test shall never be less than minimum requirements defined in the applicable ASME B30 standard. Any one of the following options will meet this requirement:

1. Use a calibrated load-measuring device during the load test.
2. Determine the test load with a calibrated load-measuring device before the test.
3. Calculate the test load based on known unit weights and dimensions of the test fixture. Dimensions and calculations must be checked (signed and dated) by a qualified engineer and determined to be accurate within tolerance (+0 percent, -5 percent)

11.5.3 Load-Test Tag
After the test is completed, the proof test (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 placed in the lifting device maintenance file. A tag indicating date of load test may be affixed to the device for filed verification.

Figure 11.5.3 – Example of a Load Test Tag

Inspection Due
10/2017

Load Test Date
10/30/2017
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12.0 HOISTS

12.1 SCOPE

This chapter applies to the marking, construction, installation, inspection, testing, maintenance and operation of the following:

- Overhead Hoists (underhung)
- Hand chain-operated chain hoists and electric and air-powered chain and wire rope hoists
- Lever Hoists
- Ratchet and pawl and friction brake type manually lever operated chain, wire rope, and web strap hoists used for lifting, pulling, and tensioning applications

The proper and safe use of hoists is governed by the American Society of Mechanical Engineers (ASME) standards and Occupational Safety and Health Administration (OSHA) regulations. This section implements required criteria from DOE/RL-92-36 and the following standards: ASME B30.16-Overhead Hoists (Underhung), and ASME B30.21-Lever Hoists.

The responsible engineer may invoke ASME NUM-1, Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type), for cranes used at nuclear facilities. ASME NUM-1 applies to the design, manufacture, testing, inspection, shipment, storage, and erection of monorails and hoists (with bridge, trolley, or hoist of the underhung type).

This chapter implements the following criteria and the applicable national standards and/or federal specifications that are mandatory requirements for each item.

- ASME B30.16-Overhead Hoists (Underhung)
  1. Marking, Construction, and Installation, Chapter 16-1
  2. Inspection and Testing, Chapter 16-2
  3. Operator Training and Operation, Chapter 16-3
  4. Maintenance Training and Maintenance, Chapter 16-4

- ASME B30.21-Lever Hoists (NOTE: Each chapter specifies marking, construction, inspection, testing, maintenance, and operation criteria)
  1. Construction and Installation, Chapter 21-1
  2. Inspection and Testing, Chapter 21-2
  3. Operation and Operator Training, Chapter 21-3
  4. Maintenance and Maintenance Training, Chapter 21-4

12.2 GENERAL REQUIREMENTS

Contractors should access ASME via one of the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. To print IHS file go to http://www.ihs.com/

2. Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.

3. To purchase standards directly from ASME go to http://www.asme.org
4. To access OSHA standards go to the following links:
   - 29 CFR 1910.179 Overhead and Gantry Cranes
   - 29 CFR 1926.554 Overhead Hoists

5. To view read only ASME files go to:
   - ASME B30.16-2012-Overhead Hoists (Underhung)
   - ASME B30.21-2014-Lever Hoists

12.3 IMPLEMENTATION
Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36, and the hoist or jib crane or monorail manufacturers’ requirements. It is the responsibility of the user of this manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Hoisting and Rigging Committee (HHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0, Interpretations, for the process to be followed when requesting an interpretation. Notify the HHRC if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within one year.

12.4 INCONSISTENT STANDARDS
No inconsistencies between standards are currently identified.

12.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

**CAUTION:** Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing, can be securely braced, or can be supported substantially by some other means that would prevent the load from moving. Some loads being lifted and set in place may require special handling control measures such as inspecting, landing, setting, or controlling the load, that may require personnel to position their hands or other body parts under the load when no other method is feasible. These special handling control activities MUST BE APPROVED by management and industrial safety PRIOR TO BEING PERFORMED.

12.5.1 Lever Hoists

**NOTE:** Wire rope ratchet and pawl lever-operated hoists are not recommended for use in lifting service at Hanford. If wire rope ratchet and pawl lever-operated hoists are used they shall comply with requirements of ASME B30.21.
12.5.2 Load-Test Weight
The load-test weight should be within a tolerance of +0 %, -5 % and shall be traceable to a recognized standard or verified by calculations. Load tests shall never be less than minimum requirements defined in the applicable ASME Standard. Any one of the following options will meet this requirement:

1. Use a calibrated (+0 percent, -5 percent) load-measuring device during the load test.
2. Determine the test load with a calibrated load-measuring device before the test.
3. Calculate the test load based on known unit weights and dimensions of the test fixture.
   Dimensions and calculations shall be checked (signed and dated) by a qualified engineer and determined to be accurate within tolerance (+0 percent, -5 percent).

12.5.2.2 Load-Test Report
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 placed in the maintenance file.

12.5.3 Maintenance Files
The maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluation, and repair of the equipment. The file may be centrally located or proportioned into satellite holding areas. The methods selected for establishing adequate information retention and retrieval shall be determined by the equipment custodian, who is the responsible person for ensuring that a safe and reliable maintenance program is in place.

12.5.3.1 Intent of Maintenance Files
The 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. Inspection records should be retained in a format and location that allows easy accessibility. Maintenance file information should provide a source for comparing existing and past conditions to determine whether existing conditions show a trending pattern of wear, deterioration, or other similar factors that may compromise safe, continued use of the equipment. Length of record retention shall be determined by the equipment custodian’s established maintenance program.

12.5.3.2 Maintenance File Contents
Maintenance files shall contain the following documentation, as applicable:

1. Periodic inspection records
2. Load test reports
3. Documentation of altered, replaced, or repaired load-sustaining parts
4. Records of special inspections on safety-related items such as brakes, hooks, ropes, hydraulic/pneumatic cylinders, and hydraulic/pneumatic pressure relief valves
5. Copies of waivers, exemptions, hostile environment plans, or similar documentation applicable to the equipment (to include manufacturer’s safety bulletins, safety alerts, and product recall information)
6. Documentation for replacement ropes (see Chapter 8.0, “Wire Rope”)
7. Wire rope manufacturer’s certification for replacement ropes
12.5.3.3 Periodic Inspection Tag

Hoists used at Hanford shall be tagged by any one of the following methods to indicate the next periodic inspection due date. See example in Figure 12.1.

1. Institute a comprehensive marking program (such as color coding) to indicate when the next inspection is required.
2. Mark each hoist with a tag that indicates when the next periodic inspection is required.

12.5.3.4 Load-Test Tag (Proof Test)

Maintenance files contain the proof test (load test) report for the hoist. Proof tests shall never be less than minimum requirements defined in the ASME B30 standards. A tag indicating date of load test may be affixed to the device for field verification. See example in Figure 12.2 below.

Figure 12.1: Example of Periodic Inspection Tag

Figure 12.2: Example of a Load Test Tag
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13.0 OVERHEAD AND GANTRY CRANES; CRANES AND MONORAILS

13.1 SCOPE

This chapter applies to the marking, construction, installation, inspection, testing, maintenance and operation of the following overhead and gantry cranes, including semi-gantry, cantilever gantry, wall cranes, bridge cranes, monorail and jib cranes, and others having the same fundamental characteristics. These cranes may be top-running, under-running, single- or double-girder. 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.

The proper and safe use of overhead gantry cranes, monorail and jib cranes is governed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. OSHA 29 CFR 1910.179 Overhead and Gantry Cranes. This section implements required criteria from DOE/RL-92-36 Hanford Site Hoisting and Rigging Manual and the following standards:

- ASME B30.2-Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
- ASME B30.17-Cranes and Monorails (with Underhung Trolley or Bridge)
- OSHA 29 CFR 1910.179 - Overhead and Gantry Cranes
- OSHA 29 CFR 1926 Subpart CC Overhead and Gantry Cranes (only applies to temporarily installed cranes)

The responsible engineer may invoke Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder) ASME NOG-1 for crane used at nuclear facilities. ASME NOG-1 applies to the design, manufacture, testing, inspection, shipment, storage, and erection of overhead and gantry cranes (Top Running Bridge, Multiple Girder).

The responsible engineer may invoke Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type) ASME NUM-1 for cranes used at nuclear facilities. ASME NUM-1 applies to the design, manufacture, testing, inspection, shipment, storage, and erection of monorails and hoists (with Bridge or Trolley or Hoist of the Underhung Type).

This section implements the following criteria and the applicable national standards and/or federal specifications that are mandatory requirements for each item.

- ASME B30.2-Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist):
  1. General Construction and Installation, Chapter 2-1
  2. Inspection and Testing, Chapter 2-2
  3. Operator Training and Operation, Chapter 2-3
  4. Maintenance Training and Maintenance, Chapter 2-4

- ASME B30.17-Cranes and Monorails (with Underhung Trolley or Bridge):
  1. General Construction and Installation Chapter 17-1
  2. Inspection and Testing, Chapter 17-2
3. Operator Training and Operation 17-3
4. Maintenance Training and Maintenance 17-4

13.2 GENERAL REQUIREMENTS

Contractors should access requirements via the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. To print IHS file go to http://www.ihs.com/

2. Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.

3. To purchase standards directly from ASME go to http://www.asme.org

4. To access OSHA 29 CFR 1910.179, Overhead and Gantry Cranes, go to the following link:

5. To access OSHA 29 CFR 1926, Subpart CC, refer to either of the following:
   - Chapter 19, OSHA 29 CFR 1926, Subpart CC

6. To view read only ASME files go to:
   - ASME B30.2-2011 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
   - ASME B30.17-2015- Cranes and Monorails (with Underhung Trolley or Bridge)

13.3 IMPLEMENTATION

Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36, and the overhead, or gantry crane, jib crane or monorail manufacturers’ requirements. It is the responsibility of the user of this Manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Site Hoisting and Rigging Committee (HHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0 for process to be followed when requesting an interpretation. Notify the Hanford Site Hoisting and Rigging Committee (HHRC) if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within the current manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within 1 year.

13.4 INCONSISTENT STANDARDS

No inconsistencies between standards are currently identified
13.5  HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

CAUTION: Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing, can be securely braced, or can be supported substantially by some other means that would prevent the load from moving. Some loads being lifted and set in place may require special handling control measures such as inspecting, landing, setting, or controlling the load, that may require personnel to position their hands or other body parts under the load when no other method is feasible. These special handling control activities MUST BE APPROVED by management and industrial safety PRIOR TO BEING PERFORMED.

13.5.1  Load-Test Weight

The load-test weight should be within a tolerance of +0 percent, -5 percent and shall be traceable to a recognized standard or verified by engineering calculations. Load tests shall never be less than minimum requirements defined in the applicable ASME Standard. Any one of the following options will meet this requirement:

- Use a calibrated (+0 percent, -5 percent) load-measuring device during the load test
- Determine the test load with a calibrated load-measuring device before the test
- Calculate the test load based on known unit weights and dimensions of the test fixture
- Dimensions and calculations have been checked (signed and dated) by a qualified engineer and determined to be accurate within tolerance (+0 percent, -5 percent)

13.5.2  Load-Test Report

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 placed in the crane maintenance file.

13.5.3  Crane Maintenance Files

The crane maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluation, and repair of the equipment. The file may be centrally located or proportioned into satellite holding areas. The methods selected for establishing adequate information retention and retrieval shall be determined by the equipment custodian, who is the responsible person for ensuring that a safe and reliable maintenance program is in place.

13.5.3.1  Intent Of Maintenance Files

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. 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. Length of record retention shall be determined by the equipment custodian’s established maintenance program.

13.5.3.2  Maintenance File Contents

Maintenance files shall contain the following documentation, as applicable:

1. Periodic inspection records
2. Load test reports
3. Documentation of altered, replaced, or repaired load-sustaining parts
4. Records of special inspections on safety-related items such as brakes, hooks, ropes, hydraulic/pneumatic cylinders, and hydraulic/pneumatic pressure relief valves
5. Copies of waivers, exemptions, hostile environment plans, or similar documentation applicable to the equipment (to include manufacturer’s safety bulletins, safety alerts, and product recall information)
6. Documentation for replacement ropes (see Chapter 8.0, “Wire Rope”)
7. Wire rope manufacturer’s certification for replacement ropes

13.5.3.3 Periodic Inspection Tag

Cranes used at Hanford shall be tagged by any one of the following methods to indicate the next periodic inspection due date. See example in Figure 13.1.

1. Institute a comprehensive marking program (such as color coding) to indicate when the next inspection is required.
2. Mark each crane with a tag that indicates when the next periodic inspection is required.

13.5.3.4 Load –Test Tag (Proof Test)

Maintenance files contain the proof test (load test) report for the crane. Proof tests shall never be less than the minimum requirements defined in the ASME B30 standards. A tag indicating date of load test may be affixed to the device for filed verification. See example in Figure 13.2 below.

Figure 13.1: Example of Periodic Inspection Tag

Figure 13.2: Example of a Load Test Tag

See Attachment 13.1 on the next page for a Sample Overhead Crane Daily Inspection Checklist.
**ATTACHMENT 13.1 - SAMPLE OVERHEAD CRANES DAILY INSPECTION CHECKLIST**

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>N/A</th>
<th>OK</th>
<th>FAULTY</th>
<th>COMMENTS</th>
</tr>
</thead>
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<tr>
<td>Main Hoist</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Push Buttons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sounds Normal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement Smooth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brakes Positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Limit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Limit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper and Lower Blocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheaves</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rope and Connections</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper Drum Spooling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hooks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Hoist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Pushbuttons</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Sounds Normal</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Movement Smooth</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Brakes Positive</td>
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</tr>
<tr>
<td>Upper Limit</td>
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<td></td>
</tr>
<tr>
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14.0 MOBILE CRANES

14.1 SCOPE

This chapter applies to the construction and characteristics, inspection, testing, maintenance, and operation of crawler cranes, locomotive cranes, wheel-mounted cranes, and other crane types that retain the same fundamental characteristics. This scope includes only cranes of the above type that are powered by internal combustion engines or electric motors. The proper and safe use of these crane types is governed by the American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. This chapter implements required criteria from DOE/RL-92-36 and the applicable national standards and/or federal specifications that are mandatory per ASME B30.5-Mobile and Locomotive Cranes, OSHA 29 CFR 1910.180 Crawler locomotive and truck cranes, and OSHA 29 CFR 1926 Subpart CC, as follows:

14.2 GENERAL REQUIREMENTS

Contractors should access requirements via the following options:

   The contractor shall have paid for access to the specific standard. To print IHS files go to http://www.ihs.com/

2. Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.

3. To purchase standards directly from ASME go to http://www.asme.org

4. To access OSHA standards go to the following links
   - 29 CFR 1926.1400 Subpart CC, see Chapter 19, OSHA 29 CFR 1926 Subpart CC, or go to the following link: http://www.osha.gov/doc/cranesreg.pdf

5. To view read only ASME file go to:
   - ASME B30.5-2014-Mobile and Locomotive Cranes

14.3 IMPLEMENTATION

Contractors shall be compliant to OSHA, ASME, DOE/RL-92-36, and the mobile or locomotive crane manufacturers’ requirements. It is the responsibility of the user of this manual to implement all of the requirements from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements. ASME standards provide the most comprehensive information. Users should contact a Hanford Site Hoisting and Rigging Committee (HSHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0, Interpretations, for process to be followed when requesting an interpretation. Notify the HHRC if any inconsistent standards are identified.

It is not the intent of this manual to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the
requirements within the current manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within one year.

14.4 INCONSISTENT STANDARDS

The Hanford Hoisting and Rigging Manual (HHRM) Chapter 2, Responsibilities, delineates responsibilities to personnel and organizations involved in hoisting and rigging (H&R) as does ASME B30.5. The HHRM will take precedence over ASME B30.5. If the responsibility is not covered or assigned in the HHRM then ASME B30.5 applies.

14.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

Follow ASME B30.5 requirements and the following Hanford requirements:

- Direction provided in the Freight Container Lifting Standard in the Attachment chapter of this Manual when lifting freight containers and/or Conex boxes.
- Directions provided in the Attachment chapter of this manual titled Lifting Requirements for Concrete Blocks when lifting concrete blocks (e.g., ecology, landscaping blocks).
- Fall protection requirements as specified in DOE-0346, Hanford Site Fall Protection Program, when performing assembly/disassembly, maintenance, repair, or inspection of mobile cranes.
- Electrical safety requirements as specified in DOE-0359, Hanford Site Electrical Safety Program, when operating mobile cranes near overhead lines.
- When working near transmitter/communication towers where the equipment is close enough for an electrical charge to be induced in the equipment or materials being handled, the transmitter shall be de-energized or the following precautions shall be taken:
  - The equipment shall be provided with an electrical ground
  - If tag lines are used, they shall be non-conductive

14.5.1 CAUTION: Ground and Bearing-Pressure Considerations

It is important to ensure that no underground installations exist that could be compromised, such as electrical vaults, conduit banks, tanks, and piping. When crane load foundations and bearing pressure are a concern to crane stability and underground installation integrity, site utility layout, crane manufacturer’s ground-loading information, crane configuration, and load and travel path information shall be evaluated and analyzed by a qualified person. The qualified person shall determine if ground scans, soil stability tests, and structural analysis of underground structures are necessary. If analysis is performed, a documented plan to ensure crane stability and integrity of underground installations shall be provided to the supervisor of the lift operation and discussed with involved or affected personnel.

14.5.1.1 Ground Conditions

The equipment shall not be assembled or used unless ground conditions are firm, drained, and graded to a sufficient extent so that, in conjunction (if necessary) with the use of supporting materials, the equipment manufacturer’s specifications for adequate support and degree of level of the equipment are met. The requirement for the ground to be drained does not apply to marshes/wetlands.
The controlling entity shall:

1. Ensure that ground preparations necessary to meet the requirements in paragraph (b) of this section are provided.

2. Inform the user of the equipment and the operator of the location of hazards beneath the equipment set-up area (such as voids, tanks, utilities) if those hazards are identified in documents (such as site drawings, as-built drawings, and soil analyses) that are in the possession of the controlling entity (whether at the site or off-site) or the hazards are otherwise known to that controlling entity.

If there is no controlling entity for the project, the above requirement shall be met by the employer that has authority at the site to make or arrange for ground preparations needed to meet ground condition requirements.

If the assembly/disassembly (A/D) director or the operator determines that ground conditions do not meet the requirements, that person’s employer shall have a discussion with the controlling entity regarding the ground preparations that are needed so that, with the use of suitable supporting materials/devices (if necessary), the ground conditions requirements can be met.

This section does not apply to cranes designed for use on railroad tracks when used on railroad tracks that are part of the general railroad system of transportation that is regulated pursuant to the Federal Railroad Administration under 49 CFR part 213 and that comply with applicable Federal Railroad Administration requirements.

14.5.2 Operating Cranes near Energized Transmitters or Electrical Power Lines

Requirements for operating cranes near energized transmitters or electrical power lines can be found in DOE-0359, Hanford Site Electrical Safety Program, Section 5.12, Mobile Cranes Operating near Energized Overhead Lines.

14.5.3 Adverse Weather

Adverse weather conditions such as, but not limited to wind, wind gusts, rain, snow, and extreme temperatures, that may inhibit the operator’s or the equipment’s ability to safely handle loads, shall be evaluated by supervision and the crane operator prior to any lifting operation. Limitations and conditions imposed by the equipment manufacturer for adverse weather shall be implemented. Mobile crane operations shall be suspended when lightning is within 50 miles of the work location, as determined by the Hanford Meteorological Station. The Hanford Meteorological station can be contacted at (509) 373-2716.

14.5.4 On-Rubber and Pick-and-Carry Operations

Mobile crane pick-and-carry and on-rubber operations may be performed at Hanford when the crane manufacturer has an approved operating chart for that specific purpose. Manufacturer’s requirements and conditions for on-rubber or pick-and-carry pre-operational checks shall be followed, such as, but not limited to, axle oscillation lockout system pre-checks and proper tire inflation validation. This information can be found in the operators or crane maintenance service manual provided with the crane.
These requirements shall be addressed in the work planning process or other implementing documents and addressed in pre-job meetings.

### 14.5.5 Multiple Load Line Operation

Multiple load line operation shall only be permitted when the equipment and procedures required by the crane manufacturer or qualified person are applied. This information may be found in the operator’s service manual provided with the crane. These requirements shall be addressed in the work planning process or other implementing documents and addressed in pre-job meetings. Read ASME B30.5-3.2.3.

### 14.5.6 Outrigger Lift-Off

Mobile crane outrigger lift-off may occur under certain loaded conditions when working within the limits of the load chart. If this condition has not been addressed in the planning process and a pre-job meeting, operations shall be stopped and a qualified person shall be consulted prior to continuing operations.

### 14.5.7 Rigging Requirements

**Caution:** Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing, can be securely braced, or can be supported substantially by some other means that would prevent the load from moving. Some loads being lifted and set in place may require special handling control measures such as inspecting, landing, setting, or controlling the load, that may require personnel to position their hands or other body parts under the load when no other method is feasible. These special handling control activities MUST BE APPROVED by management and industrial safety PRIOR TO BEING PERFORMED.

### 14.5.8 Swing Radius–Pinch Point Clearance and Swing Radius Hazards

When the crane is in operation, maintain a minimum clearance of 30 inches (76 centimeters) between the swing radius of the crane superstructure or counterweights and any stationary object.

**Swing radius hazards**

1. The requirements of this section apply where there are accessible areas in which the equipment’s rotating superstructure (whether permanently or temporarily mounted) poses a reasonably foreseeable risk of:
   a. Striking and injuring an employee; or
   b. Pinching/crushing an employee against another part of the equipment or another object.

2. To prevent employees from entering these hazard areas, the employer shall:
   a. Train each employee assigned to work on or near the equipment (“authorized personnel”) in how to recognize struck-by and pinch/crush hazard areas posed by the rotating superstructure.
   b. Erect and maintain control lines, warning lines, railings, or similar barriers to mark the boundaries of the hazard areas.

**EXCEPTION:** When the employer can demonstrate that it is neither feasible to erect such barriers on the ground nor on the equipment, the hazard areas shall be clearly marked by a combination of warning signs (such as “Danger – Swing/Crush Zone”) and high visibility
3. Protecting employees in the hazard area
   a. Before an employee goes to a location in the hazard area that is out of view of the operator, the employee (or someone instructed by the employee) shall ensure that the operator is informed that he/she is going to that location.
   b. Where the operator knows that an employee went to a location covered by paragraph 1 above, the operator shall not rotate the superstructure until the operator is informed in accordance with a prearranged system of communication that the employee is in a safe position.

Where any part of a crane/derrick is within the working radius of another crane/derrick, the controlling entity shall institute a system to coordinate operations. If there is no controlling entity, the employer(s) shall institute such a system.

14.5.9 Load Test Weight

The weight of the test loads used on site shall be accurately known within a tolerance of +0 percent to -5 percent, traceable to a recognized standard, or verified by engineering calculations.

NOTE: The Crane Load Stability Test Code, SAE J765, describes a test on new cranes done by the crane manufacturer or the manufacturer’s testing agency.

Load tests shall never be less than the minimum requirements defined in applicable ASME B30.5 Standard. Any one of the following options will meet this requirement:

1. Use a calibrated (+0 percent, -5 percent) load-measuring device during the load test.

2. Determine the test load with a calibrated load-measuring device before the test.

3. Calculate the test load based on known unit weights and dimensions of the test fixture. Dimensions and calculations shall be checked (signed and dated) by a qualified engineer and determined to be accurate within tolerance (+0 percent, -5 percent).

14.5.10 Load-Test Report

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 placed in the maintenance file.

14.5.11 Crane Maintenance Files

The crane maintenance file is a compilation of various documents and records relating to operation, maintenance, inspection, testing, evaluation, and repair of the equipment. The file may be centrally located or proportioned into satellite holding areas. The method(s) selected for establishing adequate information retention shall be determined by the equipment custodian. It is expected that the maintenance files be retrievable within three work days. The equipment custodian is responsible for ensuring that a safe and reliable maintenance program is in place.
14.5.11.1 Intent of Crane Maintenance Files

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. 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. Length of record retention shall be determined by the equipment custodian’s established maintenance program.

14.5.11.2 Maintenance File Contents

Crane maintenance files shall contain the following documentation, as applicable, and should be retained as long as the crane is assigned to a Hanford Site DOE contractor.

1. Monthly and periodic inspection records (The most recent records shall be retained in the file and the past records should be retained for trending)
2. Load test reports
3. Operational test reports
4. Documentation of altered, replaced, or repaired load-sustaining parts
5. 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.
6. Copies of waivers, exemptions, hostile environment plans, or similar documentation applicable to the crane (to include manufacturer’s safety bulletins, safety alerts, and product recall information)
7. Documentation for replacement ropes (see Chapter 8.0, Wire Rope)
8. Wire rope manufacturer’s certification for replacement ropes
9. Records of inspection on load indicating devices, anti-two block, two-block warning, and two-block damage prevention systems.

14.5.11.3 Previously Owned Cranes Maintenance Files

Although complete maintenance information for previously owned cranes may not be available, the equipment custodian shall acquire as much of the pertinent information as possible. If efforts fail to obtain the required information, the following actions, at a minimum, shall take place.

- Perform a periodic inspection by a qualified inspector, including inspection of hooks and wire ropes
- Inspect for evidence of past repairs, alterations, or modifications. Note the results of this inspection on the inspection report
- Resolve deficiencies noted by the inspector before placing the crane into service. Perform repairs and retests as needed. If there is evidence of past repairs, replacement, or alterations of load-
bearing parts and load test records are unavailable, a load test shall be performed in accordance with DOE/RL-92-36, *Hanford Site Hoisting and Rigging Manual*, Chapter 14, *Mobile Cranes*, Section 14.5.9, *Load Test Weight*.

### 14.5.12 Assembly/Disassembly – Selection of Manufacturer or Employer Procedures

When assembling or disassembling equipment (or attachments), the employer shall comply with all applicable manufacturer prohibitions and shall comply with either:

1. Manufacturer procedures applicable to assembly and disassembly, or
2. Employer procedures for assembly and disassembly. Employer procedures may be used only where the employer can demonstrate that the procedures used meet the requirements in 29 CFR 1926.1406.

The employer shall follow manufacturer procedures when using synthetic slings during assembly or disassembly rigging. (See 29 CFR 1926.1404[r])

#### 14.5.12.1 Assembly/Disassembly – General Requirements (Applicable to all Assembly and Disassembly Operations)

Assembly /Disassembly requires a qualified/competent director who is responsible to direct both the assembly and/or disassembly of equipment (cranes) covered under OSHA 1926 1400 Subpart CC and ASME B30 standards. With regard to tower cranes, “erecting and climbing” replaces the term “assembly,” and “dismantling” replaces the term “disassembly.” Regardless of whether the crane is initially erected to its full height or is climbed in stages, the process of increasing the height of the crane is an erection process. See Chapter 4, *Personnel Qualifications and Training Requirements*, for A/D Director qualification requirements and Chapter 19, *OSHA 29 CFR 1926 Subpart CC*, for Assembly/disassembly requirements.

Upon completion of assembly, the equipment shall be inspected by a qualified person to assure that it is configured in accordance with manufacturer equipment criteria.

1. Where manufacturer equipment criteria are unavailable, a qualified person shall:
   a. Determine if a registered professional engineer (RPE) familiar with the type of equipment involved is needed to develop criteria for the equipment configuration. If an RPE is not needed, the employer shall ensure that the criteria are developed by the qualified person. If an RPE is needed, the employer shall ensure that they are developed by an RPE.
   b. Determine if the equipment meets the criteria developed in accordance with paragraph (a) above.

2. Equipment shall not be used until an inspection demonstrates that the equipment is configured in accordance with the applicable criteria.

#### 14.5.12.2 Assembly/Disassembly – Employer Procedures – General Requirements

When using employer procedures instead of manufacturer procedures for assembly/disassembly, the employer shall ensure that the procedures:

1. Prevent unintended dangerous movement, and prevent collapse, of any part of the equipment.
2. Provide adequate support and stability of all parts of the equipment.

3. Position employees involved in the assembly/disassembly operation so that their exposure to unintended movement or collapse of part or all of the equipment is minimized.

Employer procedures shall be developed by a qualified person.

14.5.13 Equipment Modifications

Modifications or additions which affect the capacity or safe operation of the equipment are prohibited except where any of the following requirements are met.

1. Manufacturer review and approval
   a. The manufacturer approves the modifications/additions in writing.
   b. The load charts, procedures, instruction manuals, and instruction plates/tags/decals are modified as necessary to accord with the modification/addition.
   c. The original safety factor of the equipment is not reduced.

2. The manufacturer is provided a detailed description of the proposed modification/addition, is asked to approve the modification/addition, but it declines to review the technical merits of the proposal or fails, within 30 days, to acknowledge the request or initiate the review, and all of the following are met:
   a. An RPE who is a qualified person with respect to the equipment involved:
      i. Approves the modification/addition and specifies the equipment configurations to which that approval applies, and
      ii. Modifies load charts, procedures, instruction manuals, and instruction plates/tags/decals as necessary to accord with the modification/addition.
   b. The original safety factor of the equipment is not reduced.

3. The manufacturer is unavailable and the requirements of paragraph 2 of this section are met.

4. The manufacturer is provided a detailed description of the proposed modification/addition, is asked to approve the modification/addition, agrees to review the technical merits of the proposal, but fails to complete the review of the proposal within 120 days of the date it was provided the detailed description of the proposed modification/addition, and the requirements of paragraph 2 of this section are met.

5. The equipment is designed for marine work sites, contains major structural components from more than one manufacturer, and the requirements of paragraph 2 of this section are met.

Modifications or additions which affect the capacity or safe operation of the equipment are prohibited where the manufacturer, after a review of the technical safety merits of the proposed modification/addition, rejects the proposal and explains the reasons for the rejection in a written response. If the manufacturer rejects the proposal but does not explain the reasons for the rejection in writing, the employer may treat this as a manufacturer refusal to review the request under paragraph 2 of this section.

The provisions in the above paragraphs of this section do not apply to modifications made or approved by the U.S. military.
14.5.13.1 Modified Equipment Inspection

Equipment that has had modifications or additions which affect the safe operation of the equipment (such as modifications or additions involving a safety device or operational aid, critical part of a control system, power plant, braking system, load-sustaining structural components, load hook, or in-use operating mechanism) or capacity shall be inspected by a qualified person after such modifications/additions have been completed and prior to initial use. The inspection shall meet all of the following requirements:

1. The inspection shall assure that the modifications or additions have been done in accordance with the approval obtained pursuant to OSHA 29 CFR 1926.1434 (Equipment modifications).

2. The inspection shall include functional testing of the equipment.

The equipment shall not be used until an inspection demonstrates that the above requirements of this section have been met.

14.5.13.2 Repaired/Adjusted Equipment Inspections

Equipment that has had a repair or adjustment that relates to safe operation (such as a repair or adjustment to a safety device or operator aid, or to a critical part of a control system, power plant, braking system, load-sustaining structural components, load hook, or in-use operating mechanism), shall be inspected by a qualified person after such a repair or adjustment has been completed and prior to initial use. The inspection shall meet all of the following requirements:

1. The qualified person shall determine if the repair/adjustment meets manufacturer equipment criteria (where applicable and available).

2. Where manufacturer equipment criteria are unavailable or inapplicable, the qualified person shall:
   a. Determine if an RPE is needed to develop criteria for the repair/adjustment. If an RPE is not needed, the employer shall ensure that the criteria are developed by the qualified person. If an RPE is needed, the employer shall ensure that they are developed by an RPE.
   b. Determine if the repair/adjustment meets the criteria developed in accordance with paragraph 2.a of this section.

3. The inspection shall include functional testing of the repaired/adjusted parts and other components that may be affected by the repair/adjustment.

Equipment shall not be used until an inspection demonstrates that the repair/adjustment meets the requirements of paragraph 1 above (or, where applicable, paragraph 2 above).

Equipment shall not be used until an inspection demonstrates that the equipment is configured in accordance with the applicable criteria.
14.5.14 Leaving the Equipment Unattended

The operator shall not leave the controls while the load is suspended, except where all of the following are met:

1. The operator remains adjacent to the equipment and is not engaged in any other duties.

2. The load is to be held suspended for a period of time exceeding normal lifting operations.

3. The competent person determines that it is safe to do so and implements measures necessary to restrain the boom hoist and telescoping, load, swing, and outrigger or stabilizer functions.

4. Barricades or caution lines, and notices, are erected to prevent all employees from entering the fall zone. No employees, including those listed in 29 CFR 1926.1425(b)(1) through (3), 29 CFR 1926.1425(d), or 29 CFR 1926.1425(e), are permitted in the fall zone.

The provisions in 29 CFR 1926.1417(e)(1) do not apply to working gear (such as slings, spreader bars, ladders, and welding machines) where the weight of the working gear is negligible relative to the lifting capacity of the equipment as positioned, and the working gear is suspended over an area other than an entrance or exit.

14.5.15 Tag-out

Where the employer has taken the equipment out of service, a tag shall be placed in the cab stating that the equipment is out of service and is not to be used. Where the employer has taken a function(s) out of service, a tag shall be placed in a conspicuous position stating that the function is out of service and is not to be used.

If there is a warning (tag-out or maintenance/do not operate) sign on the equipment or starting control, the operator shall not activate the switch or start the equipment until the sign has been removed by a person authorized to remove it.

If there is a warning (tag-out or maintenance/do not operate) sign on any other switch or control, the operator shall not activate that switch or control until the sign has been removed by a person authorized to remove it, or until the operator has verified that the sign has been removed by a person authorized to remove it.

If equipment adjustments or repairs are necessary:

1. The operator shall, in writing, promptly inform the person designated by the employer to receive such information and, where there are successive shifts, to the next operator; and

2. The employer shall notify all affected employees, at the beginning of each shift, of the necessary adjustments or repairs and all alternative measures.
14.5.16 Keeping Clear of the Load

Where available, hoisting routes that minimize the exposure of employees to hoisted loads shall be used, to the extent consistent with public safety.

While the operator is not moving a suspended load, no employee shall be within the fall zone, except for employees (See Chapter 17, Interpretations):

1. Engaged in hooking, unhooking or guiding a load;
2. Engaged in the initial attachment of the load to a component or structure; or
3. Operating a concrete hopper or concrete bucket

When employees are engaged in hooking, unhooking, or guiding the load, or in the initial connection of a load to a component or structure and are within the fall zone, all of the following criteria shall be met (See Chapter 17, Interpretations):

1. The materials being hoisted shall be rigged to prevent unintentional displacement
2. Hooks with self-closing latches or their equivalent shall be used.
   
   **EXCEPTION:** “J” hooks are permitted to be used for setting wooden trusses.
3. The materials shall be rigged by a qualified rigger

Only employees needed to receive a load are permitted to be within the fall zone when a load is being landed. (See Chapter 17, Interpretations)

During a tilt-up or tilt-down operation:

1. No employee shall be directly under the load.
2. Only employees essential to the operation are permitted in the fall zone (but not directly under the load). (See Chapter 17, Interpretations) An employee is essential to the operation if the employee is conducting one of the following operations and the employer can demonstrate it is infeasible for the employee to perform that operation from outside the fall zone.
   a. Physically guide the load
   b. Closely monitor and giving instructions regarding the load’s movement
   c. Detaching the load from or initially attach it to another component or structure (such as, but not limited to, making an initial connection or installing bracing)
14.5.17 Crane Setup

When Mobile Crane is setup adjacent to a slope, excavation, or temporary structure (e.g., ecology blocks shoring) the minimum setback distance shall be as shown in Figures 14.5.15-1, 14.5.15-2, and 14.5.15-3, unless otherwise determined in an analysis performed by a qualified engineer. This method for estimating setback distance from slopes, excavations, and retaining walls can be implemented by a qualified person, but is not intended to be applicable for every situation or substituted for analysis when conditions warrant.

Figure 14.5.15-1
Set Back Distance for Sloping Ground
Figure 14.5.15-2
Set Back Distance for 1-1/2 to 1 Slopes

Figure 14.5.15-3
Set Back Distance for Temporary Wall or Shoring
14.6 BOOM FREE FALL PROHIBITIONS

The use of mobile cranes as defined in ASME B30.5, in which the boom is designed to free fall (live boom), is prohibited on the Hanford site.

14.7 DIGGER DERRICKS

Digger derricks fall within the cranes standards when used as a crane for other than augering holes for poles carrying electric and telecommunication lines, placing and removing the poles, and for handling associated materials to be installed on or removed from the poles. See Chapter 19, OSHA 29 CFR 1926 Subpart CC.

14.8 UNAVAILABLE OPERATION PROCEDURES

Where the manufacturer procedures are unavailable, the employer shall develop and ensure compliance with all procedures necessary for the safe operation of the equipment and attachments. Procedures for the operational controls shall be developed by a qualified person. Procedures related to the capacity of the equipment shall be developed and signed by an RPE familiar with the equipment.
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15.2 GENERAL REQUIREMENTS

15.3 IMPLEMENTATION

15.4 INCONSISTENT STANDARDS

15.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES
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15.0 PERSONNEL LIFTING

15.1 SCOPE
This chapter applies to the construction and characteristics, inspection, testing, maintenance and operation of personnel lifting systems. This chapter establishes the design criteria, equipment characteristics, and operational procedures that are required when material-handling equipment, as defined by ASME B30.23, Personnel Lifting Systems, is used to lift personnel.

The proper and safe use of these personnel lifting systems is governed by American Society of Mechanical Engineers (ASME) standards and Occupational Safety and Health Administration (OSHA) regulations. This section implements the following standards:

- ASME B30.23, Personnel Lifting Systems
- OSHA 29 CFR 1926 Subpart CC, Cranes and Derricks in Construction

15.2 GENERAL REQUIREMENTS
Contractors should access requirements via the following options:

1. IHS Engineering Standards, Regulations and Technical Specifications at http://www.ihs.com/. The contractor must have paid for access to the specific standard. To print IHS file go to http://www.ihs.com/

2. Thomson Reuters TECHSTREET ENTERPRISE at techstreet.subscriptions@thomsonreuters.com. The contractor must have paid for access to the specific standard.

3. To purchase standards directly from ASME, go to http://www.asme.org

4. To access OSHA standards, go to the following links:
   - 29 CFR 1926 Subpart CC, Cranes and Derricks in Construction
   - 29 CFR 1926.1431, Hoisting Personnel

5. To view the read-only ASME file go to:
   - ASME B30.23-2016, Personnel Lifting Systems

15.3 IMPLEMENTATION
As stated in 29 CFR 1926.1431(b), Use of Personnel Platform: “The use of equipment to hoist employees is prohibited except where the employer demonstrates that the erection, use, and dismantling of conventional means of reaching the work area, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform, or scaffold, would be more hazardous, or is not possible because of the project’s structural design or worksite conditions. This paragraph does not apply to work covered by 29 CFR 1926 Subpart R, Steel Erection. This statement applies to all Hanford Site personnel lifting systems.

Contractors shall be compliant with OSHA regulations, ASME standards, and the personnel lifting system manufacturers’ requirements. The user of this manual is responsible to implement all of the requirements
from listed sources. When two standards set forth inconsistent requirements, the user shall adhere to the standard containing the most stringent requirements.

If inconsistent standards are identified, or if a formal interpretation is desired, users should contact a Hanford Hoisting and Rigging Committee (HHRC) representative or send an email to Hanford Hoisting and Rigging for a formal interpretation. See Chapter 17.0, Interpretations, for the process to be followed when requesting an interpretation.

This manual does not intend to require retrofitting of existing equipment. However, when any hoisting or rigging equipment is modified, its performance requirements shall be reviewed relative to the requirements within this manual. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within one year.

15.4 INCONSISTENT STANDARDS


15.5 HANFORD SPECIFIC REQUIREMENTS AND PRACTICES

Follow ASME B30.23, Personnel Lifting Systems, and Chapter 3, Special Lifting Precautions.
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16.0  H&R BULLETIN - A-FRAMES AND TROLLEYS

16.1  BACKGROUND

In April 2002 a hoisting and rigging occurrence indicated the need to address portable A-Frames and Trolleys. Lesson Learned –I Beam Trolley Failure-2002-RL-HNF-0025 was published.

16.2  DISCUSSION AND RESOLUTION/EXPECTATION

This H&R Bulletin was implemented immediately to address portable A-frames and trolleys.

In 2015 ASME B30.17-2015-Cranes and Monorails (with Underhung Trolley or Bridge) introduced Portable Gantry Cranes (A-frame) into the standard. This can be accessed thru Chapter 13.0 of this manual.

16.2.1 Portable A-Frames And Trolleys

Manufacturers’ recommendations shall be followed regarding assembly, maintenance, and use of portable A-frames (Figure 16.1) and trolleys. Manufacturers’ instructions for use shall be posted in the area of use or on the portable A-frame, or personnel shall have been trained on the manufacturers’ instructions for use. Manufacturers’ instructions for assembly and maintenance of portable A-frames and trolleys shall be made available to inspection and maintenance personnel.

16.2.2 Documented Periodic Inspection

After repair or replacement of load-bearing parts, annually, and after being reassembled, an A-frame or trolley must undergo a documented inspection by a qualified inspector before being put into service. The inspection shall consist of a thorough examination of all components with a focus on any abnormality or damage that may affect the integrity or load-carrying capacity of the devices. Nondestructive examinations (i.e., magnetic particle or dye penetrant tests) are not required unless requested by an inspector. Written documentation of the inspection is required. The portable A-frames and trolleys shall be marked/tagged indicating the due date for the next annual inspection. The inspection shall cover the following items.

A. Look for bent, broken, damaged, corroded, cracked, or missing parts.

B. Verify that the following required markings are present and legible.
   a. Each portable A-frame has its rated capacity legibly marked on the structure on each side of the primary beam.
   b. The manufacturer’s name and model number are permanently and legibly marked on each portable A-frame.
   c. A tag indicating due date of the next inspection is attached to the trolley, A-frame, and any attached hoist.

C. Ensure that 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.

D. Ensure that A-frame components from different manufacturers are not intermixed or that components from different A-frames are not combined, regardless of similarities in manufacturers or rated capacities.

E. Validate the proper dimensional relationship between the trolley wheels and rail. (See Figures 16.2 and 16.3.)
a. 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. Refer to Figures 16.2 and 16.3 for the proper dimensional relationship between the trolley wheels and rail.

b. 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.

F. Check for evidence of worn bearings and wheels on trolleys.

G. Observe trolley side plates for any bending or distortion.

H. Check for missing or loose bolts, nuts, and retaining pins or retaining devices on trolleys and A-frames.

NOTE: If any required information is missing or illegible, an attempt shall be made via engineering drawings, prints, evaluations, manufacturers catalogs, etc., to establish the A-frame's manufacturer, rated capacity, and other pertinent criteria. If this attempt is unsuccessful, the A-frame 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 A-frame shall be identified and marked accordingly.

16.2.3 A-Frame And Trolley Use

The user of a portable A-frame shall perform a pre-use inspection (documentation not required) before use or at least once each shift. The inspection shall consist of the following items.

A. Look for bent, broken, damaged, corroded, cracked, or missing parts.

B. Verify that required markings are installed and legible.

  a. Each portable A-frame must have its rated capacity legibly marked on the structure on each side of the primary beam.

  b. A tag indicating the due date of the next inspection is attached to the trolley, A-frame, and any attached hoist.

C. Verify that the rated capacity is legibly marked on the structure on each side of the primary beam.

D. Ensure that the trolley, beam clamp, or hoist working load limits do not exceed the capacity rating of the A-frame.

E. Perform a function test of the trolley and hoist to ensure proper operation.

F. If adjustments or repairs are necessary or any defects are found that affect safe operation, the operator shall stop work and report deficiencies to the supervisor or equipment custodian.

16.2.4 Conduct Of Operations

A. When performing a lift, the load shall be positioned directly under the trolley. Side loading is prohibited. Side loading may spread the side frames, bend the suspension plate, and cause the trolley to fall from the A-frame.

B. The operator shall not pick up a load in excess of the rated capacity of the trolley except in the performance of a properly authorized load test. Load weight shall be known or a load-measuring device shall be installed to prevent overloading the hoist and/or system.
C. Attaching the hoist to the A-frame by suspending it from slings wrapped around the structure is prohibited without written approval from the manufacturer.

**CAUTION:** Working on or under a suspended load is prohibited, except when the load can be supported by blocking or cribbing, can be securely braced, or can be supported substantially by some other means that would prevent the load from moving. Some loads being lifted and set in place may require special handling control measures such as inspecting, landing, setting, or controlling the load, that may require personnel to position their hands or other body parts under the load when no other method is feasible. These special handling control activities MUST BE APPROVED by management and industrial safety PRIOR TO BEING PERFORMED.

### 16.2.5 Qualifications Of Personnel

Personnel operating hoisting equipment installed on a portable A-frame, or assembling and inspecting portable A-frames and trolleys must be trained/qualified in accordance with requirements outlined in Chapter 4, “Personnel Qualification and Training,” of DOE-RL-92-36, *Hanford Site Hoisting and Rigging Manual.*
Figure 16.1. Portable Gantry Crane (A-Frame)
Figure 16.2.-Recommended Trolley Fit

Figure obtained by Patrick Vallejos and reprinted from ASME B30.17-2015, by permission of the American Society of Mechanical Engineers. All rights reserved. No further copies can be made without written permission.

GENERAL NOTES:
(a) To adjust for wider flange widths, use additional washers inside as required. Equal numbers of washers should be used at each of cross pin.
(b) Gap between drop lugs shall be less than half of the beam width.
Figure 16.3. Trolley Wheel Configuration

Figure obtained by Patrick Vallejos and reprinted from ASME B30.17-2015, by permission of the American Society of Mechanical Engineers. All rights reserved. No further copies can be made without written permission.
16.3 INSPECTION TAGS

A-Frames, trollies and any attached hoist used at Hanford shall be tagged by any one of the following methods to indicate the next periodic inspection due date.

1. Institute a comprehensive marking program (such as color coding) to indicate when the next inspection is required
2. Mark each hoist with a tag that indicates when the next periodic inspection is required.

16.4 LOAD-TEST TAGS (PROOF TEST)

Maintenance files contain the proof test (load test) report for the portable gantry (A-frame), trolley, and hoist. Proof tests shall never be less than minimum requirements defined in the ASME B30 standards. A tag indicating the date of the load test may be affixed to the device for field verification. See examples in Figures 16.4 and 16.5 below.

Figure 16.4: Example of Periodic Inspection Tag
Figure 16.5: Example of a Load Test Tag

See Attachment 16.1 on the next page for an A-frame preuse inspection checksheet sample.
ATTACHMENT 16.1 - A-FRAME PREUSE INSPECTION CHECKSHEET SAMPLE

A-Frame Identification: ________________________________ Date: ___/___/____

The user shall perform the following checklist prior to performing hoisting and rigging operations with this A-Frame. Correct Unsat items found during this inspection before using this equipment. If Unsat items can not be corrected, tag the equipment out of use. Mark not applicable (N/A) for items not contained or applicable to this A-Frame.

<table>
<thead>
<tr>
<th>A-Frame Inspection Areas</th>
<th>N/A</th>
<th>SAT</th>
<th>UNSAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturers’ instructions for use are posted in the area of use or on the portable A-Frame.</td>
<td></td>
<td></td>
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<tr>
<td>Look for bent, broken, damaged, corroded, cracked, or missing parts</td>
<td></td>
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</tr>
<tr>
<td>Verify required markings are installed and legible: Rated capacity legibly marked on the structure on each side of the primary beam, and a tag indicating the due date of the next inspection is attached to the trolley, A-Frame, and any attached hoist.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensure the trolley, beam clamp, or hoist working load limits do not exceed the capacity rating of the A-Frame</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perform a function test of the trolley and hoist to ensure proper operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If adjustments or repairs are necessary or any defects are found that affect safe operation, stop work and report deficiencies to the equipment custodian.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Operator is qualified in accordance with the Hanford Site Hoisting and Rigging manual to perform H&amp;R operational activities</td>
<td></td>
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</tbody>
</table>

Type of hoist used on the A-Frame: None _______ Air _______ Manual _______ Electric _______

<table>
<thead>
<tr>
<th>Hoist Inspection Areas</th>
<th>N/A</th>
<th>SAT</th>
<th>UNSAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unusual sounds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brakes working properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hooks inspected in accordance with H&amp;R Manual Section 5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing integrity intact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supporting structure sound</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load bearing parts (Yoke, Clevis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable/Chain in operating condition</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Operating controls respond properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load limiting devices functional</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Limit switches work properly</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Warning labels installed in accordance with H&amp;R Manual Sect. 12.8.2.2 or 12.8.2.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheaves and Drums inspected for damage/wear</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lubrication in accordance with manufacturers’ instruction manual</td>
<td></td>
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<tr>
<td>Collectors/Load chain buckets properly affixed</td>
<td></td>
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<tr>
<td>Evidence of wiring wear or damage</td>
<td></td>
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<tr>
<td>Supply air system at rated air pressure</td>
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COMMENTS:
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17.0 INTERPRETATIONS

17.1 Scope
This section describes the process for manual users to request interpretations, and the committee’s method for issuing interpretations. At the end of this section is a listing of all issued interpretations.

NOTE: The committee does not grant variances, exemptions or waivers to requirements. Please see Chapter 1.0 Introduction, Section 1.7.1 Variances, Exemptions and Waivers.

17.2 General

17.2.1 Submitting Request for Interpretation
The Hanford Hoisting & Rigging Committee will provide an interpretation of the requirements in the DOE/RL-92-36 Hanford Site Hoisting and Rigging Manual. Interpretations requests shall be submitted for presentation to committee by any of the following methods:

1. Written request sent to the Chairman, Hanford Hoisting & Rigging Committee at Hanford Hoisting & Rigging.
2. Written request sent to any Committee Member
3. Written request to the DOE RL Hoisting & Rigging Program Manager
4. Written request presented in person at a scheduled Hanford Hoisting & Rigging Committee Meeting when the Committee Chairman is notified by the requestor seven calendar days prior to a scheduled meeting.

17.2.2 Formatting Request for Interpretation
The written request for interpretation shall be clear and unambiguous. It is further required that the requester submit his request utilizing the following format.

1. Subject: Cite the applicable chapter and paragraph number and provide a concise description.
2. Question: Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain any proprietary names or information.

Requests that are not in this arrangement will be rewritten in this format by the Committee prior to being answered, which could change the intent of the original request.

17.2.3 Committee Response to Request for Interpretation
Response to interpretations will be provided via email to the requester when approved by the committee. Publication of interpretations will occur at the time of with next published release of the manual. Interpretations will be removed from this section if the manual is revised to address the interpretation. When the committee considers it necessary it may request guidance or an interpretation of the applicable 29 CFR’s, National Consensus Standards, or DOE Orders/Standards.

17.3 Published Interpretations
Interpretations are listed in order of related chapter and date issued.
17.3.1 Chapter 1.0 Introduction

Interpretations: None

17.3.2 Chapter 2.0 Responsibilities

Interpretations:

2.2.2 Supervisor or Manager, Hoisting and Rigging Operations

A supervisor or manager shall be responsible for each H&R operation and shall ensure that:

f. A designated leader shall be assigned to hoisting and rigging operations that require more than one person. See paragraphs 2.2.4 and 2.2.5.

2.2.5 Designated Leader

A designated leader shall be appointed to hoisting and rigging activities that involve more than one person. Normal forklift truck material handling operations are not considered hoisting and rigging activities and do not require a DL. The DL may be the operator, a crew member, or any qualified person. (See Chapter 4, “Personnel Qualification and Training Requirements”) The DL shall:

May 7, 2008 Question 1: Does the requirement to assign a designated leader apply when more than one person is involved in performing inspections of mobile cranes that involve crane movements such as boom, swing or hoist but does not involve the lifting of loads?

Answer 1: It is DOE-RL’s response that a designated leader shall be assigned when more than one person is involved in performing inspections of a mobile crane involving movements such as the boom, swing or hoist and there is no lifting of loads. If you have any questions please contact Fred Beard, Hanford Hoisting and Rigging Program Manager at 376-6630.

17.3.3 Chapter 3.0 Critical Lifts

Interpretations:

The Hanford site hoisting and rigging manual states in chapter 3.5 CRITICAL LIFT PLAN: “A step-by-step plan or work instructions shall be prepared or approved by a technically qualified person. (See Attachment 3-9, "Plan Worksheet.") Critical lift plans shall contain the following:”

“7. Rigging Sketch(s), which include the following:

c. Load angle factors (e.g., vertical and horizontal vectors of sling loads)
d. Sling angles”

July 17, 2008 Question 1: Is it required to show in the lift plan load angle factors and sling angles for manufacture supplied and designed rigging hardware that is part of a below the hook lifting device (spreader beam slings) where those calculations have already been completed as part of the designed requirements.
Answer 1: No, although it must be noted on the lift sketches and or drawings that the lifting device slings were furnished by the lifting device manufacturer. Providing the manufacturer’s part number or other reference information is advisable.

July 17, 2008 Question 2: If the answer to question 1 is no, would it be required to show in the lift plan load angle factors (e.g., vertical and horizontal vectors of sling loads) and sling angles for all other slings that are not part of a manufactured supplied device?

Answer 2: Yes. The plan must show each sling(s) actual tension and loading or the sling(s) capacity as they are being used, identifying sling length, angle(s), hitch configuration and size.

July 17, 2008 Question 3: Is it the intent to show in the lift plan load angle factors (e.g., vertical and horizontal vectors of sling loads) when angles and increased loading are minimal?

Answer 3: Yes. The purpose is to indicate to the DL and other users and reviewers of the lift plan that load angle factors (e.g., vertical and horizontal vectors of sling loads) have been calculated and addressed.

3.3 CRITICAL LIFT DESIGNATION

Critical lift designation implements administrative and physical controls to minimize the possibility of equipment failure or human error to a hoisting or forklift operation involving a load that poses unacceptable consequences if mishandled. A lift shall be designated as a critical lift when any of the following criteria are met, unless otherwise specifically defined in safety basis.

5. The load being lifted is 90% or more of a mobile crane’s configured load chart rating.

July 13, 2016 Question: When conducting a Load Test with an engineered lift plan at 100% of the crane’s configuration, do we need to follow the requirements list in Chapter 3 – 3.5 Critical Lift Plan?

Answer: No – critical lift plans are administrative and physical controls used to perform lifts with a previously certified crane in the industry setting to minimize the possibility of equipment failure. A load test is a performance test in a controlled environment on an out of service crane to ensure and certify the crane is structurally and mechanically capable of performing hoisting operations.

17.3.4 Chapter 4.0 Personnel Qualifications and Training Requirements

Interpretations:

Section 4.3.5 Qualification

Personnel shall be considered qualified when they accomplish the following:

1. Satisfactorily complete training or meet the requirements of previous training (see Section 4.3.1)
2. Pass a written/oral examination of the knowledge requirements for the applicable activity.
3. Satisfactorily complete equipment specific OJT for OJT instructors, on-the-job evaluators, and equipment operators. Management may determine that previous qualification or experience fulfills this requirement.
4. Pass an equipment specific OJE for OJT instructors, evaluators, and equipment operators.

July 28, 2000 - Question 1: – Does section 4.3.5 mean that on the job evaluators (OJE) must be experienced/qualified operators of the equipment (or subject area) covered in the evaluation?
**Answer 1:** The OJT and OJE sections of Chapter 4 have been re-written as shown below to clarify the qualification and requalification required for On-the-Job Evaluators.

**Chapter 4, Appendix A, Section O, On-the-Job Evaluator** now states: On-the-job evaluators shall have the technical information on the subject area of evaluations, be qualified to perform on-the-job-evaluations of proper operator actions, and should be trained in the following:

1. Evaluation techniques
2. Test administration
3. Performance evaluation
4. Use of OJE forms
5. Records management

**Section 4.3.6.2 Requalification Methods** now states: Personnel performing the following activities may be re-qualified by the methods indicated. Personnel, who do not satisfactorily complete requalification by an identified method, shall complete training as listed in Sections 4.3.1.3:

**Section 4.3.6.2.8** now states: On-the-job training or evaluation of personnel. – Note: - On-the-job Trainers and Evaluators must maintain and demonstrate both their instructional proficiency and technical proficiency. See the Hoisting and Rigging Training Program Description Section 4.4.4.5, and Attachment 2 for examples of a flow path of this process.

**December 2011: Request for interpretation Chapter of the Hanford Hoisting and Rigging Manual-Previous Training**

DOE-RL-92-36 Hanford Site Hoisting & Rigging Manual (HSHRM) Chapter 4.3.1 States that previous training or experience may be acceptable to meet training requirements and list Journeyman Status in an Applicable Trade.

**Question 1**
What is meant by Applicable Trade?

**Answer 1**—Applicable trade means a building trade that has specific training for an activity listed and its members are trained to perform that activity on the Hanford Site.

**Question 2**
If a building trades union training program covers a topic listed in appendix A and in reviewing the program per 4.1 of the HSHRM is found to not contain all information in approved site programs for that training activity in appendix A, can the contractor still accept this as meeting previous training requirements based on the individual’s experience and or journeyman status?

**Answer 2**—Yes, the contractor can accept experience and/or journeyman status as meeting previous training requirements. The person for whom the previous training equivalency is being granted must pass a written test that covers the topics listed in Appendix A for the activity for which the previous training is being granted. The person would also have to meet all prerequisities listed in the Hoisting & Training Program Descriptions as well as complete an OJE before being deemed qualified for the activity.
**Question 3** - If a journeyman building trade member is a member of a union that has a training program that is acceptable but the individual may have been trained years ago prior to the current program, can he/she, by virtue of being a journeyman member of that trade, be granted a training equivalency?

**Answer 3 - Yes**. Training programs including those at Hanford progress over the years and older training programs may or may not have met current requirements. The process of evaluation for requalification and field experience ensures those personnel are exposed and evaluated to current standards and programs. The implementing programs and procedures of the contractor are required to reflect current requirements and ensure work is performed in accordance to those requirements. When there is a significant global change in requirements such as the new OSHA 1926.1400 then Gap training is implemented.

Chapter 4.0 now states:

**4.1 SCOPE**

This section specifies qualification and training requirements for personnel with the following responsibilities:

1. Direct hoisting and rigging (H&R) activities
2. Supervise H&R activities
3. Perform H&R activities
4. Inspect and maintain H&R equipment
5. Provide technical approval of procedures, lift plans or work instructions for H&R activities
6. Develop lift plans
7. Provide signals for H&R activities
8. Train and evaluate personnel for H&R activities and equipment operation
9. Provide safety oversight
10. Perform H&R engineering functions

**(NOTE)** Contracting organizations shall review, verify, and document that subcontractors have an acceptable training and qualification program. The contracting organization shall ensure that the program meets the requirements of this section to ensure that personnel are qualified to perform work covered by this Manual.

**4.3.1 Previous Training and Qualification**

Documented evidence of previous training or experience may be accepted to meet training requirements.

1. Previous training may include any of the following:
   a. Vendor or equipment manufacturer training
   b. Completion of an apprenticeship program
   c. Journeyman status in an applicable trade

2. For previous training to be acceptable for Hanford Site qualification, documented evidence shall include the type of class of equipment and hours of experience. For qualifications not related to equipment
operation, personnel shall have documented evidence of training and experience related to an activity covered by this Manual. As a minimum, documented evidence may be any of the following.

a. Certificates of training (See Note 4.1)
b. Journeyman card or documents issued by a trade union
c. A degree or accreditation from a college or trade school

3. When previous training or experience are reviewed for compliance to this manual, accepted and documented, personnel shall be considered qualified after they have satisfactorily completed an On-the-Job Evaluation (OJE) for the equipment or activity being performed. Operators of mobile locomotive and cab- or pulpit-operated overhead cranes shall have met the Physical Examination and Substance Abuse Testing requirements identified in 4.2.3.

May 31, 2016 Question: When a Hoisting and Rigging qualified person exceeds his 60 months (36 months for Forklift operators) of training can they perform an OJE for task and become re-qualified?

Answer: There is no grace period for the requalification of hoisting and rigging activities. Once a person has exceeded the requalification window they must then start the training cycle over again, completing either an initial training class or a challenge exam before satisfactorily completing an OJE. An OJE alone for requalification beyond the 60 month window (36 month for forklift operators) is not sufficient.

If you have any questions please contact the DOE Hanford Hoisting and Rigging Program Manager or Hanford Site Hoisting and Rigging Chairman.

17.3.5 Chapter 5.0 Hooks

Interpretations:

April 2009 - Question 1: For a remote hot cell Electric Overhead Traveling Crane is it necessary for the crane hook to have a latch?

Answer 1: No. As the requirements clearly indicates and is applied at Hanford on remotely operated cranes currently and over many decades, if the use of the hook latch is impractical then it can be removed or not used.

17.3.6 Chapter 6.0 Forklift Trucks

Interpretations:

HYSTER OPERATING MANUAL, page 38: "WARNING: Do not turn on an incline. To reduce the possibility of a tip over, a lift truck must not be driven across an incline."

September 13, 2005 - Question 1: What is the specific allowable percentage of grade for side-slope operation across an incline for safe operation of a forklift? For example, a road has a crown for water drainage, which presents a cross slope operation to a forklift. References- DOE/RL-92-36, Chapter 6: "Common Errors during Forklift Operation: Failing to keep the load "uphill" when traveling on ramps or grades."

Answer 1: Slight grades are not an issue such as crowns in roadways. Grades that can affect the stability are and should be of high concern as they may result in forklift overturning and death or serious
injury to the operator. Please see the Forklift Hazard Evaluation Checklist- (This should be used for all forklift operations) Site form A-6002-924 and the example in DOE/RL-92-36 Chapter 6, page 7. You will see the item that identifies docks, grades and ramps >5%. If the manufacture has a lower limit it must be followed and would take precedence over our general rule.

If the grade > 5% or > than a % of grade established by the specific lift manufacture we must go vertically up and down the grade or put our operators at risk. The issue of grade needs to also take into consideration these additional items that can make the manufacturer established grades or grades of less than 5% dangerous:

- The type and class of forklift being used
- The surface condition-paved dirt ground
- The truck is loaded or unloaded- if loaded where is the center of gravity of the load
- How the truck is operated on the grade- such as turning.

### 6.2.3 Forklift Truck Operator

The forklift truck operator has the following responsibilities:

6.2.3.a. Operate the truck in a safe responsible manner.

**July 28, 2005 – Question 1:** Is it allowable to partially lift/drag a container from the center of a trailer to the side of the trailer to allow further offloading?

**Answer 1:** It is an acceptable practice to partially lift and re-position a load so the lift can fully engage the load as long as the lift operator ensures the forklift does not become unstable or the integrity and stability of the load is not compromised. When the load is fully lifted to remove from the truck, it must be within the forklifts capacity at the given load center of the load.

### 17.3.7 Chapter 7.0 Shop Cranes

**Interpretations:** None

### 17.3.8 Chapter 8.0 Wire Rope

**Interpretations:**

8.3.3.3 Inspection Area: The inspection shall cover the entire length of each rope. Only the surface wires of the rope must be inspected. No attempt should be made to open the rope. Any deterioration resulting in loss of original strength shall be documented and a determination made as to whether further use of the rope would constitute a hazard. As a minimum, ropes shall be inspected for the following:

Items listed for frequent wire rope inspection.

**Question:** Does requirement to inspect the entire length of rope allow leaving the first layer of rope on the drum of mobile cranes as long as the qualified inspector can determine through visual inspection that there is no apparent condition that would require further removal or meet out of service criteria and end connections are acceptable and secure?

**Answer:** Yes
17.3.9 Chapter 9.0 Slings

Interpretations:

9.2.2.6 Chain Sling Inspection.

9.2.2.6.2 Periodic Inspection. Complete link-by-link inspections of the slings shall be performed at the intervals defined in Table 9-3. Any deficiencies shall be examined and a determination made as to whether they constitute a hazard. These inspections shall include chain sling frequent inspection, as specified above, in addition to the following.

<table>
<thead>
<tr>
<th>Service level</th>
<th>Sling service</th>
<th>Frequent inspection</th>
<th>Periodic inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Service that involves use of loads within the rated load</td>
<td>Monthly</td>
<td>Yearly</td>
</tr>
<tr>
<td>Severe</td>
<td>Service that involves normal service coupled with abnormal operating conditions</td>
<td>Daily to weekly</td>
<td>Monthly to quarterly</td>
</tr>
<tr>
<td>Special or infrequent</td>
<td>Service that involves operation, other than normal or severe, which is recommended by a qualified individual</td>
<td>Before and after each occurrence</td>
<td>Before each occurrence or sequence of occurrences within a 30-day period</td>
</tr>
</tbody>
</table>

9.2.3.8.2 Periodic Inspection. A wire rope sling periodic inspection shall be performed by a qualified inspector on a regular basis (at least annually).

1. Inspection frequency shall be based on the following criteria:
   a. Frequency of sling use
   b. Severity of service conditions
   c. Nature of lifts being made
   d. Experience gained on the service life of slings used in similar circumstances.

2. The periodic inspection shall be documented by any one of the following methods:
   a. Mark a serial number on the sling and maintaining inspection records by serial numbers.
   b. Institute a comprehensive marking program (such as color coding) to indicate when the next periodic inspection is required.
   c. Mark each sling with a tag that indicates when the next periodic inspection is required. This tag becomes the record.

9.2.5.6.3 Periodic Inspection. [Synthetic] A periodic inspection shall be performed by a qualified inspector on a regular basis with frequency of inspection based on the following criteria:

1. Frequency of sling use
2. Severity of service conditions
3. Nature of lifts being made
4. Experience gained on the service life of slings used in similar circumstances.

The periodic inspection shall be made at least annually and shall be documented by any one of the following methods:
February 21, 2007 - Question 1 - Is a periodic inspection required to be performed on a regular basis (at least annually) for slings not being used and left in locked up secured facilities, condemned facilities or facilities that are not routinely accessed do to environmental or radiological hazards?

**Answer to Question 1:** No

February 21, 2007 - Question 2 - Would these slings be considered inaccessible for use, therefore not required to have a periodic inspection done until the slings are recovered, re-inspected and put back into service?

**Answer to Question 2:** Yes

Subject: Design Factors, Chapter 9 Slings

April 15, 2008 Question 1: When using a combination of approved slings, manually operated chain hoist(s), and/or rigging hardware to attach a load to the crane, is it necessary to compensate for the difference in the design factor of individual components? For example, the rigging configuration for a specific lift consists of forged steel Weld less rings (design factor 6:1), shackles (design factor 5:1) and chain slings (design factor 4:1).

**Answer 1:** No. The design factor is the ratio between nominal or minimum breaking strength or yield strength and the rated capacity of the component. The rated load for each type of rigging is based on characteristic properties of the component material, service history established by organizations and manufacturers and therefore the design equation will vary by component. The design factors are adopted by ASME. The share of load and rigging configuration that may increase loading shall be determined to ensure rated Load or Working Load Limit (WLL) of the individual components are not exceeded.

17.3.10 Chapter 10.0 Rigging Hardware

**Interpretations:**

Subject: Design Factors, Chapter 10 Rigging Hardware

April 15, 2008 Question 1: When using a combination of approved slings, manually operated chain hoist(s), and/or rigging hardware to attach a load to the crane, is it necessary to compensate for the difference in the design factor of individual components? For example, the rigging configuration for a specific lift consists of forged steel Weld less rings (design factor 6:1), shackles (design factor 5:1) and chain slings (design factor 4:1).

**Answer 1:** No. The design factor is the ratio between nominal or minimum breaking strength or yield strength and the rated capacity of the component. The rated load for each type of rigging is based on characteristic properties of the component material, service history established by organizations and manufacturers and therefore the design equation will vary by component. The design factors are adopted by ASME. The share of load and rigging configuration that may increase loading shall be determined to ensure rated Load or Working Load Limit (WLL) of the individual components are not exceeded.

Subject: Concrete Inserts, Chapter 10 Rigging Hardware
There have been recurring questions regarding the applicable standards or requirements for concrete lifting inserts used with swivel hoist rings. There is no information regarding the inserts in either the Hanford Site H&R Manual, or the ASME B30.26 *Rigging Hardware Standard.*

**October 15, 2009 Question 1:** Do the manufacture specifications for the installation, use and design of concrete insert assembly apply and not the ASME B30.26 Rigging Hardware standard.

**Answer 1: Yes,** the manufactures specifications would apply for the installation, use and design of the inserts and not ASME B30.26, unless otherwise specified by the manufacture. See examples below of inserts in question.

Meadow Burke hoist rings meet/exceed ASME B30.26 requirements. Meadow Burke concrete coil loop lifting inserts shown below are not designed to comply with this standard.
### (2172) CX-4 COIL LOOP INSERT - FLARED

<table>
<thead>
<tr>
<th>MB Item # Plain</th>
<th>MB Item # Galv-Specify Type</th>
<th>Description</th>
<th>Safe Work Load</th>
<th>Wire Diameter</th>
<th>Weight Per 100 lbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>430201</td>
<td>430214</td>
<td>3/4&quot; x 6&quot;</td>
<td>4,750</td>
<td>0.375</td>
<td>66</td>
</tr>
<tr>
<td>430269</td>
<td>430272</td>
<td>3/4&quot; x 9&quot;</td>
<td>4,750</td>
<td>0.375</td>
<td>80</td>
</tr>
<tr>
<td>430275</td>
<td>430278</td>
<td>3/4&quot; x 9&quot;</td>
<td>6,750</td>
<td>0.440</td>
<td>79</td>
</tr>
<tr>
<td>430285</td>
<td>430298</td>
<td>3/4&quot; x 12&quot;</td>
<td>4,750</td>
<td>0.375</td>
<td>111</td>
</tr>
<tr>
<td>430308</td>
<td>430311</td>
<td>1&quot; x 9&quot;</td>
<td>4,750</td>
<td>0.375</td>
<td>120</td>
</tr>
<tr>
<td>430312</td>
<td>430313</td>
<td>1&quot; x 9&quot;</td>
<td>8,000</td>
<td>0.440</td>
<td>179</td>
</tr>
<tr>
<td>430324</td>
<td>430337</td>
<td>1&quot; x 12&quot;</td>
<td>4,750</td>
<td>0.375</td>
<td>151</td>
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<td>430338</td>
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<td>1&quot; x 12&quot;</td>
<td>8,000</td>
<td>0.440</td>
<td>178</td>
</tr>
<tr>
<td>430340</td>
<td>430341</td>
<td>1-1/4&quot; x 12&quot;</td>
<td>4,750</td>
<td>0.375</td>
<td>147</td>
</tr>
<tr>
<td>430342</td>
<td>430343</td>
<td>1-1/4&quot; x 12&quot;</td>
<td>8,000</td>
<td>0.440</td>
<td>185</td>
</tr>
<tr>
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<td>430345</td>
<td>1-1/2&quot; x 12&quot;</td>
<td>8,000</td>
<td>0.440</td>
<td>205</td>
</tr>
</tbody>
</table>

Safety Note: Minimum Coil penetration applies

Safety factor is approximately 4:1.
Set-up charge for orders less than 100 pieces per size.
Set-up charge on E-Plated or HDG orders under 350 lbs.
*NOTE: For Finish - Specify "Plain", "Electro-Plated" (E-Plated), "Hot Dip Galvanized" (HDG)

To Order, Specify: quantity, name, type, bolt diameter and finish.
Dayton Superior hoist rings meet requirements of ASME B30.26. Dayton Superior concrete lifting inserts shown below are not designed to meet this ASME standard.
CONAC inserts shown below do not comply with the ASME B30.26 standard
17.3.11 Chapter 11.0 Below The Hook Lifting Devices

Interpretations:

11.3.1 Design Factor

Load-bearing structural components of a lifter shall be designed to withstand the stresses imposed by its rated load plus the weight of the lifter, with a minimum design factor of 3, based on the yield strength of the material, and with stress ranges that do not exceed the values given in ANSI/AWS D14.1, Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment for the applicable conditions.

Date Unknown - Question 1: Is it the intent of this section to require fasteners performing as structural components of a lifter be designed so that the static stress resulting from the rated load and the weight of the lifter does not exceed 33% of the yield strength of the material?

Answer 1: Yes, the design factor of 3 is a relationship between the structural component (in this case the fasteners) material yield strength and the static stress imposed by the rated load and the weight of the lifter.

Date Unknown - Question 2: If the response to question (1) is yes, can fasteners be designed and pretension in accordance with applicable industry codes and standards without pretension stress becoming a factor in meeting the 33% of yield strength of the material criteria described in question (1)?

Answer 2: Yes, fastener pre-tension stress is not one of the stress factors in the design factor of 3 determination criteria.

September 21, 2004 - Question 1: Do the service classifications and PM/inspection frequency requirements provided in the Hanford Site Hoisting and Rigging Manual (based on ASME B30.20) apply to a “below-the-hook” lifting device when ANSI N14.6 has been imposed on that device by the responsible engineer/facility?

- Rigging Manual section 11.7 requires weekly to monthly frequent and semi-annual visual inspection for heavy service.
- ANSI N14.6 section 6.3 requires only annual load testing with visual inspections or alternatively allows special inspection, which includes NDE (Magnetic Particle).

Answer 1: The Hanford Site Hoisting and Rigging Manual section 11.2.1 Special Lifting Devices allows for the responsible engineer or design authority to invoke ANSI N14.6 for Design, Fabrication, Acceptance Testing, Maintenance, Assurance of continuing compliance, Inspection and Marking. The responsible engineer would determine the need to apply elements of ASME B30.20 such as the service classification but would not be required to when that element of ANSI N14.6 is applied such as inspection criteria.

April/1/2003 - Question 1: Are electrical switchgear (circuit breaker) lifting devices, designed, built and supplied by breaker manufacturer for handling his circuit breakers considered Below the Hook Lifting devices as defined in DOE/RL-92-36 Section 11 and ASME B30.20?
Answer 1: No. These circuit breaker lifting devices designed, built and supplied specifically for lifting the manufactures breakers are considered “Proprietary Lifting Devices” and do not meet criteria of lifting devices for freely suspended loads as defined in DOE/RL-92-36 Section 11 and ASME B30.20?

June 21, 2006 – Question 1: Is a hook such as referenced in Chapter 11.0, Attachment 11.1-5; when attached directly to the load block hook of a crane or hoist considered a Below-the–Hook Lifting Device?

Answer 1: Yes. The hook shaped device shown is classified as a Below-the-Hook Lifting Device and as such must comply with the requirements of ASME B30.20 Below-the-Hook Lifting Devices as required by Chapter 11, Section 11.7.1.

Question 2: If a hook, covered in Chapter 10 Rigging Hooks or Chapter 5 Hooks was attached directly to a load block hook would it then become a Below-the-Hook Lifting Device?

Answer 2: No. The hooks covered in Chapter 10, Riggings Hooks and Chapter 5 Hooks, of the Hanford Site Hoisting and Rigging Manual are designed and built to the requirements of ASME B30.10 Hooks and not to ASME B30.20 Below the Hook Lifting Devices. The determination of which standard is applicable is based on to which standard the device is built, and not to its use or application in a rigging system.

Subject: Design Factors, Chapter 11 Below The Hook Lifting Devices

April 15, 2008 Question 1: When using a combination of approved slings, manually operated chain hoist(s), and/or rigging hardware to attach a load to the crane, is it necessary to compensate for the difference in the design factor of individual components? For example, the rigging configuration for a specific lift consists of forged steel Weld less rings (design factor 6:1), shackles (design factor 5:1) and chain slings (design factor 4:1).

Answer 1: No. The design factor is the ratio between nominal or minimum breaking strength or yield strength and the rated capacity of the component. The rated load for each type of rigging is based on characteristic properties of the component material, service history established by organizations and manufacturers and therefore the design equation will vary by component. The design factors are adopted by ASME. The share of load and rigging configuration that may increase loading shall be determined to ensure rated Load or Working Load Limit (WLL) of the individual components are not exceeded.

17.3.12 Chapter 12.0 Hoists, Jib Cranes, and Monorail Systems

Interpretations:

Subject: Design Factors, Chapter 12 Hoists, Jib Cranes, and Monorail Systems

April 15, 2008 Question 1: When using a combination of approved slings, manually operated chain hoist(s), and/or rigging hardware to attach a load to the crane, is it necessary to compensate for the difference in the design factor of individual components? For example, the rigging configuration for a specific lift consists of forged steel Weld less rings (design factor 6:1), shackles (design factor 5:1) and chain slings (design factor 4:1).
Answer 1: No. The design factor is the ratio between nominal or minimum breaking strength or yield strength and the rated capacity of the component. The rated load for each type of rigging is based on characteristic properties of the component material, service history established by organizations and manufacturers and therefore the design equation will vary by component. The design factors are adopted by ASME. The share of load and rigging configuration that may increase loading shall be determined to ensure rated Load or Working Load Limit (WLL) of the individual components are not exceeded.

17.3.13 Chapter 13.0 Overhead and Gantry Cranes

Interpretations:

July 15, 2004 - Question 1: Can the frequent and daily inspection listed in Hanford Site Hoisting and Rigging Manual section 13.9.1.3. and section 13.9.1.2.2, be consolidated into a one (daily) inspection to take credit for the frequent and daily inspection. We could just call the first day of the month the frequent inspection. I have been told that some facilities do it that way. Is the Hanford Site Hoisting and Rigging Manual requirement such that we would have to write a new OP to perform the frequent inspection for the month?

Answer 1: As long as you cover those requirements for daily and frequent listed in the Hanford Site Hoisting and Rigging Manual (there are some differences and you must ensure they are all completed) you could consolidate to one procedure and take credit for it.

July 15, 2004 - Question 2: What qualifications are required to perform frequent and daily inspection listed in Hanford Site Hoisting and Rigging Manual Section 13.9.1.3. and Section 13.9.1.2.2?

Answer 2: The Hanford Site Hoisting and Rigging Manual does not require a "qualified inspector" to perform Frequent and Daily visual and operation checks of the crane. A qualified operator may perform these. They are observations for visual damage or malfunctions.

13.8 MODIFICATIONS

Cranes may be modified or re-rated provided such modifications and the supporting structure are analyzed thoroughly by a qualified person or crane manufacturer. A re-rated crane or one whose load-supporting components have been modified shall be subjected to a rated load test (see paragraph 13.9.3.4, “Rated Load Test”). The new rated load shall be displayed in accordance with paragraph 13.7.1, “Rated Load Marking.” Documentation supporting crane re-rating shall be contained in, or retrievable by reference from, the crane maintenance file.

February 09, 2005 - Question 1: Is the following sentence from Section 13.8: “A re-rated crane or one whose load-supporting components have been modified shall be subjected to a rated load test (see paragraph 13.9.3.4, “Rated Load Test”).” applicable to up-rating cranes only and not the down-rating of cranes?

Answer 1: If the re-rating is for other than administrative proposes and we have re-rated because of some physical condition of the crane components or supporting structure then we must load test. The new rating needs to be supported by engineering analysis.
Overhead Crane Support Structure Inspections

RE: Hanford Hoisting & Rigging manual Chapters 12 (ASME B30.11 Section 11-2.1) and Hanford Hoisting & Rigging Manual Chapters 13 (ASME B30.17-2.1)

Since BNI is in the process of installing and soon to be load testing cranes and monorails, a question has arisen.

The codes referenced above and OSHA 1910.170 state that for initial inspections, new cranes shall be inspected prior to initial use to verify compliance with requirements of frequent and periodic inspection.

The subject codes are silent on the load structures. There have been legacy opinions that the structure needs to be inspected for obvious deformed or cracked members, defects, loose bolts, cracked welds, etc.

The WTP building steel is already inspected in accordance with the drawings and codes including bolt torques and NDE on welds.

**June 4, 2010 Question:** Please provide a Hoisting & Rigging Committee interpretation for newly installed cranes and monorails, whether building steel is to have any structural inspection after a crane/monorail load test.

**Answer:** Following a review it is determined that, under existing OSHA regulations and ASME codes, no requirements exist that specify completion of a structural (supporting structure) inspection following completion of a crane and monorail load test.

17.3.14 Chapter 14.0 Mobile Cranes

**Interpretations:**

14.5.14 Keeping Clear of the Load

The US Department of Energy nuclear site at Hanford requires additional employees other than those currently identified in 1926.1425 (b), (d), and (e) (below) to be in the fall zone, but not under the load. These personnel are necessary for the performance of critical activities, such as assessment, containment, and confinement of radiological hazards as they pertain to radiation exposure as outlined in 10 CFR 835, Occupational Radiological Protection. This work has been performed safely on the Hanford Nuclear Site for many years. Essential personnel may include, but are not limited to, Health Physics Technician (HPT) and Nuclear Chemical Operator (NCO), or Industrial Health (IH).

The Preamble to 29 CFR 1926 states:

Paragraph (b)(2) permits employees engaged in the initial attachment of the load to a component or structure to be within the fall zone. One example of this activity is: A subassembly of steel members is hoisted for attachment to a structure. When initially attaching the lower portion of that subassembly, an employee is within the fall zone of the load. In this example, the employee engaged in the initial attachment of the subassembly to the structure would be permitted to be within the fall zone; that work cannot be done otherwise (emphasis added). No comments were received on this paragraph; it is promulgated as proposed.

**December 6, 2010 - Question 1:** Do you concur that essential personnel (other than those currently identified in 29 CFR 1926.1425 [b], [d], and [e]) may be permitted in the fall zone to perform work that cannot be done otherwise, which include other essential personnel, such as, but are not limited to,
Health Physics Technician (HPT) and Nuclear Chemical Operator (NCO), or Industrial Health (IH), as required for compliance to 10 CFR 835?

Reference:
- 1926.1401 Definitions
  - Fall zone means the area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall in the event of an accident.
- 1926.1425 Keeping clear of the load
  - This section of OSHA 1926 identifies personnel who can be in the fall zone while load is being rigged is stationary or being landed
  - (b) While the operator is not moving a suspended load, no employee must be within the fall zone, except for employees:
    - (1) Engaged in hooking, unhooking or guiding a load;
    - (2) Engaged in the initial attachment of the load to a component or structure; or
    - (3) Operating a concrete hopper or concrete bucket.
  - (d) Receiving a load. Only employees needed to receive a load are permitted to be within the fall zone when a load is being landed.
  - (e) During a tilt-up or tilt-down operation:
    - (1) No employee must be directly under the load.
    - (2) Only employees essential to the operation are permitted in the fall zone (but not directly under the load). An employee is essential to the operation if the employee is conducting one of the following operations and the employer can demonstrate it is infeasible for the employee to perform that operation from outside the fall zone: (1) physically guide the load; (2) closely monitor and give instructions regarding the load’s movement; or (3) either detach it from or initially attach it to another component or structure (such as, but not limited to, making an initial connection or installing bracing).

Answer 1: To the extent that a Health Physics Technician (HPT) or an Industrial Hygienist (IH) is needed to conduct radiological or chemical surveys to help determine the ultimate disposition of the load, it is permissible if the load is stationary and can only be effectively surveyed while suspended. In such circumstances, the HPT or IH is “guiding the load” per 29 CFR 1926.1425(a)(1) by helping to determine how the suspended load is to be handled subsequent to the radiological or other environmental/safety related surveys (i.e., will it be lowered immediately into the tank for further decontamination, wrapped with protective sheeting, or moved to a laydown spot without further treatment).

However, when such surveys can be effectively performed by an HPT or IH on a load that is safely on the ground or from outside the fall zone (i.e., before it is lifted or while supported on dunnage), such methods are preferable (as long as they comply with applicable nuclear or radiological safety regulations). Accordingly, an evaluation of whether the HPT or IH may survey a suspended load to determine its ultimate disposition must be conducted as part of the work planning to ascertain whether the lift and related radiological surveys can be accomplished in another manner that will not place an HPT or IH within the fall zone.

Similarly, a Nuclear Chemical Operator (NCO) may be within the fall zone if his planned work (e.g., wrapping a contaminated load in plastic sheeting) is essential to preparing the load for receipt in the laydown area (refer to 29 CFR 1926.1425(d)) and if the work cannot be otherwise performed in compliance with applicable nuclear or radiation safety rules. As noted above, a prior evaluation is
necessary to ensure that there is no other reasonable way to perform the work needed to prepare the load for receipt in the laydown area.

In the limited circumstances outlined above where HPT’s, IH's and NCO’s are permitted within the fall zone, their presence there must be as short as possible and limited to the time necessary to accomplish their assigned work activities as prescribed in the work plan.

14.4.7.5 Power Lines Energized, Crane Operating Within the Erected/Fully Extended Boom Length of the Prohibited Zone (Crane has the capacity to boom down, swing or extend into the prohibited zone. See Figure 14-2).

a. An onsite meeting (see 14.4.7.3) between project management and a qualified representative of the owner of the power lines or a designated representative of the electrical utility shall take place to establish the conditions to safely complete the operations.

April 29, 2005 - Question 1: Does project management mean somebody from the rigging crew preferably the designated leader, or does it mean anyone within management over a particular construction activity?

Answer 1: The intent is that the supervisor or person responsible for the crane crew and is involved in the crane activity be at that meeting, it could be a DL. This is the person who is responsible for the crane crew and activities, understands crane configurations, capabilities and is responsible for implementing those items listed in 14.4.7.5.b-j and 14.4.7.6 a-g. Facility or Organization where the activity is taking place wishes to have a representative at the meeting that would be good.

14.4.7.6 Crane Operations Within the Prohibited Zone and the Power Lines are Energized.

CAUTION: Working in the prohibited zone with power lines energized requires very disciplined and extraordinary safety precautions, including direct involvement and support from the electric utility organization. Working in the prohibited zone with power lines energized, shall only be performed when no alternative exists.

14.4.7.6.a. Before such operations take place, a qualified person responsible for crane operations and a qualified representative of the utility or an engineer qualified in power line transmission, after visiting the site together, shall determine whether operating the crane within the Prohibited Zone is the most feasible way to complete the job. Both persons shall set minimum required clearances and procedures for safe operations. These operations shall be under their supervision.

April 29, 2005 - Question 2: Does the definition 14.4.7.6 a., “a qualified person responsible for crane operations” mean a designated leader, crane operator, rigger, or the crane supervisor, or does it mean anyone within management over a particular construction activity?

Answer 2: See Answer 1 to Question 1 concerning 14.4.7.5.
14.4.7.4 Crane Operation Near De-energized and Grounded Electric Power Lines.

14.4.7.4.b. The lines shall be visibly grounded to avoid electrical feedback and appropriately marked at the job-site location.

**June 21, 2006 - Question 1:** Is it the intent of 14.4.7.4.b that only transmission & distribution lines be grounded to avoid electrical feedback or to become re-energized from other sources and not insulated overhead premises wiring installed in accordance with the National Electrical code (NEC).

**Answer 1:** Yes, as long as the premises line voltage does not exceed 480 volt, factory-installed insulation is on the conductor and the insulation would not be damaged while doing the work.

**June 21, 2006 - Question 2:** If an electrically safe work condition has been established, i.e., the circuit has been locked out in accordance with 29 CFR 1910.147, including authorized worker locks belonging to the crane operator and assisting workers, will that satisfy the intent of 14.4.7.4.b for insulated premises wiring lines?

**Answer 2:** No. The requirements 29CFR 1910.147 are required regardless of grounding issues.

14.3 CONDUCT OF OPERATIONS

14.3.e Before leaving the crane unattended, perform the following tasks:

1. Land any load, bucket, lifting magnet, or other device

**June 21, 2006 - Question 1:** When and under what conditions is it acceptable for a mobile crane operator to leave his/her position at the crane controls with a load suspended?

**Answer 1:** If a condition arises that puts the mobile crane operator’s life or health at risk by remaining in the cab with (or without) a load suspended, he/she shall leave the crane cab. It is also important that anytime there is a known possibility that a condition could arise during the course of a work assignment requiring the operator to leave a crane with the load suspended, it must be addressed with the assigned designated leader and the crane operator prior to commencement of the work, as a part of pre-job planning.

If there is no threat to the life or health of the crane operator, then the operator should not leave a crane with the load suspended. Leaving a load suspended from an unattended mobile crane is a hazardous practice and should never be implemented for convenience. To leave a mobile crane unattended with a suspended load, other than in a situation where the operator’s life or health is threatened, there must be an analysis completed by qualified hoisting and rigging personnel to identify manufacturer-specific recommendations as well as implement actions and methods to mitigate the hazards. The analysis shall be based on, as a minimum, the operating characteristics and limitations of the specific crane and the following elements that may affect load, crane stability and cranes structural integrity:

- Crane footing
- Load weight,
- Load radius
- Physical dimensions and shape of the load
• Criticality of the load and it’s surroundings per chapter 3 of the DOE/RL-92-36 Hoisting and Rigging Manual
• Crane capacity
• Crane condition
• Current and predicted weather conditions
• Effects on rigging, rigging hardware and lifting devices, if used
• Load stability
• Estimated time crane with suspended load will be left unattended

In most cases the safest and most expedient method is to leave the operator at the controls until the load can be landed. If after analysis it is determined that the load will be left suspended without the operator in the cab then the applicable requirements of DOE/RL-92-36, Hanford Site Hoisting and Rigging Manual sections 14.3 and 14.4, and mitigating actions identified from the analysis shall be applied. As a minimum control, the affected area shall be cordoned off to prevent personnel access into the work zone.

14.4.4 Holding the Load

14.4.4.c. No person should be permitted to stand or pass under a suspended load.

July 6, 2006 - Question 1: Can a person walk, work, or park a vehicle under a crane that is boomed up with the block and or ball hanging with no load attached?

Answer 1: Yes. The key term here is suspended load as used in DOE/RL-92-36 Hanford Site Hoisting and Rigging Manual section 14.4.4.c “Holding the Load”. The “load” referenced in Chapter 22.0 Appendix A and 14.4.2 is not referring to suspended load but is the term used in calculating crane capacities and induced loads. The boom, load block and other components of a crane referenced are not considered suspended load. The “suspended load” as it applies to personnel standing or passing under, is the item being lifted. If it were applied to the boom and load block or hook it would not only be impractical but in most cases impossible to perform work such as attaching the load and maintenance of the equipment.

17.3.15 Chapter 15.0 Personnel Lifting
Interpretations: None

17.3.16 Chapter 16.0 A-Frames and Trolleys
Interpretations: None

17.3.17 Chapter 17.0 Interpretations
Interpretations: See contents of this chapter.

17.3.18 Chapter 18.0 Hoisting & Rigging in Hostile Environments
Interpretations: None

17.3.19 Chapter 19.0: 29 CFR 1926, Subpart CC, Cranes and Derricks in Construction
Interpretations: None
17.3.20 H&R Committee Charter

Interpretations: None

17.3.21 References and Bibliography

Interpretations: None

17.3.22 Appendix A

Interpretations:

Monthly. Once each calendar month. A maintenance/inspection program should accomplish monthly tasks at approximately the same time each calendar month. To manage such programs, tasks should be scheduled as “due” on a particular date. If a task cannot reasonably be performed on the scheduled “due” date, it should promptly be rescheduled for a date during the same calendar month.

January 21, 2004 - Question 1: Does "monthly" and "annually" when applied to documented inspections of equipment covered by the Hanford Hoisting and Rigging Manual, such as wire rope and cranes, mean if these inspection are not performed 30 days or 365 days respectively from the previous inspection, the equipment is out of service?

Answer 1: Required monthly and annual inspections need to be performed once each calendar month and once each calendar year to as close to the exact date (30 or 365 days from previous date) as possible allowing for variances for weekends and work schedules. As long as the inspection is performed in the month it was due the equipment is not out of service. Monthly inspections could, on occasion be performed early in one month and late in the next, but if this were a common practice it would not be meeting the intent of the law or requirement.

Question 2: Is there a "grace period"?

Answer 2: There is no grace period.

17.3.23 ATTACHMENTS

Interpretations: None
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18.0 HOISTING AND RIGGING IN HOSTILE ENVIRONMENTS

18.1 SCOPE

18.1.1 Normal Operations

Hoisting and rigging (H&R) activities can usually be accomplished where the environment will allow normal operations with access for hands-on equipment contact. In such situations, operations, maintenance, inspections, and tests shall be done in accordance with regular provisions of this manual.

18.1.2 Special Provisions

This section contains the special provisions for H&R operations and equipment in hostile environments where standard operating, maintenance, inspection, or test procedures cannot be followed as a result of radiation or contamination, toxic/hazardous chemicals or gasses, or temperature extremes.

18.2 EQUIPMENT AND OPERATIONS REVIEW

18.2.1 Prerequisite Review

The H&R equipment or operations shall be reviewed by a designated person to determine compliance with the requirements of this manual. If it is determined to be impossible or unreasonable for the requirements of this manual to be met as a result of hostile environmental conditions, then a hostile environment plan shall be prepared to document alternative compliance methods and procedures.

18.2.2 As Low As Reasonably Achievable

All H&R operations shall be consistent with the U.S. Department of Energy's radiation exposure policy of "as low as reasonably achievable" (ALARA).

18.2.3 First Priority

Safety of personnel shall remain the first priority.

18.3 HOSTILE ENVIRONMENT PLAN

18.3.1 Preparation

A hostile environment plan shall be prepared by a designated person and shall cover operations, equipment, inspection, testing, and maintenance. See Attachment 18.1 "Hostile Environment Plan."

18.3.2 Review/Approval Requirements

As a minimum, the plan shall be reviewed and approved (signed and dated) by responsible management at the facility where the crane/hoist or other equipment is located and responsible management of an overview organization (such as Safety or Quality Assurance). Depending upon the site-specific organizational structure, the following review/approvals are recommended:
1. *Facility manager

2. *Responsible management, oversight organization (safety or quality assurance/control)

3. Responsible operations manager

4. Equipment custodian

5. Cognizant engineer.

*Review/approval is mandatory.

18.3.3 Hostile Environment Plan Contents

The plan shall address only those actions or features that require deviation from the requirements of this manual because of a hostile environment, but shall contain the following information as a minimum:

1. The specific requirement(s) that are not in compliance

2. The difference between the requirement and actual conditions

3. Justification for not meeting this manual's requirements

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

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

6. Replacement or retirement criteria for equipment that is designed to operate with minimum or no maintenance.

18.3.4 Additional Procedures

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

18.3.5 Hostile Environment Plan Distribution

The facility manager shall ensure that the approved hostile environment plan is distributed as follows:

1. U.S. Department of Energy, Richland Operations Office Hoisting and Rigging Program Manager, MSIN R3-78 (for information)

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


**NOTE:** Hostile environment plans in the equipment history file shall be readily available to appointed personnel.
18.4 MARKING AND POSTING

Equipment that requires a hostile environment plan should be posted "Hostile Environment Plan--Special Maintenance and Operating Instructions."

18.5 INSPECTION AND MATERIAL LIMITATIONS

18.5.1 Hardware

Handling fixtures, rigging, and rigging accessories shall be marked, tagged, load tested, and otherwise qualified, as appropriate, in accordance with this manual before being exposed to the hostile environment.

18.5.2 Synthetic Fiber Slings

Synthetic fiber slings, including Kevlar\textsuperscript{1}, K-Spec\textsuperscript{2}, nylon, and polyester may be used in radiation areas only when the responsible person ensures that the absorbed dose shall not exceed 100,000 rads during the life of the sling.

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\textsuperscript{1} Kevlar is a registered trademark of DuPont de Nemours.

\textsuperscript{2} K-Spec is a registered trademark of SlingMax.
ATTACHMENT 18.1 -1 TYPICAL HOSTILE ENVIRONMENT PLAN

Building: __________________ Location: ________________________________

Type crane/hoist: ____________________________ (e.g., overhead top-running bridge and trolley; top-running bridge with underhung hoist; jib crane; monorail hoist; overhead hoist)

Capacity (main and auxiliary): _______________________________________

Power method: ____________________________ (e.g., hand operated, electrical powered)

Manufacturer: ______________________________________________________

1.a. Paragraph number of the H&R manual requirement that will not be met: __________________

(Copy the applicable paragraph)

1.b. Difference between manual requirement and what is to be allowed by this plan: __________________

__________________________________________

1.c. Justification for not meeting the manual requirement: __________________

__________________________________________

1.d. Actions or features to compensate for differences: __________________

__________________________________________

Include information regarding replacement or retirement criteria for this equipment. Also include information regarding any special design, maintenance, or test considerations that apply to this equipment. __________________

[ADD ADDITIONAL SECTIONS TO THIS PLAN AS REQUIRED. (e.g., 2.a THROUGH 2.d).]

APPROVALS

Facility Manager____________________ Manager, Oversight Organization:____________________

(signature/date) (signature/date)

• Other: ____________________________

(signature/date)

* Modify approval cycle, see paragraph 18.3.2

Place approved Hostile Environment Plan in Equipment History File

Make readily available to operating and maintenance personnel-
Monday,
August 9, 2010

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Part 1926
Cranes and Derricks in Construction; Final Rule
Subpart S—Underground Construction, Caissons, Cofferdams, and Compressed Air

19. The authority citation for subpart S of 29 CFR part 1926 is revised to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (40 U.S.C. 333); secs. 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor’s Orders 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), or 5–2007 (72 FR 31159) as applicable.

20. Section 1926.800 is amended by revising paragraph (t) to read as follows:

§ 1926.800 Underground construction.

(t) Hoisting unique to underground construction. Employers must comply with § 1926.550(g) of § 1926 subpart DD. Except as modified by this paragraph (t), the following provisions of subpart N of this part apply: Requirements for material hoists are found in §§ 1926.552(a) and (b) of this part. Requirements for personnel hoists are found in the personnel hoists requirements of §§ 1926.552(a) and (c) of this part and in the elevator requirement of §§ 1926.552(a) and (d) of this part.

Subpart T—Demolition

21. The authority citation for subpart T of 29 CFR part 1926 is revised to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (40 U.S.C. 333); secs. 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor’s Orders 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), or 5–2007 (72 FR 31159) as applicable.

22. Section 1926.856 is amended by revising paragraph (c) to read as follows:

§ 1926.856 Removal of walls, floors, and material with equipment.

(c) Mechanical equipment used shall meet the requirements specified in subparts N and O of § 1926.1501 of § 1926 subpart DD.

23. Section 1926.858 is amended by revising paragraph (h) to read as follows:

§ 1926.858 Removal of walls, floors, and material with equipment.

(h) Cranes, derricks, and other hoisting equipment used shall meet the requirements specified in § 1926.1501 of § 1926 subpart DD.

Subpart V—Power Transmission and Distribution

24. The authority citation for subpart V of part 1926 is revised to read as follows:

Authority: Section 3704 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3701); secs. 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor’s Order Nos. 12–71 (36 FR 8754); 8–76 (41 FR 25059); 9–83 (48 FR 35736), 1–90 (55 FR 9033), and 5–2007 (72 FR 31159). Section 1926.951 also issued under 29 CFR part 1911.

25. Section 1926.952 is amended by revising paragraph (c) to read as follows:

§ 1926.952 Mechanical equipment.

(c) Cranes and other lifting equipment.

(1) All equipment shall comply with subparts CC and O of this part, as applicable.

(2) Digger derricks used for augering holes for poles carrying electric lines, placing and removing poles, or for handling associated materials to be installed or removed from the poles must comply with 29 CFR 1910.269.

(3) With the exception of equipment certified for work on the proper voltage, mechanical equipment shall not be operated closer to any energized line or equipment than the clearances set forth in § 1926.950(c) unless, in addition to the requirements in § 1926.1410:

(i) The mechanical equipment is insulated, or

(ii) The mechanical equipment is considered as energized.

Note to paragraph (c)(3): In accordance with 29 CFR 1926.1400(g), compliance with 29 CFR 1910.269(p) will be deemed in compliance with §§ 1926.1407 through 1926.1411, including § 1926.1410.

Subpart X—Stairways and Ladders

26. The authority citation for subpart X of 1926 part 1926 is amended by revising paragraph (a) to read as follows:

Authority: Section 107, Contract Work Hours and Safety Standards Act (Construction Safety Act)(40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor’s Orders Nos. 1–90 (55 FR 9033), 5–2007 (72 FR 31159); and 29 CFR part 1911.

27. Section 1926.1050 is amended by revising paragraph (a) to read as follows:

§ 1926.1050 Scope, application, and definitions applicable to this subpart.

(a) Scope and application. This subpart applies to all stairways and ladders used in construction, alteration, repair (including painting and decorating), and demolition workplaces covered under 29 CFR part 1926, and also sets forth, in specified circumstances, when ladders and stairways are required to be provided. Additional requirements for ladders used on or with scaffolds are contained in subpart L—Scaffolds. This subpart does not apply to integral components of equipment covered by subpart CC. Subpart CC exclusively sets forth the circumstances when ladders and stairways must be provided on equipment covered by subpart CC.
Signals—radio, telephone or other electronic transmission of signals. 
Signals—voice signals—additional requirements. 
Signals—hand signal chart. 
Fall protection. 
Work area control. 
Keeping clear of the load. 
Free fall and controlled load lowering. 
Operator qualification and certification. 
Signal person qualifications. 
Qualifications of maintenance & repair employees. 
Training. 
Hoisting personnel. 
Multiple-crane/derrick lifts—supplemental requirements. 
Design, construction and testing. 
Equipment modifications. 
Tower cranes. 
Derricks. 
Floating cranes/derricks and land cranes/derricks on barges. 
Overhead & gantry cranes. 
Telescopic/hydraulic gantry cranes. 
Machinery that hoists by using a come-a-long or chainfall. 
Gin poles when used for the erection of communication towers. 
"Hammerhead boom", luffing boom and self-erecting; pedestal cranes; portal cranes; overhead and gantry cranes; straddle cranes; sideboom cranes; derricks; and variations of such equipment. However, items listed in paragraph (c) of this section are excluded from the scope of this standard. 
(a) This standard applies to power-operated equipment, when used in construction, that can hoist, lower and horizontally move a suspended load. 
(b) Machinery included in paragraph (a) of this section while it has been converted or adapted for a non-hoisting/lifting use. Such conversions/adaptations include, but are not limited to: 
(1) Power shovels, excavators and concrete pumps. 
(2) Power shovels, excavators, wheel loaders, backhoes, loader backhoes, track loaders. This machinery is also excluded when used with chains, slings or other rigging to lift suspended loads. 
(3) Automotive wreckers and tow trucks when used to clear wrecks and haul vehicles. 
(4) Digger derricks when used for augering holes for poles carrying electric and telecommunication lines, placing and removing the poles, and for handling associated materials to be installed on or removed from the poles. Digger derricks used in work subject to 29 CFR part 1926, subpart V, must comply with 29 CFR 1910.269. Digger derricks used in construction work for telecommunication service (as defined at 29 CFR 1910.269(a)(40)) must comply with 29 CFR 1910.269. 
(5) Machinery originally designed as vehicle-mounted aerial devices (for lifting personnel) and self-propelled elevating work platforms. 
(6) Telescopic/hydraulic gantry systems. 
(7) Stacker cranes. 
(8) Powered industrial trucks (forklifts), except when configured to hoist and lower (by means of a winch or hook) and horizontally move a suspended load. 
(9) Mechanic’s truck with a hoisting device when used in activities related to equipment maintenance and repair. 
(10) Machinery that hoists by using a come-a-long or chainfall. 
(11) Dedicated drilling rigs. 
(12) Gin poles when used for the erection of communication towers. 
(13) Tree trimming and tree removal work. 
(14) Anchor handling or dredge-related operations with a vessel or barge using an affixed A-frame. 
(15) Roustabouts. 
(16) Helicopter cranes. 
(17) Material Delivery 
(i) Articulating/knuckle-boom truck cranes that deliver material to a construction site when used to transfer materials from the truck crane to the ground, without arranging the materials in a particular sequence for hoisting. 
(ii) Articulating/knuckle-boom truck cranes that deliver material to a construction site when the crane is used to transfer building supply sheet goods or building supply packaged materials from the truck crane onto a structure, using a fork/cradle at the end of the boom, but only when the truck crane is equipped with a properly functioning automatic overload prevention device. Such sheet goods or packaged materials include, but are not limited to: Sheets of sheet rock, sheets of plywood, bags of cement, sheets of or packages of roofing shingles, and rolls of roofing felt. 
(iii) This exclusion does not apply when: 
(A) The articulating/knuckle-boom crane is used to hold, support or stabilize the material to facilitate a construction activity, such as holding material in place while it is attached to the structure; 
(B) The material being handled by the articulating/knuckle-boom crane is a prefabricated component. Such prefabricated components include, but are not limited to: Precast concrete members or panels, roof trusses (wooden, cold-formed metal, steel, or other material), prefabricated building sections such as, but not limited to: Floor panels, wall panels, roof panels, roof structures, or similar items; 
(C) The material being handled by the crane is a structural steel member (for example, steel joists, beams, columns, steel decking (bundled or unbundled) or a component of a systems-engineered metal building (as defined in 29 CFR 1926 subpart K). 
(D) The activity is not specifically excluded under § 1400(c)(17)(i) and (ii). 
(e) All sections of this subpart CC apply to the equipment covered by this standard unless specified otherwise. 
(f) Where provisions of this standard direct an operator, crewmember, or other employee to take certain actions, the employer must establish, effectively
communicate to the relevant persons, and enforce, work rules to ensure compliance with such provisions.

(g) For work covered by subpart V of this part, compliance with 29 CFR § 1910.269(p) is deemed compliance with §§ 1926.1407 through 1926.1411.

(h) Section 1926.1402 does not apply to use designed for use on railroad tracks, when used on railroad tracks that are part of the general railroad system of transportation that is regulated pursuant to the Federal Railroad Administration under 49 CFR part 213, and that comply with applicable Federal Railroad Administration requirements. See § 1926.1402(f).

§ 1926.1401 Definitions.

A/D director (Assembly/Disassembly director) means an individual who meets this subpart’s requirements for an A/D director, irrespective of the person’s formal job title or whether the person is non-management or management personnel.

Articulating crane means a crane whose boom consists of a series of folding, pin connected structural members, typically manipulated to extend or retract by power from hydraulic cylinders.

Assembly/Disassembly means the assembly and/or disassembly of equipment covered under this standard. With regard to tower cranes, “erecting and climbing” replaces the term “assembly,” and “dismantling” replaces the term “disassembly.” Regardless of whether the crane is initially erected to its full height or is climbed in stages, the process of increasing the height of the crane is an erection process.

Assist crane means a crane used to assist in assembling or disassembling a crane.

Attachments means any device that expands the range of tasks that can be done by the equipment. Examples include, but are not limited to: An auger, drill, magnet, pile-driver, and boom-attached personnel platform.

Audible signal means a signal made by a distinct sound or series of sounds. Examples include, but are not limited to, sounds made by a bell, horn, or speaker.

Blocking (also referred to as “cribbing”) is wood or other material used to support equipment or a component and distribute loads to the ground. It is typically used to support lattice boom sections during assembly/ disassembly and under outrigger and stabilizer floats.

Boatswain’s chair means a single-point adjustable suspension scaffold consisting of a seat or sling (which may be incorporated into a full body harness) designed to support one employee in a sitting position.

Bogie means “travel bogie,” which is defined below.

Boom (equipment other than tower crane) means an inclined spar, strut, or other long structural member which supports the upper hoisting tackle on a crane or derrick. Typically, the length and vertical angle of the boom can be varied to achieve increased height or height and reach when lifting loads. Booms can usually be grouped into general categories of hydraulically extendable, cantilevered type, lattice section, cable supported type or articulating type.

Boom (tower cranes): On tower cranes, if the “boom” (i.e., principal horizontal structure) is fixed, it is referred to as a jib; if it is moveable up and down, it is referred to as a boom.

Boom angle indicator means a device which measures the angle of the boom relative to horizontal.

Boom hoist limiting device includes boom hoist disengaging device, boom hoist shut-off, boom hoist disconnect, boom hoist hydraulic relief, boom hoist kick-outs, automatic boom stop device, or derricking limiter. This type of device disengages boom hoist power when the boom reaches a predetermined operating angle. It also sets brakes or closes valves to prevent the boom from lowering after power is disengaged.

Boom length indicator indicates the length of the permanent part of the boom (such as ruled markings on the boom) or, as in some computerized systems, the length of the boom with extensions/attachments.

Boom stop includes boom stops, (belly straps with struts/standoff), telescoping boom stops, attachment boom stops, and backstops. These devices restrict the boom from moving above a certain maximum angle and toppling over backward.

Boom suspension system means a system of pendants, running ropes, sheaves, and other hardware which supports the boom tip and controls the boom angle.

Builder means the builder/constructor of equipment.

Center of gravity: The center of gravity of any object is the point in the object around which its weight is evenly distributed. If you could put a support under that point, you could balance the object on the support.

Certified welder means a welder who meets nationally recognized certification requirements applicable to the task being performed.

Climbing means the process in which a tower crane is raised to a new working height, either by adding additional tower sections to the top of the crane (top climbing), or by a system in which the entire crane is raised inside the structure (inside climbing).

Cone-a-long means a mechanical device typically consisting of a chain or cable attached at each end that is used to facilitate movement of materials through leverage.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Controlled load lowering means lowering a load by means of a mechanical hoist drum device that allows a hoisted load to be lowered with maximum control using the gear train or hydraulic components of the hoist mechanism. Controlled load lowering requires the use of the hoist drive motor, rather than the load hoist brake, to lower the load.

Controlling entity means an employer that is a prime contractor, general contractor, construction manager or any other legal entity which has the overall responsibility for the construction of the project—its planning, quality and completion.

Counterweight means a weight used to supplement the weight of equipment in providing stability for lifting loads by counterbalancing those loads.

Craner/derrick includes all equipment covered by this subpart.

Crawler crane means equipment that has a type of base mounting which incorporates a continuous belt of sprocket driven track.

Crossover points means locations on a work rope which is spooled on a drum where one layer of rope climbs up on and crosses over the previous layer. This takes place at each flange of the drum as the rope is spooled onto the drum, reaches the flange, and begins to wrap back in the opposite direction.

Dedicated channel means a line of communication assigned by the employer who controls the communication system to only one signal person and crane/derrick or to a coordinated group of cranes/derricks/signal person(s).

Dedicated pile-driver is a machine that is designed to function exclusively as a pile-driver. These machines typically have the ability to both hoist the material that will be pile-driven and to pile-drive that material.

Dedicated spotter (power lines): To be considered a dedicated spotter, the requirements of § 1926.1428 (Signal person qualifications) must be met and
his/her sole responsibility is to watch the separation between the power line and the equipment, load line and load (including rigging and lifting accessories), and ensure through communication with the operator that the applicable minimum approach distance is not breached.

Directly under the load means a part or all of an employee is directly beneath the load.

Dismantling includes partial dismantling (such as dismantling to shorten a boom or substitute a different component).

Drum rotation indicator means a device on a crane or hoist which indicates in which direction and at what relative speed a particular hoist drum is turning.

Electrical contact occurs when a person, object, or equipment makes contact or comes in close proximity with an energized conductor or equipment that allows the passage of current.

Employer-made equipment means floating cranes/derricks designed and built by an employer for the employer’s own use.

Encroachment is where any part of the crane, load line or load (including rigging and lifting accessories) breaches a minimum clearance distance that this subpart requires to be maintained from a power line.

Equipment means equipment covered by this subpart.

Equipment criteria means instructions, recommendations, limitations and specifications.

Fall protection equipment means guardrail systems, safety net systems, personal fall arrest systems, positioning device systems or fall restraint systems.

Fall zone means the area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall in the event of an accident.

Flange points are points of contact between rope and drum flange where the rope changes layers.

Floating cranes/derricks means equipment designed by the manufacturer (or employer) for marine use by permanent attachment to a barge, pontoons, vessel or other means of flotation.

For example means “one example, although there are others.”

Free fall (of the load line) means that only the brake is used to regulate the descent of the load line (the drive mechanism is not used to drive the load down faster or retard its lowering).

Free surface effect is the uncontrolled transverse movement of liquids in compartments which reduce a vessel’s transverse stability.

Hoist means a mechanical device for lifting and lowering loads by winding a line onto or off a drum.

Hoisting is the act of raising, lowering or otherwise moving a load in the air with equipment covered by this standard. As used in this standard, “hoisting” can be done by means other than wire rope/hoist drum equipment.

Include/including means “including but not limited to.”

Insulating link/device means an insulating device listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with 29 CFR 1910.7.

Jib stop (also referred to as a jib backstop), is the same type of device as a boom stop but is for a fixed or luffing jib.

Land crane/derrick is equipment not originally designed by the manufacturer for marine use by permanent attachment to barges, pontoons, vessels, or other means of floatation.

List means the angle of inclination about the longitudinal axis of a barge, pontoons, vessel or other means of floatation.

Load refers to the object(s) being hoisted and/or the weight of the object(s); both uses refer to the object(s) and the load-attaching equipment, such as, the load block, ropes, slings, shackles, and any other ancillary attachment.

Load moment (or rated capacity) indicator means a system which aids the equipment operator by sensing (directly or indirectly) the overturning moment on the equipment, i.e., load multiplied by radius. It compares this lifting condition to the equipment’s rated capacity, and indicates to the operator the percentage of capacity at which the equipment is working. Lights, bells, or buzzers may be incorporated as a warning of an approaching overload condition.

Load moment (or rated capacity) limiter means a system which aids the equipment operator by sensing (directly or indirectly) the overturning moment on the equipment, i.e., load multiplied by radius. It compares this lifting condition to the equipment’s rated capacity, and when the rated capacity is reached, it shuts off power to those equipment functions which can increase the severity of loading on the equipment, e.g., hoisting, telescoping out, or luffing out. Typically, those functions which decrease the severity of loading on the equipment remain operational, e.g., lowering, telescoping in, or luffing in.

Locomotive crane means a crane mounted on a base or car equipped for travel on a railroad track.

Luffing jib limiting device is similar to a boom hoist limiting device, except that it limits the movement of the luffing jib.

Marine hoisted personnel transfer device means a device, such as a “transfer net,” that is designed to protect the employees being hoisted during a marine transfer and to facilitate rapid entry into and exit from the device.

Such devices do not include boatswain’s chairs when hoisted by equipment covered by this standard.

Marine worksite means a construction worksite located in, on or above the water.

Mobile crane means a lifting device incorporating a cable suspended latticed boom or hydraulic telescopic boom designed to be moved between operating locations by transport over the road.

Moving point-to-point means the times during which an employee is in the process of going to or from a work station.

Multi-purpose machine means a machine that is designed to be configured in various ways, at least one of which allows it to hoist (by means of a winch or hook) and horizontally move a suspended load. For example, a machine that can rotate and can be configured with removable forks/tongs (for use as a forklift) or with a winch pack, jib (with a hook at the end) or jib used in conjunction with a winch.

When configured with the forks/tongs, it is not covered by this subpart. When configured with a winch pack, jib (with a hook at the end) or jib used in conjunction with a winch, it is covered by this subpart.

Nationally recognized accrediting agency is an organization that, due to its independence and expertise, is widely recognized as competent to accredit testing organizations. Examples of such accrediting agencies include, but are not limited to, the National Commission for Certifying Agencies and the American National Standards Institute.

Nonconductive means that, because of the nature and condition of the materials used, and the conditions of use (including environmental conditions and condition of the material), the object in question has the...
property of not becoming energized (that is, it has high dielectric properties offering a high resistance to the passage of current under the conditions of use).

Operational aids are devices that assist the operator in the safe operation of the crane by providing information or automatically taking control of a crane function. These include, but are not limited to, the devices listed in §1926.1416 ("listed operational aids").

Operational controls means levers, switches, pedals and other devices for controlling equipment operation.

Operator means a person who is operating the equipment.

Overhead and gantry cranes includes overhead/bridge cranes, semigantry, cantilever gantry, wall cranes, storage bridge cranes, launching gantry cranes, and similar equipment, irrespective of whether it travels on tracks, wheels, or other equipment.

Paragraph refers to a paragraph in the same section of this subpart that the word "paragraph" is used, unless otherwise specified.

Pendants includes both wire and bar types. Wire type: A fixed length of wire rope with mechanical fittings at both ends for pinning segments of wire rope together. Bar type: Instead of wire rope, a bar is used. Pendants are typically used in a latticed boom crane system to easily change the length of the boom suspension system without completely changing the rope on the drum when the boom length is increased or decreased.

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, a body harness and may include a lanyard, deceleration device, lifeline, or suitable combination of these.

Portal crane is a type of crane consisting of a rotating upperstructure, hoist machinery, and boom mounted on top of a structural gantry which may be fixed in one location or have travel capability. The gantry legs or columns usually have portal openings in between to allow passage of traffic beneath the gantry.

Power lines means electric transmission and distribution lines.

Procedures include, but are not limited to: Instructions, diagrams, recommendations, warnings, specifications, protocols and limitations.

Proximity alarm is a device that provides a warning of proximity to a power line and that has been listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with 29 CFR 1910.7.

Qualified evaluator (not a third party) means a person employed by the signal person’s employer who has demonstrated that he/she is competent in accurately assessing whether individuals meet the Qualification Requirements in this subpart for a signal person.

Qualified evaluator (third party) means an entity that, due to its independence and expertise, has demonstrated that it is competent in accurately assessing whether individuals meet the Qualification Requirements in this subpart for a signal person.

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

Qualified rigger is a rigger who meets the criteria for a qualified person.

Range control limit device is a device that can be set by an equipment operator to limit movement of the boom or jib tip to a plane or multiple planes.

Range control warning device is a device that can be set by an equipment operator to warn that the boom or jib tip is at a plane or multiple planes.

Rated capacity means the maximum working load permitted by the manufacturer under specified working conditions. Such working conditions typically include a specific combination of factors such as equipment configuration, radii, boom length, and other parameters of use.

Rated capacity indicator: See load moment indicator.

Rated capacity limiter: See load moment limiter.

Repetitive pickup points refer to, when operating on a short cycle operation, the rope being used on a single layer and being spooled repetitively over a short portion of the drum.

Running wire rope means a wire rope that moves over sheaves or drums.

Runway means a firm, level surface designed, prepared and designated as a path of travel for the weight and configuration of the crane being used to lift and travel with the crane suspended platform. An existing surface may be used as long as it meets these criteria.

Section means a section of this subpart, unless otherwise specified.

Sideboom crane means a track-type or wheel-type tractor having a boom mounted on the side of the tractor, used for lifting, lowering or transporting a load suspended from the load hook. The boom or hook can be lifted or lowered in a vertical direction only.

Special hazard warnings means warnings of site-specific hazards (for example, proximity of power lines).

Stability (flotation device) means the tendency of a barge, pontoons, vessel or other means of flotation to return to an upright position after having been inclined by an external force.

Standard Method means the protocol in Appendix A of this subpart for hand signals.

Such as means “such as, but not limited to.”

Superstructure: See Upperworks.

Tagline means a rope (usually fiber) attached to a lifted load for purposes of controlling load spinning and pendular motions or used to stabilize a bucket or magnet during material handling operations.

Tender means an individual responsible for monitoring and communicating with a diver.

Tilt up or tilt down operation means raising/lowering a load from the horizontal to vertical or vertical to horizontal.

Tower crane is a type of lifting structure which utilizes a vertical mast or tower to support a working boom (jib) in an elevated position. Loads are suspended from the working boom. While the working boom may be of the fixed type (horizontal or angled) or have luffing capability, it can always rotate to swing loads, either by rotating on the top of the tower (top slewing) or by the rotation of the tower (bottom slewing). The tower base may be fixed in one location or ballasted and moveable between locations. Mobile cranes that are configured with luffing jib and/or tower attachments are not considered tower cranes under this section.

Travel bogie (tower cranes) is an assembly of two or more axles arranged to permit vertical wheel displacement and equalize the loading on the wheels.

Trim means angle of inclination about the transverse axis of a barge, pontoons, vessel or other means of flotation.

Two blocking means a condition in which a component that is uppermost on the hoist line such as the load block, hook block, overhaul ball, or similar component, comes in contact with the boom tip, fixed upper block or similar component. This hinders the system and continued application of power can cause failure of the hoist rope or other component.

Unavailable procedures means procedures that are no longer available from the manufacturer, or have never been available, from the manufacturer.

Upperstructure: See Upperworks.
§ 1926.1402 Ground conditions.
(a) Definitions.
(1) "Ground conditions" means the ability of the ground to support the equipment (including slope, compaction, and firmness).

(b) "Supporting materials" means blocking, mats, cribbing, marsh buggies (in marshes/wetlands), or similar supporting materials or devices.

(c) The equipment must not be assembled or used unless ground conditions are firm, drained, and graded to a sufficient extent so that, in conjunction (if necessary) with the use of supporting materials, the equipment manufacturer’s specifications for adequate support and degree of level of the equipment are met. The requirement for the ground to be drained does not apply to marshes/wetlands.

(d) The controlling entity must:
(1) Ensure that ground preparations necessary to meet the requirements in paragraph (b) of this section are provided.
(2) Inform the user of the equipment and the operator of the location of hazards beneath the equipment set-up area (such as voids, tanks, utilities) if those hazards are identified in documents (such as site drawings, as-built drawings, and soil analyses) that are in the possession of the controlling entity (whether at the site or off-site) or the hazards are otherwise known to that controlling entity.

(e) If there is no controlling entity for the project, the requirement in paragraph (c)(1) of this section must be met by the employer that has authority at the site to make or arrange for ground preparations needed to meet paragraph (b) of this section.

(f) If the A/D director or the operator determines that ground conditions do not meet the requirements in paragraph (b) of this section, that person’s employer must have a discussion with the controlling entity regarding the ground preparations that are needed so that, with the use of suitable supporting materials/devices (if necessary), the requirements in paragraph (b) of this section can be met.

(g) This section does not apply to cranes designed for use on railroad tracks when used on railroad tracks that are part of the general railroad system of transportation that is regulated pursuant to the Federal Railroad Administration under 49 CFR part 213 and that comply with applicable Federal Railroad Administration requirements.

§ 1926.1403 Assembly/Disassembly—selection of manufacturer or employer procedures.
When assembling or disassembling equipment (or attachments), the employer must comply with all applicable manufacturer prohibitions and must comply with either:
(a) Manufacturer or employer procedures applicable to assembly and disassembly, or
(b) Employer procedures for assembly and disassembly. Employer procedures may be used only where the employer can demonstrate that the procedures used meet the requirements in § 1926.1406.

Note: The employer must follow manufacturer procedures when an employer uses synthetic slings during assembly or disassembly rigging. (See § 1926.1404(r).

§ 1926.1404 Assembly/Disassembly—general requirements (applies to all assembly and disassembly operations).
(a) Supervision—competent-qualified person.
(1) Assembly/disassembly must be directed by a person who meets the criteria for both a competent person and a qualified person, or by a competent person who is assisted by one or more qualified persons ("A/D director").
(2) Where the assembly/disassembly is being performed by only one person, that person must meet the criteria for both the competent person and a qualified person. For purposes of this standard, a person is considered the A/D director.

(b) Knowledge of procedures. The A/D director must understand the applicable assembly/disassembly procedures.

(c) Review of procedures. The A/D director must review the applicable assembly/disassembly procedures immediately prior to the commencement of assembly/disassembly unless the A/D director understands the procedures and has applied them to the same type and configuration of equipment (including accessories, if any).

(d) Crew instructions.
(1) Before commencing assembly/disassembly operations, the A/D director must ensure that the crew members understand all of the following:
(i) Their tasks.
(ii) The hazards associated with their tasks.
(iii) The hazardous positions/layers that they need to avoid.

(2) During assembly/disassembly operations, before a crew member takes on a different task, or when adding new personnel during the operations, the requirements in paragraphs (d)(1)(i) through (d)(1)(iii) of this section must be met.

(e) Protecting assembly/disassembly crew members out of operator view.
(1) Before a crew member goes to a location that is out of view of the operator and is either in, on, or under the equipment, or near the equipment (or load) where the crew member could be injured by movement of the equipment (or load), the crew member must inform the operator that he/she is going to that location.

(ii) The operator knows that a crew member went to a location covered by paragraph (e)(1) of this section, the operator must not move any part of the equipment (or load) until the operator is informed in accordance with a pre-arranged system of communication that the crew member is in a safe position.

(f) Working under the boom, jib or other components.
(1) When pins (or similar devices) are being removed, employees must not be under the boom, jib, or other components, except where the requirements of paragraph (f)(2) of this section are met.

(ii) The crew members out of operator view.

(2) During assembly/disassembly operations, before a crew member takes on a different task, or when adding new personnel during the operations, the requirements in paragraphs (d)(1)(i) through (d)(1)(iii) of this section must be met.

(h) Exception. When the employer demonstrates that site constraints require one or more employees to be under the boom, jib, or other components when pins (or similar devices) are being removed, the A/D director must implement procedures that minimize the risk of unintended dangerous movement and minimize the duration and extent of exposure under the boom. (See Non-mandatory Appendix B of this subpart for an example.)

(g) Capacity limits. During all phases of assembly/disassembly, rated capacity limits for loads imposed on the equipment, equipment components (including rigging), lifting lugs and equipment accessories, must not be exceeded for the equipment being assembled/disassembled.

(i) Addressing specific hazards. The A/D director supervising the assembly/disassembly operation must address the hazards associated with the operation, which include:

Uperworks means the revolving frame of equipment on which the operating machinery (and many cases the engine) are mounted along with the operator’s cab. The counterweight is typically supported on the rear of the upperstructure and the boom or other front end attachment is mounted on the front.

Up to means “up to and including.” Wire rope means a flexible rope constructed by laying steel wires into various patterns of multi-wired strands around a core system to produce a helically wound rope.
(1) Site and ground bearing conditions. Site and ground conditions must be adequate for safe assembly/disassembly operations and to support the equipment during assembly/disassembly (see § 1926.1402 for ground condition requirements).

(2) Blocking material. The size, amount, condition and method of stacking the blocking must be sufficient to sustain the loads and maintain stability.

(3) Proper location of blocking. When used to support lattice booms or components, blocking must be appropriately placed to:

(i) Protect the structural integrity of the equipment, and

(ii) Prevent dangerous movement and collapse.

(4) Verifying assist crane loads. When using an assist crane, the loads that will be imposed on the assist crane at each phase of assembly/disassembly must be verified in accordance with § 1926.1417(o)(3) before assembly/disassembly begins.

(5) Boom and jib pick points. The point(s) of attachment of rigging to a boom (or boom sections or jib or jib sections) must be suitable for preventing structural damage and facilitating safe handling of these components.

(6) Center of gravity.

(i) The center of gravity of the load must be identified if that is necessary for the method used for maintaining stability.

(ii) Where there is insufficient information to accurately identify the center of gravity, measures designed to prevent unintended dangerous movement resulting from an inaccurate identification of the center of gravity must be used. (See Non-mandatory Appendix B of this subpart for an example.)

(7) Stability upon pin removal. The boom sections, boom suspension systems (such as gantry A-frames and jib struts), and components must be rigged or supported to maintain stability upon the removal of the pins.

(8) Snagging. Suspension ropes and pendants must not be allowed to catch on the boom or jib connection pins or cotter pins (including keepers and locking pins).

(9) Struck by counterweights. The potential for unintended movement from inadequately supported counterweights and from hoisting counterweights.

(10) Boom hoist brake failure. Each time reliance is to be placed on the boom hoist brake to prevent boom movement during assembly/disassembly, the brake must be tested prior to such reliance to determine if it is sufficient to prevent boom movement. If it is not sufficient, a boom hoist pawl, other locking device/back-up braking device, or another method of preventing dangerous movement of the boom (such as blocking or using an assist crane) from a boom hoist brake failure must be used.

(11) Loss of backward stability. Backward stability before swinging the upperworks, travel, and when attaching or removing equipment components.

(12) Wind speed and weather. The effect of wind speed and weather on the equipment.

(i) [Reserved.]

(j) Cantilevered boom sections. Manufacturer limitations on the maximum amount of boom supported only by cantilevering must not be exceeded. Where these are unavailable, a registered professional engineer familiar with the type of equipment involved must determine in writing this limitation, which must not be exceeded.

(k) Weight of components. The weight of each of the components must be readily available.

(l) [Reserved.]

(m) Components and configuration. The selection of components, and configuration of the equipment, that affect the capacity or safe operation of the equipment must be in accordance with:

(i) Manufacturer instructions, prohibitions, limitations, and specifications. Where these are unavailable, a registered professional engineer familiar with the type of equipment involved must approve, in writing, the selection and configuration of components; or

(ii) Approved modifications that meet the requirements of § 1926.1434 (Equipment modifications).

(2) Post-assembly inspection. Upon completion of assembly, the equipment must be inspected to ensure compliance with paragraph (m)(1) of this section (see § 1926.1412(c) for post-assembly inspection requirements).

(n) [Reserved.]

(o) Shipping pins. Reusable shipping pins, straps, links, and similar equipment must be removed. Once they are removed they must either be stowed or otherwise stored so that they do not present a falling object hazard.

(p) Pile driving. Equipment used for pile driving must not have a jib attached during pile driving operations.

(q) Outriggers and Stabilizers. When the load to be handled and the operating radius require the use of outriggers or stabilizers, or at any time when outriggers or stabilizers are used, all of the following requirements must be met (except as otherwise indicated):

(1) The outriggers or stabilizers must be either fully extended or, if manufacturer procedures permit, deployed as specified in the load chart.

(2) The outriggers must be set to remove the equipment weight from the wheels, except for locomotive cranes (see paragraph (q)(6) of this section for use of outriggers on locomotive cranes). This provision does not apply to stabilizers.

(3) When outrigger floats are used, they must be attached to the outriggers. When stabilizer floats are used, they must be attached to the stabilizers.

(4) Each outrigger or stabilizer must be visible to the operator or to a signal person during extension and setting.

(5) Outrigger and stabilizer blocking must:

(i) Meet the requirements in paragraphs (h)(2) and (h)(3) of this section.

(ii) Be placed only under the outrigger or stabilizer float/pad of the jack or, where the outrigger or stabilizer is designed without a jack, under the outer bearing surface of the extended outrigger or stabilizer beam.

(6) For locomotive cranes, when using outriggers or stabilizers to handle loads, the manufacturer’s procedures must be followed. When lifting loads without using outriggers or stabilizers, the manufacturer’s procedures must be met regarding truck wedges or screws.

(r) Rigging. In addition to following the requirements in 29 CFR 1926.251 and other requirements in this and other standards applicable to rigging, when rigging is used for assembly/disassembly, the employer must ensure that:

(1) The rigging work is done by a qualified rigger.

(2) Synthetic slings are protected from: Abrasive, sharp or acute edges, and configurations that could cause a reduction of the sling’s rated capacity, such as distortion or localized compression. Note: Requirements for the protection of wire rope slings are contained in 29 CFR 1926.251(c)(9).

(3) When synthetic slings are used, the synthetic sling manufacturer’s instructions, limitations, specifications and recommendations must be followed.

§ 1926.1405 Disassembly—additional requirements for dismantling of booms and jibs (applies to both the use of manufacturer procedures and employer procedures).

Dismantling (including dismantling for changing the length of) booms and jibs.

(a) None of the pins in the pendants are to be removed (partly or completely) when the pendants are in tension.
(b) None of the pins (top or bottom) on boom sections located between the uppermost boom section and the crane/derrick body are to be removed (partly or completely) when the booms are in tension.
(c) None of the pins (top or bottom) on boom sections located between the uppermost boom section and the crane/derrick body are to be removed (partly or completely) when the boom is being supported by the uppermost boom section resting on the ground (or other support).
(d) None of the top pins on boom sections located on the cantilevered portion of the boom being removed (the portion being removed ahead of the pendant attachment points) are to be removed (partly or completely) until the cantilevered portion to be removed is fully supported.

§ 1926.1406 Assembly/Disassembly—employer procedures—general requirements.

(a) When using employer procedures instead of manufacturer procedures for assembly/disassembly, the employer must ensure that the procedures:
(1) Prevent unintended dangerous movement, and prevent collapse, of any part of the equipment.
(2) Provide adequate support and stability of all parts of the equipment.
(3) Position employees involved in the assembly/disassembly operation so their exposure to unintended movements or collapse of part or all of the equipment is minimized.

(b) Qualified person. Employer procedures must be developed by a qualified person.

§ 1926.1407 Power line safety (up to 350 kV)—assembly and disassembly.

(a) Before assembling or disassembling equipment, the employer must 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 employer must meet the requirements in Option (1), Option (2), or Option (3) of this section, as follows:
(1) Option (1)—Deenergize and ground. Confirm from the utility owner/operator that the power line has been deenergized and visibly grounded at the worksite.
(2) Option (2)—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 measures specified in paragraph (b) of this section.
(3) Option (3)—Table A clearance.
   (i) Determine the line’s voltage and the minimum clearance distance permitted under Table A (see §1926.1408).
   (ii) Determine if any part of the equipment, load line, or load (including rigging and lifting accessories), could get closer than the minimum clearance distance to the power line permitted under Table A (see §1926.1408). If so, then the employer must follow the requirements in paragraph (b) of this section 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 clearance distance.
   (b) Preventing encroachment/electrocution. Where encroachment precautions are required under Option (2), or Option (3) of this section, all of the following requirements must be met:
   (1) Conduct a planning meeting with the Assembly/Disassembly director (A/D director), operator, assembly/disassembly crew and the other workers who will be in the assembly/disassembly area to review the location of the power line(s) and the steps that will be implemented to prevent encroachment/electrocution.
   (2) If tag lines are used, they must be nonconductive.
   (3) At least one of the following additional measures must be in place. The measure selected from this list must be effective in preventing encroachment.
      The additional measures are:
      (i) Use a dedicated spotter who is in continuous contact with the equipment operator. The dedicated spotter must:
         (A) Be equipped with a visual aid to assist in identifying the minimum clearance distance of the visual aid, 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);
         (B) Be positioned to effectively gauge the clearance distance.
      (C) Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.
      (D) Give timely information to the operator so that the required clearance distance can be maintained.
      (ii) A proximity alarm set to give the operator sufficient warning to prevent encroachment.
      (iii) 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.
   (C) 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 deenergized and and visibly grounded at the worksite.

§ 1926.1408 Power line safety (up to 350 kV)—equipment operations.

(a) Hazard assessments and precautions inside the work zone. Before beginning equipment operations, the employer must:
(1) Identify the work zone by either:
   (i) 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, or
   (ii) Defining the work zone as the area 360 degrees around the equipment, up to the equipment’s maximum working radius.

(b) Spotter. The employer must:
(1) Provide adequate support and stability of all parts of the equipment.
(2) Position employees involved in the assembly/disassembly operation so that their exposure to unintended movements or collapse of part or all of the equipment is minimized.
(3) Position an operator who is in continuous contact with the equipment operator. The operator must:
   (i) Be equipped with a visual aid to assist in identifying the minimum clearance distance of the visual aid, 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);
   (ii) Be positioned to effectively gauge the clearance distance.
   (C) Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.
   (D) Give timely information to the operator so that the required clearance distance can be maintained.
(2) Position at least one personnel who is in continuous contact with the equipment operator. The personnel must:
   (i) Be equipped with a visual aid to assist in identifying the minimum clearance distance of the visual aid, 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);
   (ii) Be positioned to effectively gauge the clearance distance.
(3) Where necessary, use equipment that enables the personnel to communicate directly with the operator.
(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) of this section, as follows:

(i) Option (1)—Deenergize and ground. Confirm from the utility owner/operator that the power line has been deenergized and visibly grounded at the worksite.

(ii) Option (2)—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 measures specified in paragraph (b) of this section.

(iii) Option (3)—Table A clearance. (A) Determine the line's voltage and the minimum approach distance permitted under Table A (see § 1926.1408).

(B) 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 A (see § 1926.1408). If so, then the employer must follow the requirements in paragraph (b) of this section 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.

(b) Preventing encroachment/electrocution Where encroachment precautions are required under Option (2) or Option (3) of this section, all of the following requirements must be met:

(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.

(2) If tag lines are used, they must be non-conductive.

(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 A (see § 1926.1408) (if using Option (3) of this section). If the operator is unable to see the elevated warning line, a dedicated spotter must be used as described in § 1926.1408(b)(4)(ii) in addition to implementing one of the measures described in §§ 1926.1408(b)(4)(i), (iii), (iv) and (v).

(4) Implement at least one of the following measures:

(i) A proximity alarm set to give the operator sufficient warning to prevent encroachment.

(ii) A dedicated spotter who is in continuous contact with the operator. Where this measure is selected, the dedicated spotter must:

(A) 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).

(B) Be positioned to effectively gauge the clearance distance.

(C) Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.

(D) Give timely information to the operator so that the required clearance distance can be maintained.

(iii) 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.

(iv) A device that automatically limits range of movement, set to prevent encroachment.

(v) An insulating link/device, as defined in § 1926.1401, installed at a point between the end of the load line (or below) and the load.

(5) The requirements of paragraph (b)(4) of this section do not apply to work covered by subpart V of this part.

(c) Voltage information. Where Option (3) of this section is used, the utility owner/operator of the power lines must provide the requested voltage information within two working days of the employer's request.

(d) Operations below power lines.

(1) 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 deenergized and (at the worksite) visibly grounded the power line, except where one of the exceptions in paragraph (d)(2) of this section applies.

(2) Exceptions. Paragraph (d)(1) of this section is inapplicable where the employer demonstrates that one of the following applies:

(i) The work is covered by subpart V of this part.

(ii) 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 A of this section minimum clearance distance below the plane of the power line.

(iii) 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 A of this section minimum clearance distance below the plane of the power line.

(iv) The employer demonstrates that compliance with paragraph (d)(1) of this section is infeasible and meets the requirements of § 1926.1410.

(e) 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 deenergized and visibly grounded at the worksite.

(f) When working near transmitter/communication towers where the equipment is close enough for an electrical charge to be induced in the equipment or materials being handled, the transmitter must be deenergized or the following precautions must be taken:

(1) The equipment must be provided with an electrical ground.

(2) If tag lines are used, they must be non-conductive.

(g) Training.

(1) The employer must train each operator and crew member assigned to work with the equipment on all of the following:

(i) The procedures to be followed in the event of electrical contact with a power line. Such training must include:

(A) Information regarding the danger of electrocution from the operator simultaneously touching the equipment and the ground.

(B) The importance to the operator's safety of remaining inside the cab except where there is an imminent danger of fire, explosion, or other emergency that necessitates leaving the cab.

(C) The safest means of evacuating from equipment that may be energized.

(D) The danger of the potentially energized zone around the equipment (step potential).

(E) The need for crew in the area to avoid approaching or touching the equipment and the load.

(F) Safe clearance distance from power lines.

(ii) Power lines are presumed to be energized unless the utility owner/
operator confirms that the power line has been deenergized and visibly grounded at the worksite.

(iii) Power lines are presumed to be uninsulated unless the utility owner/operator or a registered professional engineer who is a qualified person with respect to electrical power transmission and distribution confirms that a line is insulated.

(iv) The limitations of an insulating link/device, proximity alarm, and range control (and similar) device, if used.

(v) The procedures to be followed to properly ground equipment and the limitations of grounding.

(2) Employees working as dedicated spotters must be trained to enable them to effectively perform their task, including training on the applicable requirements of this section.

(3) Training under this section must be administered in accordance with § 1926.1430(g).

(h) Devices originally designed by the manufacturer for use as: A safety device (see § 1926.1415), operational aid, or a means to prevent power line contact or electrocution, when used to comply with this section, must meet the manufacturer’s procedures for use and conditions of use.

### TABLE A—MINIMUM CLEARANCE DISTANCES

<table>
<thead>
<tr>
<th>Voltage (nominal, kV, alternating current)</th>
<th>Minimum clearance distance (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 50</td>
<td>10</td>
</tr>
<tr>
<td>over 50 to 200</td>
<td>15</td>
</tr>
<tr>
<td>over 200 to 350</td>
<td>20</td>
</tr>
<tr>
<td>over 350 to 500</td>
<td>25</td>
</tr>
<tr>
<td>over 500 to 750</td>
<td>35</td>
</tr>
<tr>
<td>over 750 to 1,000</td>
<td>45</td>
</tr>
<tr>
<td>over 1,000</td>
<td></td>
</tr>
</tbody>
</table>

(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: The value that follows “to” is up to and includes that value. For example, over 50 to 200 means up to and including 200 kV.

§ 1926.1409 Power line safety (over 350 kV).

The requirements of § 1926.1407 and § 1926.1408 apply to power lines over 350 kV except:

(a) For power lines at or below 1000 kV, wherever the distance “20 feet” is specified, the distance “50 feet” must be substituted; and

(b) 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.

§ 1926.1410 Power line safety (all voltages)—equipment operations closer than the Table A zone.

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 A of § 1926.1408 to an energized power line is prohibited, except where the employer demonstrates that all of the following requirements are met:

(a) The employer determines that it is infeasible to do the work without breaching the minimum approach distance under Table A of § 1926.1408.

(b) The employer determines that, after consultation with the utility owner/operator, it is infeasible to deenergize and ground the power line or relocate the power line.

(c) Minimum clearance distance.

(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, and other conditions affecting the ability to prevent electrical contact.

(2) Paragraph (c)(1) of this section does not apply to work covered by subpart V of this part; instead, for such work, the minimum clearance distances specified in § 1926.950 Table V–1 apply. Employers engaged in subpart V work are permitted to work closer than the distances in § 1926.950 Table V–1 where both the requirements of this section and § 1926.952(c)(3)(i) or (ii) are met.

(d) 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:

(1) 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.

(2) A dedicated spotter who is in continuous contact with the operator.

The dedicated spotter must:

(i) 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 sight landmarks (such as a fence post behind the dedicated spotter and a building corner ahead of the dedicated spotter).

(ii) Be positioned to effectively gauge the clearance distance.

(iii) Where necessary, use equipment that enables the dedicated spotter to communicate directly with the operator.

(iv) Give timely information to the operator so that the required clearance distance can be maintained.

(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.

(4) Insulating link/device.

(i) An insulating link/device installed at a point between the end of the load line (or below) and the load.

(ii) For work covered by subpart V of this part, the requirement in paragraph
(d)(4)(ii) of this section applies only when working inside the § 1926.950 Table V–1 clearance distances.

(iii) For work covered by subpart V of this part involving operations where use of an insulating link/device is infeasible, the requirements of § 1910.269(p)(4)(iii)(B) or (C) may be substituted for the requirement in (d)(4)(ii) of this section.

(iv) Until November 8, 2011, the following procedure may be substituted for the requirement in paragraph (d)(4)(ii) of this section: All employees, excluding equipment operators located on the equipment, who may come in contact with the equipment, the load line, or the load must be insulated or guarded from the equipment, the load line, and the load. Insulating gloves rated for the voltage involved are adequate insulation for the purposes of this paragraph.

(v) Until November 8, 2013, the following procedure may be substituted for the requirement in (d)(4)(ii) of this section:

(A) The employer must use a link/device manufactured on or before November 8, 2011, that meets the definition of an insulating link/device, except that it has not been approved by a Nationally Recognized Testing Laboratory, and that is maintained and used in accordance with manufacturer requirements and recommendations, and is installed at a point between the end of the load line (or below) and the load; and

(B) All employees, excluding equipment operators located on the equipment, who may come in contact with the equipment, the load line, or the load must be insulated or guarded from the equipment, the load line, and the load through an additional means other than the device described in paragraph (d)(4)(iv)(A) of this section. Insulating gloves rated for the voltage involved are adequate additional means of protection for the purposes of this paragraph.

(5) Nonconductive rigging if the rigging may be within the Table A of § 1926.1408 distance during the operation.

(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 V–1 clearance distances established under paragraph (c) of this section.

(7) If a tag line is used, it must be of the nonconductive type.

(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) 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.

(10) Only personnel essential to the operation are permitted to be in the area of the crane and load.

(11) The equipment must be properly grounded.

(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.

(e) The procedures developed to comply with paragraph (d) of this section are documented and immediately available on-site.

(f) The equipment user and utility owner/operator (or registered professional engineer) 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 (c) of this section and prevent electrocution.

(g) The procedures developed to comply with paragraph (d) of this section are implemented.

(h) 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.

(i) [Reserved.]

(j) 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 repeat the 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.
§ 1926.1412 Inspections.

(a) Modified equipment.
(1) Equipment that has had modifications or additions which affect the safe operation of the equipment (such as modifications or additions involving a safety device or operational aid, critical part of a control system, power plant, braking system, load-sustaining structural components, load hook, or in-use operating mechanism) or capacity must be inspected by a qualified person after such modifications/additions have been completed, prior to initial use. The inspection must meet all of the following requirements:
   (i) The inspection must assure that the modifications or additions have been done in accordance with the approval obtained pursuant to § 1926.1434 (equipment modifications).
   (ii) The inspection must include functional testing of the equipment.
(2) Equipment must not be used until an inspection under this paragraph demonstrates that the requirements of paragraph (a)(1)(i) of this section have been met.

(b) Repaired/adjusted equipment.
(1) Equipment that has had a repair or adjustment that relates to safe operation (such as: A repair or adjustment to a safety device or operator aid, or to a critical part of a control system, power plant, braking system, load-sustaining structural components, load hook, or in-use operating mechanism), must be inspected by a qualified person after such a repair or adjustment has been completed, prior to initial use. The inspection must meet all of the following requirements:
   (i) The qualified person must determine if the repair/adjustment meets manufacturer equipment criteria (where applicable and available).
   (ii) Where manufacturer equipment criteria are unavailable or inapplicable, the qualified person must:
      (A) Determine if a registered professional engineer (RPE) is needed to develop criteria for the repair/adjustment. If an RPE is not needed, the employer must ensure that the criteria are developed by the qualified person. If an RPE is needed, the employer must ensure that they are developed by an RPE.
      (B) Determine if the repair/adjustment meets the criteria developed in accordance with paragraph (b)(1)(ii)(A) of this section.
   (iii) The inspection must include functional testing of the repaired/adjusted parts and other components that may be affected by the repair/adjustment.
(4) Equipment must not be used until an inspection under this paragraph demonstrates that the repair/adjustment meets the requirements of paragraph (b)(1)(i) of this section (or, where applicable, paragraph (b)(1)(ii) of this section).

(c) Post-assembly.
(1) Upon completion of assembly, the equipment must be inspected by a qualified person to assure that it is configured in accordance with manufacturer equipment criteria.
(2) Where manufacturer equipment criteria are unavailable, a qualified person must:
   (i) Determine if a registered professional engineer (RPE) familiar with the type of equipment involved is needed to develop criteria for the equipment configuration. If an RPE is not needed, the employer must ensure that the criteria are developed by the qualified person. If an RPE is needed, the employer must ensure that they are developed by an RPE.
   (ii) Determine if the equipment meets the criteria developed in accordance with paragraph (c)(2)(i) of this section.
(3) Equipment must not be used until an inspection under this paragraph demonstrates that the equipment is configured in accordance with the applicable criteria.

(d) Each shift.
(1) A competent person must begin a visual inspection prior to each shift the equipment will be used, which must be completed before or during that shift. The inspection must consist of observation for apparent deficiencies.

Taking apart equipment components and booming down is not required as part of this inspection unless the results of the visual inspection or trial operation indicate that further investigation necessitating taking apart equipment components or booming down is needed. Determinations made in conducting the inspection must be reassessed in light of observations made during operation. At a minimum the inspection must include all of the following:
   (i) Control mechanisms for maladjustments interfering with proper operation.
   (ii) Control and drive mechanisms for apparent excessive wear of components and contamination by lubricants, water or other foreign matter.
   (iii) Air, hydraulic, and other pressurized lines for deterioration or leakage, particularly those which flex in normal operation.
   (iv) Hydraulic system for proper fluid level.
   (v) Hooks and latches for deformation, cracks, excessive wear, or damage such as from chemicals or heat.
   (vi) Wire rope reeving for compliance with the manufacturer’s specifications.
   (vii) Wire rope, in accordance with § 1926.1413(a).
   (viii) Electrical apparatus for malfunctioning, signs of apparent excessive deterioration, dirt or moisture accumulation.
   (ix) Tires (when in use) for proper inflation and condition.
   (x) Ground conditions around the equipment for proper support, including ground settling under and around outriggers/stabilizers and supporting foundations, ground water accumulation, or similar conditions.

This paragraph does not apply to the inspection of ground conditions for railroad tracks and their underlying support when the railroad tracks are part of the general railroad system of transportation that is regulated pursuant to the Federal Railroad Administration under 49 CFR part 213.

(x) The equipment for level position
within the tolerances specified by the

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### Table T—Minimum Clearance Distances While Traveling With No Load

<table>
<thead>
<tr>
<th>Voltage (nominal, kV, alternating current)</th>
<th>While traveling—minimum clearance distance (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 0.75</td>
<td>4</td>
</tr>
<tr>
<td>over 0.75 to 50</td>
<td>6</td>
</tr>
<tr>
<td>over 50 to 345</td>
<td>10</td>
</tr>
<tr>
<td>over 345 to 750</td>
<td>16</td>
</tr>
<tr>
<td>Over 750 to 1,000</td>
<td>20</td>
</tr>
<tr>
<td>Over 1,000</td>
<td>(as established by the utility owner/operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution).</td>
</tr>
</tbody>
</table>

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Over 750 to 1,000: 20 feet
Over 345 to 750: 16 feet
Over 0.75 to 50: 6 feet
Over 50 to 345: 10 feet
Over 0.75: 4 feet

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(adjusted. If an RPE is not needed, the professional engineer (RPE) is needed to develop criteria for the qualified person must: criteria are unavailable or inapplicable, the qualified person must: A repair or adjustment to a...
equipment manufacturer’s recommendations, both before each shift and after each move and setup.

(xiii) Operator cab windows for significant cracks, breaks, or other deficiencies that would hamper the operator’s view.

(xiv) Rails, rail stops, rail clamps and supporting surfaces when the equipment has rail traveling. This paragraph does not apply to the inspection of rails, rail stops, rail clamps and supporting surfaces when the railroad tracks are part of the general railroad system of transportation that is regulated pursuant to the Federal Railroad Administration under 49 CFR part 213.

(xv) Safety devices and operational aids for proper operation.

(2) If any deficiency in paragraphs (d)(1)(ii) through (xiii) of this section (or in additional inspection items required to be checked for specific types of equipment in accordance with other sections of this standard) is identified, an immediate determination must be made by the competent person as to whether the deficiency constitutes a safety hazard. If the deficiency is determined to constitute a safety hazard, the equipment must be taken out of service until it has been corrected. See § 1926.1417.

(3) If any deficiency in paragraph (d)(2)(i)xiv) of this section (safety devices/operational aids) is identified, the action specified in § 1926.1417 and § 1926.1416 must be taken prior to using the equipment.

(a) Monthly.

(1) Each month the equipment is in service it must be inspected in accordance with paragraph (d) of this section (each shift).

(2) Equipment must not be used until an inspection under this paragraph demonstrates that no corrective action under paragraphs (d)(2) and (3) of this section is required.

(b) Documentation.

(i) The following information must be documented and maintained by the employer that conducts the inspection:

(A) The items checked and the results of the inspection.

(B) The name and signature of the person who conducted the inspection and the date.

(ii) This document must be retained for a minimum of three months.

(c) Annual/comprehensive.

(1) At least every 12 months the equipment must be inspected by a qualified person in accordance with paragraph (d) of this section (each shift) except that the corrective action set forth in paragraphs (f)(4), (f)(5), and (f)(6) of this section must apply in place of the corrective action required by paragraphs (d)(2) and (d)(3) of this section.

(2) In addition, at least every 12 months, the equipment must be inspected by a qualified person. Disassembly is required, as necessary, to complete the inspection. The equipment must be inspected for all of the following:

(i) Equipment structure (including the boom and, if equipped, the jib):

(A) Structural members: Deformed, cracked, or significantly corroded.

(B) Bolts, rivets and other fasteners: loose, failed or significantly corroded.

(C) Welds for cracks.

(ii) Sheaves and drums for cracks or significant wear.

(iii) Parts such as pins, bearings, shafts, gears, rollers and locking devices for distortion, cracks or significant wear.

(iv) Brake and clutch system parts, linings, pads and ratchets for excessive wear.

(v) Safety devices and operational aids for proper operation (including significant inaccuracies).

(vi) Gasoline, diesel, electric, or other power plants for safety-related problems (such as leaking exhaust and emergency shut-down feature) and conditions, and proper operation.

(vii) Chains and chain drive sprockets for excessive wear of sprockets and excessive chain stretch.

(viii) Travel steering, brakes, and locking devices, for proper operation.

(ix) Tires for damage or excessive wear.

(x) Hydraulic, pneumatic and other pressurized hoses, fittings and tubing, as follows:

(A) Flexible hose or its junction with the fittings for indications of leaks.

(B) Threaded or clamped joints for leaks.

(C) Outer covering of the hose for blistering, abnormal deformation or other signs of failure/impending failure.

(D) Outer surface of a hose, rigid tube, or fitting for indications of excessive abrasion or scrubbing.

(xi) Hydraulic and pneumatic pumps and motors, as follows:

(A) Spools: Sticking, improper return to neutral, and leaks.

(B) Leaks.

(C) Valve housing cracks.

(D) Relief valves: Failure to reach correct pressure (if there is a manufacturer procedure for checking pressure, it must be followed).

(xii) Hydraulic and pneumatic cylinders, as follows:

(A) Drifting caused by fluid leaking across the piston.

(B) Rod seals and welded joints for leaks.

(C) Cylinder rods for scores, nicks, or dents.

(D) Case (barrel) for significant dents.

(E) Rod eyes and connecting joints: Leaky or deformed.

(xiv) Outrigger or stabilizer pads/floats for excessive wear or cracks.

(xx) Slider pads for excessive wear or cracks.

(xx) Electrical components and wiring for cracked or split insulation and loose or corroded terminations.

(xxii) Warning labels and decals originally supplied with the equipment by the manufacturer or otherwise required under this standard: Missing or unreadable.

(xxiv) Originally equipped operator seat (or equivalent): Missing.

(xxv) Operator seat: Unserviceable.

(xxvi) Originally equipped steps, ladders, handrails, guards: Missing.

(xxvii) Steps, ladders, handrails, guards: In unusable/unsafe condition.

(3) This inspection must include functional testing to determine that the equipment as configured in the inspection is functioning properly.

(4) If any deficiency is identified, an immediate determination must be made by the qualified person as to whether the deficiency constitutes a safety hazard or, though not yet a safety hazard, needs to be monitored in the monthly inspections.

(5) If the qualified person determines that a deficiency is a safety hazard, the equipment must be taken out of service until it has been corrected, except when temporary alternative measures are implemented as specified in § 1926.1416(d) or § 1926.1435(e). See § 1926.1417.

(6) If the qualified person determines that, though not presently a safety hazard, the deficiency needs to be monitored, the employer must ensure that the deficiency is checked in the monthly inspections.

(7) Documentation of annual/comprehensive inspection. The following information must be documented, maintained, and retained for a minimum of 12 months, by the employer that conducts the inspection:

(i) The items checked and the results of the inspection.

(ii) The name and signature of the person who conducted the inspection and the date.

(g) Severe service. Where the severity of use/conditions is such that there is a
reasonable probability of damage or excessive wear (such as loading that may have exceeded rated capacity, shock loading that may have exceeded rated capacity, and/or prolonged exposure to a corrosive atmosphere), the employer must stop using the equipment and a qualified person must:

1. Inspect the equipment for structural damage to determine if the equipment can continue to be used safely.

2. In light of the use/conditions determine whether any items/conditions listed in paragraph (f) of this section need to be inspected; if so, the qualified person must inspect those items/conditions.

3. If a deficiency is found, the employer must follow the requirements in paragraphs (f)(4) through (6) of this section.

(b) Equipment not in regular use. Equipment that has been idle for 3 months or more must be inspected by a qualified person in accordance with the requirements of paragraph (e) (Monthly) of this section before initial use.

(i) [Reserved.]

(j) Any part of a manufacturer’s procedures regarding inspections that relate to safe operation (such as to a safety device or operational aid, critical part of a control system, power plant, braking system, load-sustaining structural components, load hook, or in-use operating mechanism) that is more comprehensive or has a more frequent schedule of inspection than the requirements of this section must be followed.

(k) All documents produced under this section must be available, during the applicable document retention period, to all persons who conduct inspections under this section.

§ 1926.1413 Wire rope—inspection.

(a) Shift inspection.

(1) A competent person must begin a visual inspection prior to each shift the equipment is used, which must be completed before or during that shift. The inspection must consist of observation of wire ropes (running and standing) that are likely to be in use during the shift for apparent deficiencies, including those listed in paragraph a)(2) of this section. Untwisting (opening) of wire rope or booming down is not required as part of this inspection.

(2) Apparent deficiencies.

(i) Category I. Apparent deficiencies in this category include the following:

(A) Significant distortion of the wire rope structure such as kinking, crushing, unstranding, birdcaging, signs of core failure or steel core protrusion between the outer strands.

(B) Significant corrosion.

(C) Electric arc damage (from a source other than power lines) or heat damage.

(D) Improperly applied end connections.

(E) Significantly corroded, cracked, bent, or worn end connections (such as from severe service).

(ii) Category II. Apparent deficiencies in this category are:

(A) Visible broken wires, as follows:

(1) In running wire ropes: Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay, where a rope lay is the length along the rope in which one strand makes a complete revolution around the rope.

(2) In rotation resistant ropes: Two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in 30 rope diameters.

(B) In pendant or standing wire ropes: More than two broken wires in one rope lay located in rope beyond end connections and/or more than one broken wire in a rope lay located at an end connection.

(C) A diameter reduction of more than 5% from nominal diameter.

(iii) Category III. Apparent deficiencies in this category include the following:

(A) In rotation resistant wire rope, core protrusion or other distortion indicating core failure.

(B) Prior electrical contact with a power line.

(C) A broken strand.

(D) Critical review items. The competent person must give particular attention to all of the following:

(i) Rotation resistant wire rope in use.

(ii) Wire rope being used for boom hoists and luffing hoists, particularly at reverse bends.

(iii) Wire rope at flange points, crossover points and repetitive pickup points on drums.

(iv) Wire rope at or near terminal ends.

(v) Wire rope in contact with saddles, equalizer sheaves or other sheaves where rope travel is limited.

(4) Removal from service.

(i) If a deficiency in Category I (see paragraph (a)(2)(i) of this section) is identified, an immediate determination must be made by the competent person as to whether the deficiency constitutes a safety hazard. If the deficiency is determined to constitute a safety hazard, operations involving use of the wire rope in question must be prohibited until:

(A) The wire rope is replaced (see § 1926.1417), or

(B) If the deficiency is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Jointing lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.

(ii) If a deficiency in Category II (see paragraph (a)(2)(ii) of this section) is identified, operations involving use of the wire rope in question must be prohibited until:

(A) The employer complies with the wire rope manufacturer’s established criterion for removal from service or a different criterion that the wire rope manufacturer has approved in writing for that specific wire rope (see § 1926.1417).

(B) The wire rope is replaced (see § 1926.1417), or

(C) If the deficiency is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.

(iii) If a deficiency in Category III is identified, operations involving use of the wire rope in question must be prohibited until:

(A) The wire rope is replaced (see § 1926.1417), or

(B) If the deficiency (other than power line contact) is localized, the problem is corrected by severing the wire rope in two; the undamaged portion may continue to be used. Joining lengths of wire rope by splicing is prohibited. Repair of wire rope that contacted an energized power line is also prohibited. If a rope is shortened under this paragraph, the employer must ensure that the drum will still have two wraps of wire when the load and/or boom is in its lowest position.

(iv) Where a wire rope is required to be removed from service under this section, either the equipment (as a whole) or the hoist with that wire rope must be tagged-out, in accordance with § 1926.1417(f)(1), until the wire rope is repaired or replaced.

(b) Monthly inspection.

(1) Each month an inspection must be conducted in accordance with paragraph (a) (shift inspection) of this section.

(2) The inspection must include any deficiencies that the qualified person who conducts the annual inspection...
determines under paragraph (c)(3)(i) of this section must be monitored.

(ii) If the qualified person determines that, though not presently a safety hazard, the deficiency needs to be monitored, the employer must ensure that the deficiency is checked in the monthly inspections.

(iii) Type II rotation resistant wire rope ("Type II"). Type II rotation resistant rope is stranded rope constructed to have significant resistance to rotation. It has at least 10 outer strands and comprises an assembly of two or more layers of strands laid helically over a center in two or three operations. The direction of lay of the outer strands is opposite to that of the underlying layer.

(iv) Types II and III must have an operating design factor of no less than 5, except where the requirements of paragraphs (e)(3) and (e)(4)(ii) of this section are met.

(v) When Types II and III with an operating design factor of less than 5 are used for duty cycle, non-repetitive lifts, the following requirements must be met for each lifting operation:

(a) The qualified person must inspect the rope in accordance with §1926.1413(a). The rope must be used only if the qualified person determines that there are no deficiencies constituting a hazard. In making this determination, more than one broken wire in any one rope lay must be considered a hazard.

(b) Operations must be conducted in such a manner and at such speeds as to minimize dynamic effects.

(c) Each lift made under §1926.1414(e)(3) must be recorded in the monthly and annual inspection documents. Such prior uses must be considered by the qualified person in determining whether to use the rope again.

Additional requirements for rotation resistant ropes for boom hoist reeving

(i) Rotation resistant ropes must not be used for boom hoist reeving, except where the requirements of paragraph (e)(4)(ii) of this section are met.
(ii) Rotation resistant ropes may be used as boom hoist reeving when load hoisting angles are as boom hoists for attachments such as luffing attachments or boom and mast attachment systems. Under these conditions, all of the following requirements must be met:
(A) The drum must provide a first layer rope pitch diameter of not less than 18 times the nominal diameter of the rope used.
(B) The requirements in §1926.1426(a) (irrespective of the date of manufacture of the equipment), and §1926.1426(b).
(C) The requirements in ASME B30.5–2004 sections 5–1.3.1.2(a), (a)(2) through (a)(4), (b) and (d) (incorporated by reference, see §1926.6) except that the minimum pitch diameter for sheaves used in multiple rope reeving is 18 times the nominal diameter of the rope used (instead of the value of 16 specified in section 5–1.3.2(d)).
(D) All sheaves used in the boom hoist reeving system must have a rope pitch diameter of not less than 18 times the nominal diameter of the rope used.
(E) The operating design factor for the boom hoist reeving system must be not less than five.
(F) The operating design factor for these ropes must be the total minimum breaking force of all parts of rope in the system divided by the load imposed on the rope system when supporting the static weights of the structure and the load within the equipment’s rated capacity.
(G) When provided, a power-controlled lowering system must be capable of handling rated capacities and speeds as specified by the manufacturer.
(H) The rope clips used in conjunction with wedge sockets must be attached to the unloaded dead end of the rope only, except that the use of devices specifically designed for dead-ending rope in a wedge socket is permitted.
(i) Socketing must be done in the manner specified by the manufacturer of the wire rope or fitting.
(j) Prior to cutting a wire rope, seizures must be placed on each side of the point to be cut. The length and number of seizures must be in accordance with the wire rope manufacturer’s instructions.

§1926.1415 Safety devices.
(a) Safety devices. The following safety devices are required on all equipment covered by this subpart, unless otherwise specified:
(i) Crane level indicator.
(ii) The equipment must have a crane level indicator that is either built into the equipment or is available on the equipment.
(iii) If a built-in crane level indicator is not working properly, it must be tagged-out or removed. If a removable crane level indicator is not working properly, it must be removed.
(iv) This requirement does not apply to portal cranes, derricks, floating cranes/derricks and land cranes/derricks on barges, pontoons, vessels or other means of flotation.
(b) Boom stops, except for derricks and hydraulic booms.
(c) Jib stops (if a jib is attached), except for derricks.
(d) Equipment with foot pedal brakes must have locks.
(e) Hydraulic outrigger jacks and hydraulic stabilizer jacks must have an integral holding device/check valve.
(f) Equipment on rails must have rail clamps and rail stops, except for portal cranes.

§1926.1416 Operational aids.
(a) The devices listed in this section (“listed operational aids”) are required on all equipment covered by this subpart, unless otherwise specified.
(1) The requirements in paragraphs (e)(1), (e)(2), and (e)(3) of this section do not apply to articulating cranes.
(2) The requirements in paragraphs (d)(3), (e)(1), and (e)(4) of this section apply only to those digger derricks manufactured after November 8, 2011.
(b) Operations must not begin unless all of the devices listed in this section are in proper working order. If a device stops working properly during operations, the operator must safely stop operations. If any of the devices listed in this section are not in proper working order, the equipment must be taken out of service and operations must not resume until the device is again working properly. See §1926.1417 (Operation). Alternative measures are not permitted to be used.
(c) If a listed operational aid stops working properly during operations, the operator must safely stop operations until the temporary alternative measures are implemented or the device is again working properly. If a replacement part is no longer available, the use of a substitute device that performs the same type of function is permitted and is not considered a modification under §1926.1434.
(d) Category I operational aids and alternative measures. Operational aids listed in this paragraph that are not working properly must be repaired no later than 7 calendar days after the deficiency occurs. Exception: If the employer documents that it has ordered the necessary parts within 7 calendar days of the occurrence of the deficiency, the repair must be completed within 7 calendar days of receipt of the parts. See §1926.1417(j) for additional requirements.
(1) Boom hoist limiting device.
(i) For equipment manufactured after December 16, 1969, a boom hoist limiting device is required. Temporary alternative measures (use at least one).
(ii) If the equipment was manufactured after February 28, 1992, a boom hoist cable (so that it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the hoist to keep the boom within the minimum allowable radius. In addition, install mirrors or remote video cameras and displays if necessary for the operator to see the mark.
(2) Luffing jib limiting device.
Equipment with a luffing jib must have a luffing jib limiting device. Temporary alternative measures are the same as in paragraph (d)(1)(i) of this section, except to limit the movement of the luffing jib rather than the boom hoist.
(3) Anti two-blocking device.
(i) Telescopic boom cranes manufactured after February 28, 1992, must be equipped with a device which automatically prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip or fixed upper block.
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Temporary alternative measures: Clearly mark the cable (so that it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, and use a spotter when extending the boom.

(ii) Lattice boom cranes.

(A) Lattice boom cranes manufactured after Feb 28, 1992, must be equipped with a device that either automatically prevents damage and load failure from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component), or warns the operator in time for the operator to prevent two-blocking. The device must prevent such damage/failure or provide adequate warning for all points where two-blocking could occur.

(B) Lattice boom cranes and derricks manufactured after November 8, 2011 must be equipped with a device which automatically prevents damage and load failure from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device(s) must prevent such damage/failure at all points where two-blocking could occur.

(C) Exception. The requirements in paragraphs (d)(3)(ii)(A) and (B) of this section do not apply to such lattice boom equipment when used for dragline, clamshell (grapple), magnet, drop ball, container handling, concrete bucket, marine operations that do not involve hoisting personnel, and pile driving work.

(D) Temporary alternative measures. Clearly mark the cable (so that it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, or use a spotter.

(iii) Articulating cranes manufactured after December 31, 1999, that are equipped with a load hoist must be equipped with a device that automatically prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device must prevent such damage at all points where two-blocking could occur. Temporary alternative measures: When two-blocking could only occur with movement of the load hoist, clearly mark the cable (so that it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, or use a spotter. When two-blocking could occur without movement of the load hoist, clearly mark the cable (so that it can easily be seen by the operator) at a point that will give the operator sufficient time to stop the hoist to prevent two-blocking, and use a spotter when extending the boom.

(e) Category II operational aids and alternative measures. Operational aids listed in this paragraph that are not working properly must be repaired no later than 30 calendar days after the deficiency occurs. Exception: If the employer documents that it has ordered the necessary parts within 7 calendar days of the occurrence of the deficiency, and the part is not received in time to complete the repair in 30 calendar days, the repair must be completed within 7 calendar days of receipt of the parts. See § 1926.1417(j) for additional requirements.

(1) Boom angle or radius indicator. The equipment must have a boom angle or radius indicator readable from the operator’s station. Temporary alternative measures: Radii or boom angle must be determined by measuring the radii or boom angle with a measuring device.

(2) Jib angle indicator if the equipment has a luffing jib. Temporary alternative measures: Radii or jib angle must be determined by ascertaining the main boom angle and then measuring the radii or jib angle with a measuring device.

(3) Boom length indicator if the equipment has a telescopic boom, except where the rated capacity is independent of the boom length. Temporary alternative measures. One or more of the following methods must be used:

(i) Mark the boom with measured marks to calculate boom length.

(ii) Calculate boom length from boom angle and radius measurements.

(iii) Measure the boom with a measuring device.

(4) Load weighing and similar devices.

(i) Equipment (other than derricks and articulating cranes) manufactured after March 29, 2003 with a rated capacity over 6,000 pounds must have at least one of the following: load weighing device, load moment (or rated capacity) indicator, or load moment (or rated capacity) limiter. Temporary alternative measures: The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer) or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight). This information must be provided to the operator prior to the lift.

(ii) Articulating cranes manufactured after November 8, 2011 must have at least one of the following: automatic overload prevention device, load weighing device, load moment (or rated capacity) indicator, or load moment (rated capacity) limiter. Temporary alternative measures: The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer) or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight). This information must be provided to the operator prior to the lift.

(iii) Outrigger/stabilizer position (horizontal beam extension) sensor/monitor if the equipment has outriggers or stabilizers. Temporary alternative measures: The operator must verify that the position of the outriggers or stabilizers is correct (in accordance with manufacturer procedures) before beginning operations requiring outrigger or stabilizer deployment.

(iv) Hoist drum rotation indicator if the equipment has a hoist drum not visible from the operator’s station. Temporary alternative measures: Mark the drum to indicate the rotation of the drum. In addition, install mirrors or remote video cameras and displays if necessary for the operator to see the mark.

§ 1926.1417 Operation.

(a) The employer must comply with all manufacturer procedures applicable to the operational functions of equipment, including its use with attachments.

(b) Unavailable operation procedures.

(1) Where the manufacturer procedures are unavailable, the employer must develop and ensure compliance with all procedures necessary for the safe operation of the equipment and attachments.

(2) Procedures for the operational controls must be developed by a qualified person.

(3) Procedures related to the capacity of the equipment must be developed and signed by a registered professional engineer familiar with the equipment.

(c) Accessibility of procedures.

(1) The procedures applicable to the operation of the equipment, including rated capacities (load charts), recommended operating speeds, special hazard warnings, instructions, and operator’s manual, must be readily available in the cab at all times for use by the operator.
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(2) Where rated capacities are available in the cab only in electronic form, in the event of a failure which makes the rated capacities inaccessible, the operator must immediately cease operations or follow safe shut-down procedures until the rated capacities (in electronic or other form) are available.

(d) The operator must not engage in any practice or activity that diverts his/her attention while actually engaged in operating the equipment, such as the use of cellular phones (other than when used for signal communications).

(e) Leaving the equipment unattended.

(i) The operator must not leave the controls while the load is suspended, except where all of the following are met:

(A) The equipment must be in the proper starting position and that all personnel are in the clear.

(B) The operator must verify that all controls are in the proper starting position and that all personnel are in the clear.

(ii) If there is a warning (tag-out or maintenance/do not operate) sign on any other switch or control, the operator must not activate that switch or control until the sign has been removed by a person authorized to remove it, or until the operator has verified that:

(m) Safety devices and operational aids must not be used as a substitute for the exercise of professional judgment by the operator.

(2) The operator must test the brakes each time a load that is 90% or more of the maximum line pull is handled by lifting the load a few inches and applying the brakes. In duty cycle and repetitive lifts where each lift is 90% or more of the maximum line pull, this requirement applies to the first lift but not to successive lifts.

(f) Tag-out.

(1) Tagging out of service equipment/functions. Where the employer has taken the equipment out of service, a tag must be placed in the cab stating that the equipment is out of service and is not to be used. Where the employer has taken a function(s) out of service, a tag must be placed in a conspicuous position stating that the function is out of service and is not to be used.

(2) Response to “do not operate”/tag-out signs.

(i) If there is a warning (tag-out or maintenance/do not operate) sign on the equipment or starting control, the operator must not activate the switch or start the equipment until the sign has been removed by a person authorized to remove it, or until the operator has verified that:

(A) No one is servicing, working on, or otherwise in a dangerous position on the machine.

(B) The equipment has been repaired and is working properly.

(3) Load weight. The operator must verify that the load is within the rated capacity of the equipment by at least one of the following methods:

(i) The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer), or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight), or by other equally reliable means. In addition, when requested by the operator, this information must be provided to the operator prior to the lift; or

(ii) The operator must begin hoisting the load to determine, using a load weighing device, load moment indicator, rated capacity indicator, or rated capacity limiters, if it exceeds 75 percent of the maximum rated capacity at the longest radius that will be used during the lift operation. If it does, the operator must not proceed with the lift until he/she verifies the weight of the load in accordance with paragraph (o)(3)(i) of this section.

(p) The boom or other parts of the equipment must not contact any obstruction.

(g) The equipment must not be used to drag or pull loads sideways.

(r) On wheel-mounted equipment, no loads must be lifted over the front area, except as permitted by the manufacturer.

(s) The operator must test the brakes each time a load that is 90% or more of the maximum line pull is handled by lifting the load a few inches and applying the brakes. In duty cycle and repetitive lifts where each lift is 90% or more of the maximum line pull, this requirement applies to the first lift but not to successive lifts.

(t) The equipment must not be left standing on its wheels, unless it is in the proper starting position and that all personnel are in the clear.

(2) Where traveling with a load, the employer must ensure that:

(i) A competent person supervises the operation, determines if it is necessary to reduce rated capacity, and makes determinations regarding load position, boom location, ground support, travel route, overhead obstructions, and speed of movement necessary to ensure safety.

(ii) If a warning (tag-out or maintenance/do not operate) sign on any other switch or control, the operator must not activate that switch or control until the sign has been removed by a person authorized to remove it, or until the operator has verified that:

(m) Safety devices and operational aids must not be used as a substitute for the exercise of professional judgment by the operator.

(i) [Reserved.]

(l) [Reserved.]

(n) The competent person must adjust the equipment and/or operations to address the effect of wind, ice, and snow on equipment stability and rated capacity.

(o) Compliance with rated capacity.

(1) The equipment must not be operated in excess of its rated capacity.

(2) The operator must not be required to operate the equipment in a manner that would violate paragraph (o)(1) of this section.

(3) Load weight. The operator must verify that the load is within the rated capacity of the equipment by at least one of the following methods:

(i) The weight of the load must be determined from a source recognized by the industry (such as the load's manufacturer), or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight), or by other equally reliable means. In addition, when requested by the operator, this information must be provided to the operator prior to the lift; or

(ii) The operator must begin hoisting the load to determine, using a load weighing device, load moment indicator, rated capacity indicator, or rated capacity limiters, if it exceeds 75 percent of the maximum rated capacity at the longest radius that will be used during the lift operation. If it does, the operator must not proceed with the lift until he/she verifies the weight of the load in accordance with paragraph (o)(3)(i) of this section.

(p) The boom or other parts of the equipment must not contact any obstruction.

(q) The equipment must not be used to drag or pull loads sideways.

(r) On wheel-mounted equipment, no loads must be lifted over the front area, except as permitted by the manufacturer.

(s) The operator must test the brakes each time a load that is 90% or more of the maximum line pull is handled by lifting the load a few inches and applying the brakes. In duty cycle and repetitive lifts where each lift is 90% or more of the maximum line pull, this requirement applies to the first lift but not to successive lifts.

(t) The equipment must not be left standing on its wheels, unless it is in the proper starting position and that all personnel are in the clear.

(2) Where traveling with a load, the employer must ensure that:

(i) A competent person supervises the operation, determines if it is necessary to reduce rated capacity, and makes determinations regarding load position, boom location, ground support, travel route, overhead obstructions, and speed of movement necessary to ensure safety.

(ii) If a warning (tag-out or maintenance/do not operate) sign on any other switch or control, the operator must not activate that switch or control until the sign has been removed by a person authorized to remove it, or until the operator has verified that:

(m) Safety devices and operational aids must not be used as a substitute for the exercise of professional judgment by the operator.

(i) [Reserved.]

(l) [Reserved.]

(n) The competent person must adjust the equipment and/or operations to address the effect of wind, ice, and snow on equipment stability and rated capacity.

(o) Compliance with rated capacity.

(1) The equipment must not be operated in excess of its rated capacity.

(2) The operator must not be required to operate the equipment in a manner that would violate paragraph (o)(1) of this section.

(3) Load weight. The operator must verify that the load is within the rated capacity of the equipment by at least one of the following methods:

(i) The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer), or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight), or by other equally reliable means. In addition, when requested by the operator, this information must be provided to the operator prior to the lift; or

(ii) The operator must begin hoisting the load to determine, using a load weighing device, load moment indicator, rated capacity indicator, or rated capacity limiters, if it exceeds 75 percent of the maximum rated capacity at the longest radius that will be used during the lift operation. If it does, the operator must not proceed with the lift until he/she verifies the weight of the load in accordance with paragraph (o)(3)(i) of this section.

(p) The boom or other parts of the equipment must not contact any obstruction.

(q) The equipment must not be used to drag or pull loads sideways.

(r) On wheel-mounted equipment, no loads must be lifted over the front area, except as permitted by the manufacturer.

(s) The operator must test the brakes each time a load that is 90% or more of the maximum line pull is handled by lifting the load a few inches and applying the brakes. In duty cycle and repetitive lifts where each lift is 90% or more of the maximum line pull, this requirement applies to the first lift but not to successive lifts.

(t) Neither the load nor the boom must be lowered below the point where less than two full wraps of rope remain on their respective drums.

(u) Traveling with a load.

(1) Traveling with a load is prohibited if the practice is prohibited by the manufacturer.

(2) Where traveling with a load, the employer must ensure that:

(i) A competent person supervises the operation, determines if it is necessary to reduce rated capacity, and makes determinations regarding load position, boom location, ground support, travel route, overhead obstructions, and speed of movement necessary to ensure safety.

(ii) If a warning (tag-out or maintenance/do not operate) sign on any other switch or control, the operator must not activate that switch or control until the sign has been removed by a person authorized to remove it, or until the operator has verified that:

(m) Safety devices and operational aids must not be used as a substitute for the exercise of professional judgment by the operator.

(i) [Reserved.]

(l) [Reserved.]

(n) The competent person must adjust the equipment and/or operations to address the effect of wind, ice, and snow on equipment stability and rated capacity.

(o) Compliance with rated capacity.

(1) The equipment must not be operated in excess of its rated capacity.

(2) The operator must not be required to operate the equipment in a manner that would violate paragraph (o)(1) of this section.

(3) Load weight. The operator must verify that the load is within the rated capacity of the equipment by at least one of the following methods:

(i) The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer), or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight), or by other equally reliable means. In addition, when requested by the operator, this information must be provided to the operator prior to the lift; or

(ii) The operator must begin hoisting the load to determine, using a load weighing device, load moment indicator, rated capacity indicator, or rated capacity limiters, if it exceeds 75 percent of the maximum rated capacity at the longest radius that will be used during the lift operation. If it does, the operator must not proceed with the lift until he/she verifies the weight of the load in accordance with paragraph (o)(3)(i) of this section.
(x) The brakes must be adjusted in accordance with manufacturer procedures to prevent unintended movement.

(y) The operator must obey a stop (or emergency stop) signal, irrespective of who gives it.

(x) Swinging locomotive cranes. A locomotive crane must not be swung into a position where railway cars on an adjacent track could strike it, until it is determined that cars are not being moved on the adjacent track and that proper flag protection has been established.

(aa) Counterweight/ballast. 
(1) The following applies to equipment other than tower cranes: 
(i) Equipment must not be operated without the counterweight or ballast in place specified by the manufacturer. 
(ii) The maximum counterweight or ballast specified by the manufacturer for the equipment must not be exceeded.

(2) Counterweight/ballast requirements for tower cranes are specified in §1926.1435(b)(8).

§1926.1418 Authority to stop operation.
Whenever there is a concern as to safety, the operator must have the authority to stop and refuse to handle loads until a qualified person has determined that safety has been assured.

§1926.1419 Signals—general requirements.
(a) A signal person must be provided in each of the following situations: 
(1) The point of operation, meaning the load travel or the area near or at load placement, is not in full view of the operator.

(2) When the equipment is traveling, the view in the direction of travel is obstructed.

(3) Due to site specific safety concerns, either the operator or the person handling the load determines that it is necessary.

(b) Types of signals. Signals to operators must be by hand, voice, audible, or new signals.

(c) Hand signals.
(1) When using hand signals, the Standard Method must be used (see Appendix A of this subpart). Exception: Where use of the Standard Method for hand signals is infeasible, or where an operation or use of an attachment is not covered in the Standard Method, non-standard hand signals may be used in accordance with paragraph (c)(2) of this section.

(2) Non-standard hand signals. When using non-standard hand signals, the signal person, operator, and lift director (where there is one) must contact each other prior to the operation and agree on the non-standard hand signals that will be used.

(d) New signals. Signals other than hand, voice, or audible signals may be used where the employer demonstrates that:

(1) The new signals provide at least equally effective communication as voice, audible, or Standard Method hand signals, or

(2) The new signals comply with a national consensus standard that provides at least equally effective communication as voice, audible, or Standard Method hand signals.

(e) Suitability. The signals used (hand, voice, audible, or new), and means of transmitting the signals to the operator (such as direct line of sight, video, radio, etc.), must be appropriate for the site conditions.

(f) During operations requiring signals, the ability to transmit signals between the operator and signal person must be maintained. If that ability is interrupted at any time, the operator must safely stop operations requiring signals until it is reestablished and a proper signal is given and understood.

(g) If the operator becomes aware of a safety problem and needs to communicate with the signal person, the operator must safely stop operations. Operations must not resume until the operator and signal person agree that the problem has been resolved.

(h) Only one person may give signals to a crane/derrick at a time, except in circumstances covered by paragraph (j) of this section.

(i) [Reserved.]

(j) Anyone who becomes aware of a safety problem must alert the operator or signal person by giving the stop or emergency stop signal. (Note: §1926.1417(y) requires the operator to obey a stop or emergency stop signal).

(k) All directions given to the operator by the signal person must be given from the operator’s direction perspective.

(l) [Reserved.]

(m) Communication with multiple cranes/derricks. Where a signal person(s) is in communication with more than one crane/derrick, a system must be used for identifying the crane/derrick each signal is for, as follows:

(1) For each signal, prior to giving the function/direction, the signal person must identify the crane/derrick the signal is for, or

(2) Must use an equally effective method of identifying which crane/derrick the signal is for.

§1926.1420 Signals—radio, telephone or other electronic transmission of signals.
(a) The device(s) used to transmit signals must be tested on site before beginning operations to ensure that the signal transmission is effective, clear, and reliable.

(b) Signal transmission must be through a dedicated channel, except:

(1) Multiple cranes/derricks and one or more signal persons may share a dedicated channel for the purpose of coordinating operations.

(2) Where a crane is being operated on or adjacent to railroad tracks, and the actions of the crane operator need to be coordinated with the movement of other equipment or trains on the same or adjacent tracks.

(c) The operator’s reception of signals must be by a hands-free system.

§1926.1421 Signals—voice signals—additional requirements.
(a) Prior to beginning operations, the operator, signal person and lift director (if there is one), must contact each other and agree on the voice signals that will be used. Once the voice signals are agreed upon, these workers need not meet again to discuss voice signals unless another worker is added or substituted, there is confusion about the voice signals, or a voice signal is to be changed.

(b) Each voice signal must contain the following three elements, given in the following order: function (such as hoist, boom, etc.), direction; distance and/or speed; function, stop command.

(c) The operator, signal person and lift director (if there is one), must be able to effectively communicate in the language used.

§1926.1422 Signals—hand signal chart.
Hand signal charts must be either posted on the equipment or conspicuously posted in the vicinity of the hoisting operations.

§1926.1423 Fall protection.
(a) Application.

(1) Paragraphs (b), (c)(3), (e) and (f) of this section apply to all equipment covered by this subpart except tower cranes.

(2) Paragraphs (c)(1), (c)(2), (d), (g), (j) and (k) of this section apply to all equipment covered by this subpart.

(3) Paragraphs (c)(4) and (h) of this section apply only to tower cranes.

(b) Boom walkways.

(1) Equipment manufactured after November 8, 2011 with lattice booms must be equipped with walkways on the boom(s) if the vertical profile of the boom (from cord centerline to cord centerline) is 6 or more feet.

(2) Boom walkway criteria.

(i) The walkways must be at least 12 inches wide.
(ii) Guardrails, railings and other permanent fall protection attachments along walkways are:
(A) Not required.
(B) Prohibited on booms supported by pendant ropes or bars if the guardrails/railings/attachments could be snagged by the ropes or bars.
(C) Prohibited if of the removable type (designed to be installed and removed each time the boom is assembled/dismounted).

(D) Where not prohibited, guardrails or railings may be of any height up to, but not more than, 45 inches.
(c) Steps, handholds, ladders, grabrails, guardrails and railings.
(1) Section 1926.502(b) does not apply to equipment covered by this subpart.
(2) The employer must maintain in good condition originally-equipped steps, handholds, ladders and guardrails/railings/grabrails.
(3) Equipment manufactured after November 8, 2011 must be equipped so as to provide safe access and egress between the ground and the operator work station(s), including the forward and rear positions, by the provision of devices such as steps, handholds, ladders and guardrails/railings/grabrails. These devices must meet the following criteria:
(i) Steps, handholds, ladders and guardrails/railings/grabrails must meet the criteria of SAE J185 (May 2003) (incorporated by reference, see §1926.6) or ISO 11660–2:1994(E) (incorporated by reference, see §1926.6) except where infeasible.
(ii) Walking/stepping surfaces, except for crawler treads, must have slip-resistant features/properties (such as diamond plate metal, strategically placed grip tape, expanded metal, or slip-resistant paint).
(iii) Tower cranes manufactured after November 8, 2011 must be equipped so as to provide safe access and egress between the ground and the cab, machinery platforms, and tower (mast), by the provision of devices such as steps, handholds, ladders, and guardrails/railings/grabrails. These devices must meet the following criteria:
(i) Steps, handholds, ladders, and guardrails/railings/grabrails must meet the criteria of ISO 11660–1:2008(E) (incorporated by reference, see §1926.6) and ISO 11660–3:2008(E) (incorporated by reference, see §1926.6) or SAE J185 (May 2003) (incorporated by reference, see §1926.6) except where infeasible.
(ii) Walking/stepping surfaces must have slip-resistant features/properties (such as diamond plate metal, strategically placed grip tape, expanded metal, or slip-resistant paint).
(d) Personal fall arrest and fall restraint systems. Personal fall arrest system components must be used in personal fall arrest and fall restraint systems and must conform to the criteria in §1926.502(d) except that §1926.502(d)(15) does not apply to components used in personal fall arrest and fall restraint systems. Either body belts or body harnesses must be used in personal fall arrest and fall restraint systems.
(e) For non-assembly/dismounting work, the employer must provide and ensure the use of fall protection equipment for employees who are on a walking/working surface with an unprotected side or edge more than 6 feet above a lower level as follows:
(1) When moving point-to-point:
(i) On non-lattice booms (whether horizontal or not horizontal). (ii) On lattice booms that are not horizontal.
(iii) On horizontal lattice booms where the fall distance is 15 feet or more.
(2) While at a work station on any part of the equipment (including the boom, of any type), except when the employee is at or near draw-works (when the equipment is running), in the cab, or on the deck.
(F) For assembly/dismounting work, the employer must provide and ensure the use of fall protection equipment for employees who are on a walking/working surface with an unprotected side or edge more than 15 feet above a lower level, except when the employee is at or near draw-works (when the equipment is running), in the cab, or on the deck.
(g) Anchorage criteria.
(1) Sections 1926.502(d)(15) and 1926.502(e)(2) apply to equipment covered by this subpart only to the extent delineated in paragraph (g)(2) of this section.
(2) Anchorage for personal fall arrest and positioning device systems.
(i) Personal fall arrest systems must be anchored to any apparently substantial part of the equipment unless a competent person, from a visual inspection, without an engineering analysis, would conclude that the criteria in §1926.502(d)(15) would not be met.
(ii) Positioning device systems must be anchored to any apparently substantial part of the equipment unless a competent person, from a visual inspection, without an engineering analysis, would conclude that the criteria in §1926.502(e)(2) would not be met.
(iii) Attachable anchor devices (portable anchor devices that are attached to the equipment) must meet the anchorage criteria in §1926.502(d)(15) for personal fall arrest systems and §1926.502(e)(2) for positioning device systems.
(h) Tower cranes.
(1) For work other than erecting, climbing, and dismantling, the employer must provide and ensure the use of fall protection equipment for employees who are on a walking/working surface with an unprotected side or edge more than 6 feet above a lower level, except when the employee is at or near draw-works (when the equipment is running), in the cab, or on the deck.
(2) For erecting, climbing, and dismantling work, the employer must provide and ensure the use of fall protection equipment for employees who are on a walking/working surface with an unprotected side or edge more than 15 feet above a lower level.
(i) [Reserved.]
(j) Anchoring to the load line. A personal fall arrest system is permitted to be anchored to the crane/derrick’s hook (or other part of the load line) where all of the following requirements are met:
(1) A qualified person has determined that the set-up and rated capacity of the crane/derrick (including the hook, load line, and rigging) meets or exceeds the requirements in §1926.502(d)(15).
(2) The equipment operator must be at the work site and informed that the equipment is being used for this purpose.
(3) No load is suspended from the load line when the personal fall arrest system is anchored to the crane/derrick’s hook (or other part of the load line).
(k) Training. The employer must train each employee who may be exposed to fall hazards while on, or hoisted by, equipment covered by this subpart on all of the following:
(1) the requirements in this subpart that address fall protection.
(2) the applicable requirements in §§1926.500 and 1926.502.
§1926.1424 Work area control.
(a) Swing radius hazards.
(1) The requirements in paragraph (a)(2) of this section apply where there are accessible areas in which the equipment’s rotating superstructure (whether permanently or temporarily
employees:

(a) Engaged in hooking, unhooking or guiding a load;
(b) Engaged in the initial attachment of the load to a component or structure;
(c) Operating a concrete hopper or concrete bucket;
(d) Receiving a load. Only employees needed to receive a load are permitted to be within the fall zone when a load is being landed;
(e) During a tilt-up or tilt-down operation:
(1) No employee must be directly under the load;
(2) Only employees essential to the operation are permitted in the fall zone (but not directly under the load). An employee is essential to the operation if the employee is conducting one of the following operations and the employer can demonstrate it is infeasible for the employee to perform that operation from outside the fall zone: (1) Physically guide the load; (2) closely monitor and give instructions regarding the load’s movement; or (3) either detach it from or initially attach it to another component or structure (such as, but not limited to, making an initial connection or installing bracing).

Note: Boom free fall is prohibited when an employee is in the fall zone of the boom or load, and load line free fall is prohibited when an employee is directly under the load; see §1926.1426.

§1926.1426 Free fall and controlled load lowering.

(a) Boom free fall prohibitions.
(1) The use of equipment in which the boom is designed to free fall (live boom) is prohibited in each of the following circumstances:
(i) An employee is in the fall zone of the boom or load.
(ii) An employee is being hoisted.
(iii) The load or boom is directly over a power line, or over any part of the area extending the Table A of §1926.1408 clearance distance to each side of the power line; or any part of the area extending the Table A clearance distance to each side of the power line

§1926.1425 Keeping clear of the load.

(a) Where available, hoisting routes that minimize the exposure of employees to hoisted loads must be used, to the extent consistent with public safety.

(b) While the operator is not moving a suspended load, no employee must be within the fall zone, except for employees:

(i) Engaged in hooking, unhooking or guiding a load;
(ii) Engaged in the initial attachment of the load to a component or structure;
(iii) Operating a concrete hopper or concrete bucket.

§1926.1426 Free fall and controlled load lowering.

(b) Preventing boom free fall. Where the use of equipment with a boom that is designed to free fall (live boom) is prohibited, the boom hoist must have a secondary mechanism or device designed to prevent the boom from falling in the event the primary system used to hold or regulate the boom hoist fails, as follows:

(1) Friction drums must have:
(i) A friction clutch and, in addition, a braking device, to allow for controlled boom lowering.
(ii) A secondary braking or locking device, which is manually or automatically engaged, to back-up the primary brake while the boom is held (such as a secondary friction brake or a ratchet and pawl device).
(2) Hydraulic drums must have an integrally mounted holding device or internal static brake to prevent boom hoist movement in the event of hydraulic failure.

(3) Neither clutches nor hydraulic motors must be considered brake or locking devices for purposes of this subpart.
(4) Hydraulic boom cylinders must have an integrally mounted holding device.

(c) Preventing uncontrolled retraction. Hydraulic telescoping booms must have an integrally mounted holding device to prevent the boom from retracting in the event of hydraulic failure.

(d) Load line free fall. In each of the following circumstances, controlled load lowering is required and free fall of the load line hoist is prohibited:
(1) An employee is directly under the load.
(2) An employee is being hoisted.
(3) The load is directly over a power line, or over any part of the area extending the Table A of §1926.1408 clearance distance to each side of the power line; or any part of the area extending the Table A of §1926.1408
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clearance distance to each side of the power line is within the radius of vertical travel of the load.
(4) The load is over a shaft.
(5) The load is over a caisson, except where there are no employees in the fall zone of the load.
§ 1926.1427 Operator qualification and certification.
(a) The employer must ensure that, prior to operating any equipment covered under subpart CC, the person is operating the equipment during a training period in accordance with paragraph (f) of this section, or the operator is qualified or certified to operate the equipment in accordance with the following:
(1) When a non-military government entity issues operator licenses for equipment covered under subpart CC, and that government licensing program meets the requirements of paragraphs (e)(2) and (j) of this section, the equipment operator must either be:
(i) Licensed by that government entity for operation of equipment within that entity’s jurisdiction; or
(ii) qualified in compliance with paragraph (d) of this section.
(2) Where paragraph (a)(1) of this section is not applicable, the certification or qualification must comply with one of the options in paragraphs (b) through (d) of this section.
(3) Exceptions: Operator qualification or certification under this section is not required for operators of derricks (see §1926.1436), sideboom cranes (see §1926.1440), or equipment with a maximum manufacturer-rated hoisting/lifting capacity of 2,000 pounds or less (see §1926.1441).
(b) **Option (1): Certification by an accredited crane operator testing organization.**
(1) For a testing organization to be considered accredited to certify operators under this subpart, it must:
(i) Be accredited by a nationally recognized accrediting agency based on that agency’s determination that industry recognized criteria for written testing materials, practical examinations, test administration, grading, facilities/equipment and personnel have been met.
(ii) Administer written and practical tests that:
(A) Assess the operator applicant regarding, at a minimum, the knowledge and skills listed in paragraphs (j)(1) and (2) of this section.
(B) Provide different levels of certification based on equipment capacity and type.
(iii) Have procedures for operators to re-apply and be re-tested in the event an operator applicant fails a test or is decertified.
(iv) Have testing procedures for re-certification designed to ensure that the operator continues to meet the technical knowledge and skills requirements in paragraphs (j)(1) and (2) of this section.
(v) Have its accreditation reviewed by the nationally recognized accrediting agency at least every three years.
(2) An operator will be deemed qualified to operate a particular piece of equipment if the operator is certified under paragraph (b) of this section for that type and capacity of equipment or for higher-capacity equipment of that type. If no accredited testing agency offers certification examinations for a particular type and/or capacity of equipment, an operator will be deemed qualified to operate that equipment if the operator has been certified for the type/capacity that is most similar to that equipment and for which a certification examination is available. The operator’s certificate must state the type/capacity of equipment for which the operator is certified.
(3) A certification issued under this option is portable and meets the requirements of paragraph (a)(2) of this section.
(4) A certification issued under this paragraph is valid for 5 years.
(c) **Option (2): Qualification by an accredited employer program.**
(1) The written and practical tests must be either:
(i) Developed by an accredited crane operator testing organization (see paragraph (b) of this section); or
(ii) Approved by an auditor in accordance with the following requirements:
(A) The auditor is certified to evaluate such tests by an accredited crane operator testing organization (see paragraph (b) of this section).
(B) The auditor is not an employee of the employer.
(C) The approval must be based on the auditor’s determination that the written and practical tests meet nationally recognized test development criteria and are valid and reliable in assessing the operator applicants regarding, at a minimum, the knowledge and skills listed in paragraphs (j)(1) and (2) of this section.
(2) Administration of tests.
(i) The written and practical tests must be administered under circumstances approved by the auditor as meeting nationally recognized test administration standards.
(ii) The auditor must be certified to evaluate the administration of the written and practical tests by an accredited crane operator testing organization (see paragraph (b) of this section).
(iii) The auditor must not be an employee of the employer.
(iv) The audit must be conducted in accordance with nationally recognized auditing standards.
(3) The employer program must be audited within 3 months of the beginning of the program and at least every 3 years thereafter.
(4) The employer program must have testing procedures for re-qualification designed to ensure that the operator continues to meet the technical knowledge and skills requirements in paragraphs (j)(1) and (2) of this section. The re-qualification procedures must be audited in accordance with paragraphs (c)(1) and (2) of this section.
(5) **Deficiencies.** If the auditor determines that there is a significant deficiency (“deficiency”) in the program, the employer must ensure that:
(i) No operator is qualified until the auditor confirms that the deficiency has been corrected.
(ii) The program is audited again within 180 days of the confirmation that the deficiency was corrected.
(iii) The auditor files a documented report of the deficiency to the appropriate Regional Office of the Occupational Safety and Health Administration within 15 days of the auditor’s determination that there is a deficiency.
(iv) Records of the audits of the employer’s program are maintained by the auditor for three years and are made available by the auditor to the Secretary of Labor or the Secretary’s designated representative upon request.
(6) A qualification under this paragraph is:
(i) Not portable. Such a qualification meets the requirements of paragraph (a) of this section only where the operator is employed by (and operating the equipment for) the employer that issued the qualification.
(ii) Valid for 5 years.
(d) **Option (3): Qualification by the U.S. military.**
(1) For purposes of this section, an operator who is an employee of the U.S. military...
military is considered qualified if he/she has a current operator qualification issued by the U.S. military for operation of the equipment. An employee of the U.S. military is a Federal employee of the Department of Defense or Armed Forces and does not include employees of private contractors.

(2) A qualification under this paragraph is:

(i) Not portable. Such a qualification meets the requirements of paragraph (a) of this section only where the operator is employed by (and operating the equipment for) the employer that issued the qualification.

(ii) Valid for the period of time stipulated by the issuing entity.

(e) Option (4): Licensing by a government entity.

(1) For purposes of this section, a government licensing department/office that issues operator licenses for operating equipment covered by this standard is considered a government accredited crane operator testing organization if the criteria in paragraph (e)(2) of this section are met.

(2) Licensing criteria.

(i) The requirements for obtaining the license include an assessment, by written and practical tests, of the operator applicant regarding, at a minimum, the knowledge and skills listed in paragraphs (j)(1) and (2) of this section.

(ii) The testing meets industry recognized criteria for written testing materials, practical examinations, test administration, grading, facilities/equipment and personnel.

(iii) The government authority that oversees the licensing department/office has determined that the requirements in paragraphs (e)(2)(i) and (ii) of this section have been met.

(iv) The licensing department/office has testing procedures for re-licensing designed to ensure that the operator continues to meet the technical knowledge and skills requirements in paragraphs (j)(1) and (2) of this section.

(3) A license issued by a government accredited crane operator testing organization that meets the requirements of this option:

(i) Meets the operator qualification requirements of this section for operation of equipment only within the jurisdiction of the government entity.

(ii) Is valid for the period of time stipulated by the licensing department/office, but no longer than 5 years.

(J) Pre-qualification/certification training period. An employee who is not qualified or certified under this section is permitted to operate equipment only as an operator-in-training and only where the requirements of this paragraph are met.

(1) The employer must provide each operator-in-training with sufficient training prior to operating the equipment to enable the operator-in-training to operate the equipment safely under limitations established by this section (including continuous monitoring) and any additional limitations established by the employer.

(2) The tasks performed by the operator-in-training while operating the equipment must be within the operator-in-training’s ability.

(3) Trainer. While operating the equipment, the operator-in-training must be continuously monitored by an individual (“operator’s trainer”) who meets all of the following requirements:

(i) The operator’s trainer is an employee or agent of the operator-in-training’s employer.

(ii) The operator’s trainer is either a certified operator under this section, or has passed the written portion of a certification test under one of the options in paragraphs (b) through (e) of this section, and is familiar with the proper use of the equipment’s controls.

(iii) While monitoring the operator-in-training, the operator’s trainer performs no tasks that detract from the trainer’s ability to monitor the operator-in-training.

(iv) For equipment other than tower cranes: The operator’s trainer and the operator-in-training must be in direct line of sight of each other. In addition, they must communicate verbally or by hand signals. For tower cranes: The operator’s trainer and the operator-in-training must be in direct communication with each other.

(4) Continuous monitoring. The operator-in-training must be monitored by the operator’s trainer at all times, except for short breaks where all of the following are met:

(i) The break lasts no longer than 15 minutes and there is no more than one break per hour.

(ii) Immediately prior to the break the operator’s trainer informs the operator-in-training of the specific tasks that the operator-in-training is to perform and limitations to which he/she must adhere during the operator trainer’s break.

(iii) The specific tasks that the operator-in-training will perform during the operator trainer’s break are within the operator-in-training’s abilities.

(5) The operator-in-training must not operate the equipment in any of the following circumstances unless the exception stated in paragraph (f)(5)(v) of this section is applicable:

(i) 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 (see §1926.148(b)(1)(i)), could get within 20 feet of a power line that is up to 350 kV, or within 50 feet of a power line that is over 350 kV.

(ii) If the equipment is used to hoist personnel.

(iii) In multiple-equipment lifts.

(iv) If the equipment is used over a shaft, cofferdam, or in a tank farm.

(v) In multiple-lift rigging operations, except where the operator’s trainer determines that the operator-in-training skills are sufficient for this high-skill work.

(g) Under this section, a testing entity is permitted to provide training as well as testing services as long as the criteria of the applicable accrediting agency (in the option selected) for an organization providing both services are met.

(h) Language and Literacy Requirements.

(1) Tests under this section may be administered verbally, with answers given verbally, where the operator candidate:

(i) Passes a written demonstration of literacy relevant to the work.

(ii) Demonstrates the ability to use the type of written manufacturer procedures applicable to the class/type of equipment for which the candidate is seeking certification.

(2) Tests under this section may be administered in any language the operator candidate understands, and the operator’s certificate must note the language in which the test was given. The operator is qualified under paragraph (b)(2) of this section to operate equipment that is furnished with materials required by this subpart that are written in the language of the certification. The operator may only operate equipment furnished with such materials.

[j][Reserved.] (j) Certification criteria. Qualifications and certifications must be based, at a minimum, on the following:

(1) A determination through a written test that:

(i) The individual knows the information necessary for safe operation of the specific type of equipment the individual will operate, including all of the following:

(A) The controls and operational/performance characteristics.

(B) Use of, and the ability to calculate (manually or with a calculator), load/capacity information on a variety of configurations of the equipment.

(C) Procedures for preventing and responding to power line contact.

(D) Technical knowledge similar to the subject matter criteria listed in
§ 1926.1428 Signal person qualifications.

(a) The employer of the signal person must ensure that each signal person meets the Qualification Requirements (paragraph (c) of this section) prior to giving any signals. This requirement must be met by using either Option (1) or Option (2) of this section.

(1) Option (1)—Third party qualified evaluator. The signal person has documentation from a third party qualified evaluator (see Qualified Evaluator (third party), § 1926.1401 for definition) showing that the signal person meets the Qualification Requirements (see paragraph (c) of this section).

(2) Option (2)—Employer’s qualified evaluator. The employer’s qualified (see Qualified Evaluator (not a third party), § 1926.1401 for definition) evaluator assesses the individual and determines that the individual meets the Qualification Requirements (see paragraph (c) of this section) and provides documentation of that determination. An assessment by an employer’s qualified evaluator under this option is not portable—other employers are not permitted to use it to meet the requirements of this section.

(3) The employer must make the documentation for whichever option is used available at the site while the signal person is employed by the employer. The documentation must specify each type of signaling (e.g. hand signals, radio signals, etc.) for which the signal person meets the requirements of paragraph (c) of this section.

(b) If subsequent actions by the signal person indicate that the individual does not meet the Qualification Requirements (see paragraph (c) of this section), the employer must not allow the individual to continue working as a signal person until re-training is provided and a re-assessment is made in accordance with paragraph (a) of this section that confirms that the individual meets the Qualification Requirements.

(c) Qualification Requirements. Each signal person must:

(1) Know and understand the type of signals used. If hand signals are used, the signal person must know and understand the Standard Method for hand signals.

(2) Be competent in the application of the type of signals used.

(3) Have a basic understanding of equipment operation and limitations, including the crane dynamics involved in swinging and stopping loads and the type of equipment.

(4) Know and understand the relevant requirements of § 1926.1419 through § 1926.1422 and § 1926.1428.

(5) Demonstrate that he/she meets the requirements in paragraphs (c)(1) through (4) of this section through an oral or written test, and through a practical test.

§ 1926.1429 Qualifications of maintenance & repair employees.

(a) Maintenance, inspection and repair personnel are permitted to operate the equipment only where all of the following requirements are met:

(1) The operation is limited to those functions necessary to perform maintenance, inspect the equipment, or verify its performance.

(2) The personnel either:

(i) Operate the equipment under the direct supervision of an operator who meets the requirements of § 1926.1427 (Operator qualification and certification); or

(ii) Are familiar with the operation, limitations, characteristics and hazards associated with the type of equipment.

(b) Maintenance and repair personnel must meet the definition of a qualified person with respect to the equipment and maintenance/repair tasks performed.

§ 1926.1430 Training.

The employer must provide training as follows:

(a) Overhead powerlines. The employer must train each employee specified in § 1926.1408(g) and § 1926.1410(m) in the topics listed in § 1926.1408(g).

(b) Signal persons. The employer must train each employee who will be assigned to work as a signal person who does not meet the requirements of § 1926.1428(c) in the areas addressed in that paragraph.

(c) Operators.

(1) Operators-in-Training for equipment where certification or qualification is required by this subpart. The employer must train each operator-in-training in the areas addressed in § 1926.1427(i). The employer must provide re-training if the operator-in-training does not pass a qualification or certification test.

(2) Transitional Period. During the four-year phase-in period for operator certification or qualification, as provided in § 1926.1427(k), employers must train each operator who has not yet been certified or qualified in the areas addressed in § 1926.1427(j).

(3) Operators excepted from the requirements of § 1926.1427. The employer must train each operator excepted under § 1926.1427(a) from the requirements of § 1926.1427 on the safe operation of the equipment the operator will be using.

(4) The employer must train each operator of the equipment covered by this subpart in the following practices:

(i) On friction equipment, whenever moving a boom off a support, first raise the boom a short distance (sufficient to take the load of the boom) to determine if the boom hoist brake needs to be adjusted. On other types of equipment with a boom, the same practice is applicable, except that typically there is no means of adjusting the brake; if the
(2) Exceptions: A personnel platform is not required for hoisting employees:

(a) Into and out of drill shafts that are up to and including 8 feet in diameter (see paragraph (o) of this section for requirements for hoisting these employees).

(b) In pile driving operations (see paragraph (p) of this section for requirements for hoisting these employees).

(c) Solely for transfer to or from a marine worksite in a marine-hoisted personnel transfer device (see paragraph (q) of this section for requirements for hoisting these employees).

(iv) Equipment with telescoping shaft and chimney operations (see paragraph (r) of this section for requirements for hoisting these employees).

(v) Anti-two-block. A device which automatically prevents damage and load failure from contact between the load block, overhang ball, or similar component, and the boom tip (or fixed upper block or similar component) must be used. The device(s) must prevent such damage/failure at all points where two-blocking could occur. Exception: This device is not required when hoisting personnel in pile driving operations. Instead, paragraph (p)(2) of this section specifies how to prevent two-blocking during such operations.

(c) Equipment set-up.

(1) The equipment must be uniformly level, within one percent of level grade, and located on footing that a qualified person has determined to be sufficiently firm and stable.

(2) Equipment with outriggers or stabilizers must have them all extended and locked. The amount of extension must be the same for all outriggers and stabilizers and in accordance with manufacturer procedures and load charts.

(d) Equipment criteria.

(1) Capacity: Use of suspended personnel platforms. The total load (with the platform loaded, including the hook, load line and rigging) must not exceed 50 percent of the rated capacity for the radius and configuration of the equipment, except during proof testing.

(2) Capacity: Use of boom-attached personnel platforms. The total weight of the loaded personnel platform must not exceed 50 percent of the rated capacity for the radius and configuration of the equipment (except during proof testing).

(4) When the occupied personnel platform is in a stationary working position, the load and boom hoist brakes, swing brakes, and operator actuated secondary braking and locking features (such as paws or dogs) or automatic secondary brakes must be engaged.

(i) Equipment (except for derricks and articulating cranes) with a variable angle boom must be equipped with all of the following:

(A) A boom angle indicator, readily visible to the operator, and

(B) A boom hoist limiting device.

(ii) Articulating cranes must be equipped with a properly functioning automatic overload protection device.

(iii) Equipment with a luffing jib must be equipped with:

(A) A jib angle indicator, readily visible to the operator, and

(B) A jib hoist limiting device.

(iv) Equipment with telescoping booms must be equipped with a device to indicate the boom’s extended length clearly to the operator, or must have measuring marks on the boom.

(v) Anti-two-block. A device which automatically prevents damage and load failure from contact between the load block, overhang ball, or similar component, and the boom tip (or fixed upper block or similar component) must be used. The device(s) must prevent such damage/failure at all points where two-blocking could occur. Exception: This device is not required when hoisting personnel in pile driving operations. Instead, paragraph (p)(2) of this section specifies how to prevent two-blocking during such operations.

(vi) Controlled load lowering. The load line hoist drum must have a system, other than the load line hoist brake, which regulates the lowering rate of speed of the hoist mechanism. This system or device must be used when hoisting personnel.

Note: Free fall of the load line hoist is prohibited (see §1926.1426(d); the use of equipment in which the boom hoist mechanism can free fall is also prohibited (see §1926.1426(a)(1)).

(vii) Operation required. Personnel hoisting operations must not begin unless the devices listed in this section are in proper working order. If a device stops working properly during such operations, the operator must safely stop operations. Personnel hoisting operations must not resume until the device is again working properly. Alternative measures are not permitted. (See §1926.1417 for tag-out and related requirements.)

(6) Direct attachment of a personnel platform to a luffing jib is prohibited.

(e) Personnel platform criteria.

(1) A qualified person familiar with structural design must design the personnel platform and attachment/suspension system used for hoisting personnel.

(2) The system used to connect the personnel platform to the equipment
must allow the platform to remain within 10 degrees of level, regardless of hoist angle.

(3) The suspension system must be designed to minimize tipping of the platform due to movement of employees occupying the platform.

(4) The personnel platform itself (excluding the guardrail system and personal fall arrest system anchorages) must be capable of supporting, without failure, its own weight and at least five times the maximum intended load.

(5) All welding of the personnel platform and its components must be performed by a certified welder familiar with the weld grades, types and material specified in the platform design.

(6) The personnel platform must be equipped with a guardrail system which must meet the requirements of subpart M of this part, and must be enclosed at least from the toeboard to mid-rail with either solid construction material or expanded metal having openings no greater than ½ inch (1.27 cm). Points to which personal fall arrest systems are attached must meet the anchorage requirements in subpart M of this part.

(7) A grab rail must be installed inside the entire perimeter of the personnel platform except for access gates/doors.

(8) Access gates/doors. If installed, access gates/doors of all types (including swinging, sliding, folding, or other types) must:

(i) Not swing outward. If due to the size of the personnel platform, such as a 1-person platform, it is infeasible for the door to swing inward and allow safe entry for the platform occupant, then the access door/gate may swing outward.

(ii) Be equipped with a device that prevents accidental opening.

(9) Headroom must be sufficient to allow employees to stand upright in the platform.

(10) In addition to the use of hard hats, employees must be protected by overhead protection on the personnel platform when employees are exposed to falling objects. The platform overhead protection must not obscure the view of the operator or platform occupants (such as wire mesh that has up to ½ inch openings), unless full protection is necessary.

(11) All edges exposed to employee contact must be smooth enough to prevent injury.

(12) The weight of the platform and its rated capacity must be conspicuously posted on the platform with a plate or other permanent marking.

(f) Personnel platform loading. (1) The personnel platform must not be loaded in excess of its rated capacity. (2) Use.

(i) Personnel platforms must be used only for employees, their tools, and the materials necessary to do their work. Platforms must not be used to hoist materials or tools when not hoisting personnel.

(ii) Exception: Materials and tools to be used during the lift, if secured and distributed (parachute bags, back or lumbar support harnesses, etc.) during the trial lift must be repeated prior to the anticipated liftweight must be made from ground level, or any other location where employees will enter the platform, to each location at which the platform is to be hoisted and positioned. Where there is more than one location to be reached from a single set-up position, either individual trial lifts for each location, or a single trial lift, in which the platform is moved sequentially to each location, must be performed; the method selected must be the one that will be used to hoist the personnel.

(2) The trial lift must be performed immediately prior to each shift in which personnel will be hoisted. In addition, the trial lift must be repeated prior to hoisting employees in each of the following circumstances:

(i) The equipment is moved and set up in a new location or returned to a previously used location.

(ii) The lift route is changed, unless the competent person determines that the new route presents no new factors affecting safety.

(3) The competent person must determine that:

(i) Safety devices and operational aids required by this section are activated and functioning properly. Other safety devices and operational aids must meet the requirements of § 1926.1415 and § 1926.1416.

(ii) Nothing interferes with the equipment or the personnel platform in the course of the trial lift.

(iii) The lift will not exceed 50 percent of the equipment’s rated capacity at any time during the lift.

(iv) The load radius to be used during the lift has been accurately determined.

(4) Immediately after the trial lift, the competent person must:

(i) Conduct a visual inspection of the equipment, base support or ground, and personnel platform, to determine whether the trial lift has exposed any defect or problem or produced any adverse effect.

(ii) Confirm that, upon the completion of the trial lift process, the test weight has been removed.

(5) Immediately prior to each lift:

(i) The platform must be hoisted a few inches with the personnel and materials/tools on board and inspected by a competent person to ensure that it is secure and properly balanced.
(ii) The following conditions must be determined by a competent person to exist before the lift of personnel proceeds:
(A) Hoist ropes must be free of deficiencies in accordance with §1926.1413(a).
(B) Multiple part lines must not be twisted around each other.
(C) The primary attachment must be centered over the platform.
(D) If the load rope is slack, the hoisting system must be inspected to ensure that all ropes are properly seated on drums and in sheaves.
(E) Any condition found during the trial lift and subsequent inspection(s) that fails to meet a requirement of this standard or otherwise creates a safety hazard must be corrected before hoisting personnel. (See §1926.1417 for tag-out and related requirements.)
   (1) [Reserved.]
   (j) Proof testing.
   (1) At each jobsite, prior to hoisting employees on the personnel platform, and after any repair or modification, the platform and rigging must be proof tested to 125 percent of the platform’s rated capacity. The proof test may be done concurrently with the trial lift.
   (2) The platform must be lowered by controlled load lowering, braked, and held in a suspended position for a minimum of five minutes with the test load evenly distributed on the platform.

(3) After proof testing, a competent person must inspect the platform and rigging to determine if the test has been passed. If any deficiencies are found that pose a safety hazard, the platform and rigging must not be used to hoist personnel unless the deficiencies are corrected, the test is repeated, and a competent person determines that the test has been passed. (See §1926.1417 for tag-out and related requirements.)

(4) Personnel hoisting must not be conducted until the competent person determines that the platform and rigging have successfully passed the proof test.

(k) Work practices.

(1) Hoisting of the personnel platform must be performed in a slow, controlled, cautious manner, with no sudden movements of the equipment or the platform.

(2) Platform occupants must:
   (i) Keep all parts of the body inside the platform during raising, lowering, and horizontal movement. This provision does not apply to an occupant of the platform when necessary to position the platform or while performing the duties of a signal person.
   (ii) Not stand, sit on, or work from the top or intermediate rail or tooboard, or use any other means/device to raise their working height.

(iii) Not pull the platform out of plumb in relation to the hoisting equipment.

(3) Before employees exit or enter a hoisted personnel platform that is not landed, the platform must be secured to the structure where the work is to be performed, unless the employer can demonstrate that securing the structure would create a greater hazard.

(4) If the platform is tied to the structure, the operator must not move the platform until the operator receives confirmation that it is freely suspended.

(5) Tag lines must be used when necessary to control the platform.

(6) Platforms without controls. Where the platform is not equipped with controls, the equipment operator must remain at the equipment controls, on site, and in view of the equipment, at all times while the platform is occupied.

(7) Platforms with controls. Where the platform is equipped with controls, all of the following must be met at all times while the platform is occupied:
   (i) The occupant using the controls in the platform must be a qualified person with respect to their use, including the safe limitations of the equipment and hazards associated with its operation.
   (ii) The equipment operator must be at a set of equipment controls that include boom and swing functions of the equipment, and must be on site and in view of the equipment.

(iii) The platform operating manual must be in the platform or on the equipment.

(8) Environmental conditions.

(i) Wind. When wind speed (sustained or gusts) exceeds 20 mph at the personnel platform, a qualified person must determine if, in light of the wind conditions, it is not safe to lift personnel. If it is not, the lifting operation must not begin (or, if already in progress, must be terminated).

(ii) Other weather and environmental conditions. A qualified person must determine if, in light of indications of dangerous weather conditions, or other impending or existing danger, it is not safe to lift personnel. If it is not, the lifting operation must not begin (or, if already in progress, must be terminated).

(9) Employees being hoisted must remain in direct communication with the signal person (where used), or the operator.

(10) Fall protection.

(1) Except over water, employees occupying the personnel platform must be provided and use a personal fall arrest system. The system must be attached to a structural member within the personnel platform. When working over or near water, the requirements of §1926.106 apply.

(ii) The fall arrest system, including the attachment point (anchorage) used to comply with paragraph (i) of this section, must meet the requirements in §1926.502.

(11) Other load lines.

(i) No lifts must be made on any other of the equipment’s load lines while personnel are being hoisted, except in pile driving operations.

(ii) Factory-produced boom-mounted personnel platforms that incorporate a winch as original equipment. Loads are permitted to be hoisted by such a winch while employees occupy the personnel platform only where the load on the winch line does not exceed 500 pounds and does not exceed the rated capacity of the winch and platform.

(12) Traveling—equipment other than derricks.

   (i) Hoisting of employees while the equipment is traveling is prohibited, except for:

   (A) Equipment that travels on fixed rails or
   (B) Where the employer demonstrates that there is no less hazardous way to perform the work.

   (C) This exception does not apply to rubber-tired equipment.

   (ii) Where employees are hoisted while the equipment is traveling, all of the following criteria must be met:

   (A) Equipment travel must be restricted to a fixed track or runway.

   (B) Where a runway is used, it must be a firm, level surface designed, prepared and designated as a path of travel for the weight and configuration of the equipment being used to lift and travel with the personnel platform. An existing surface may be used as long as it meets these criteria.

   (C) Equipment travel must be limited to boom length.

   (D) The boom must be parallel to the direction of travel, except where it is safer to do otherwise.

   (E) A complete trial run must be performed to test the route of travel before employees are allowed to occupy the platform. This trial run can be performed at the same time as the trial lift required by paragraph (h) of this section which tests the lift route.

   (13) Traveling—derricks. Derricks are prohibited from traveling while personnel are hoisted.

   (i) [Reserved.]

   (m) Pre-lift meeting. A pre-lift meeting must be held to review the applicable requirements of this section and the procedures that will be followed.

   (2) Attended by the equipment operator, signal person (if used for the
Hoisting personnel for marine transfer. When hoisting employees solely for transfer to or from a marine worksite, the following requirements must be met:

1. The employee must be in either a personnel platform or a marine-hoisted personnel transfer device.

2. If using a personnel platform, paragraphs (a) through (n) of this section apply.

3. If using a marine-hoisted personnel transfer device:

   i. The following paragraphs of this section apply: (a), (c), (d)(1), (d)(3), (d)(4), (e)(1) through (5), (f)(1), (f)(2), (g), (h), (j), (k)(1), (k)(6), (k)(8), (k)(9), (k)(11)(i), (m), and (n). Where the terms “personnel platform” or “platform” are used in these paragraphs, substitute them with “boatswain’s chair.”

   ii. The employee must be hoisted in a slow, controlled descent and ascent.

   iii. The employee must use personal fall protection equipment, including a full body harness, attached independent of the crane/derrick.

   iv. The fall protection equipment must meet the applicable requirements in §1926.502.

   v. The boatswain’s chair itself (excluding the personal fall arrest system anchorages), must be capable of supporting, without failure, its own weight and at least five times the maximum intended load.

   vi. No more than one person must be hoisted at a time.

Hoisting personnel for storage-tank (steel or concrete), shaft and chimney operations. When hoisting an employee in storage tank (steel or concrete), shaft and chimney operations, the following requirements must be met:

1. The employee must be in a personnel platform except when the employer can demonstrate that use of a personnel platform is infeasible; in such a case, a boatswain’s chair must be used.

2. If using a personnel platform, paragraphs (a) through (n) of this section apply.

3. If using a boatswain’s chair:

   i. The following paragraphs of this section apply: (a), (c), (d)(1), (d)(3), (d)(4), (e)(1) through (5), (f)(1), (f)(2), (g), (h), (j), (k)(1), (k)(6), (k)(8), (k)(9), (k)(11)(i), (m), and (n). Where the terms “personnel platform” or “platform” are used in these paragraphs, substitute them with “boatswain’s chair.”

   ii. The employee must be hoisted in a slow, controlled descent and ascent.

   iii. The employee must use personal fall protection equipment, including a full body harness, attached independent of the crane/derrick.

   iv. The fall protection equipment must meet the applicable requirements in §1926.502.
§ 1926.1433 Design, construction and testing.

The following requirements apply to equipment that has a manufacturer-rated hoisting/lifting capacity of more than 2,000 pounds.

(a) Crawler, truck and locomotive cranes manufactured prior to November 8, 2010 must meet the applicable requirements for design, construction, and testing as prescribed in ANSI B30.5–1986 (incorporated by reference, see § 1926.6), PCSA Std. No. 2 (1968) (incorporated by reference, see § 1926.6), the requirements in paragraphs (b) of this section, or the applicable DIN standards that were in effect at the time of manufacture.

(b) Mobile (including crawler and truck) and locomotive cranes manufactured on or after November 8, 2010 must meet the following portions of ASME B30.5–2004 (incorporated by reference, see § 1926.6) as applicable:

(1) In section 5–1.1.1 ("Load Ratings—Where Stability Governs Lifting Performance"), paragraphs (a)–(d) (including subparagraphs)

(2) In section 5–1.1.2 ("Load Ratings—Where Structural Competence Governs Lifting Performance"), paragraph (b).

(3) Section 5–1.2 ("Stability (Backward and Forward)"")

(4) In section 5–1.3.1 ("Boom Hoist Mechanism"), paragraphs (a), (b)(1) and (b)(2), except that when using rotation resistant rope, § 1926.1414(c)(4)(ii) applies.

(5) In section 5–1.3.2 ("Load Hoist Mechanism"), paragraph (a)(4) (including subparagraphs), (b) (including subparagraphs), (c) (first sentence only) and (d).

(6) Section 5–1.3.3 ("Telescoping Boom").

(7) Section 5–1.4 ("Swing Mechanism").

(8) In section 5–1.5 ("Crane Travel"), all provisions except 5–1.5.3(d).

(9) In section 5–1.6 ("Controls"), all provisions except 5–1.6.1 (c).

(10) Section 5–1.7.4 ("Sheaves").

(11) Section 5–1.7.5 ("Sheave sizes").

(12) In section 5–1.9.1 ("Booms"), paragraph (f).

(13) Section 5–1.9.3 ("Outriggers").

(14) Section 5–1.9.4 ("Locomotive Crane Equipment").

(15) Section 5–1.9.7 ("Clutch and Brake Protection").

(c) Prototype testing: mobile (including crawler and truck) and locomotive cranes manufactured on or after November 8, 2010 must meet the prototype testing requirements in Test Option A or Test Option B of this section. Tower cranes manufactured on or after November 8, 2010 must meet the prototype testing requirements in BS EN 14439:2006 (incorporated by reference, see § 1926.6).

Note: Prototype testing of crawler, locomotive and truck cranes manufactured prior to November 8, 2010 must conform to paragraph (a) of this section.

(1) Test Option A.

(i) The following applies to equipment with cantilevered booms (such as hydraulic boom cranes):

All the tests listed in SAE J1063 (Nov. 1993) Table 1 (incorporated by reference, see § 1926.6) must be performed to load all critical structural elements to their respective limits. All the strength margins listed in SAE J1063 (Nov. 1993) Table 2 (incorporated by reference, see § 1926.6) must be met.

(ii) The following applies to equipment with pendant supported lattice booms: All the tests listed in SAE J987 (Jun. 2003) Table 1 (incorporated by reference, see § 1926.6) must be performed to load all critical structural elements to their respective limits. All the strength margins listed in SAE J987 (Jun. 2003) Table 2 (incorporated by reference, see § 1926.6) must be met.

(2) Test Option B: The testing and verification requirements of BS EN 13000:2004 (incorporated by reference, see § 1926.6) must be met. In applying § 1926.6, Table 2 (incorporated by reference, see § 1926.6) must be met. In applying§ 1926.6, the following additional requirements must be met: (i) The following applies to equipment with cantilevered booms (such as hydraulic boom cranes):

All the tests listed in SAE J987 (Jun. 2003) Table 1 (incorporated by reference, see § 1926.6) must be performed to load all critical structural elements to their respective limits. All the strength margins listed in SAE J987 (Jun. 2003) Table 2 (incorporated by reference, see § 1926.6) must be met.

The load cases listed in SAE J987 (Jun. 2003) Table 1 (incorporated by reference, see § 1926.6) must be performed to load all critical structural elements to their respective limits. All the strength margins listed in SAE J987 (Jun. 2003) Table 2 (incorporated by reference, see § 1926.6) must be met.
§ 1926.1434 Equipment modifications.

(a) Modifications or additions which affect the capacity or safe operation of the equipment are prohibited except where the requirements of paragraphs (a)(1), (a)(2), (a)(3), (a)(4), or (a)(5) of this section are met.

(b) Modifications or additions which affect the capacity or safe operation of the equipment are prohibited except where the requirements of paragraphs (a)(1), (a)(2), (a)(3), (a)(4), or (a)(5) of this section are met.

(c) Windows must be of safety glass or material with similar optical and safety properties, that introduce no visible distortion or otherwise obscure visibility that interferes with the safe operation of the equipment.

(d) A cab passageway must be provided from the operator’s station to an exit door on the operator’s side.

(e) Areas of the cab roof that serve as a workstation for rigging, maintenance or other equipment-related tasks must be capable of supporting 250 pounds without permanent distortion.

(f) Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains, and other parts or components that reciprocate, rotate or otherwise move must be guarded where contact by employees (except for maintenance and repair employees) is possible in the performance of normal duties.

(g) All exhaust pipes, turbochargers, and charge air coolers must be insulated and protected from damage to the extent feasible.

(h) Hydraulic and pneumatic lines must be protected from damage to the extent feasible.

(i) Of a size and thermal capacity sufficient to control all rated loads with the minimum recommended reeving.

(j) Adjustable to permit compensation for lining wear to prevent load hoist movement in the event of hydraulic failure.

(k) Hydraulic load hoists. Hydraulic drums must have an integrally mounted holding device or internal static brake to prevent load hoist movement in the event of hydraulic failure.

(l) Designed and tested in accordance with those paragraphs.
§ 1926.1435 Tower cranes.

(a) This section contains supplemental requirements for tower cranes; all sections of this subpart apply to tower cranes unless specified otherwise.

(b) Erecting, climbing and dismantling.

(1) Section 1926.1403 (Assembly/Disassembly—selection of manufacturer or employer procedures), §1926.1404 (Assembly/Disassembly—general requirements (applies to all assembly and disassembly operations)), §1926.1405 (Disassembly—additional requirements for dismantling of booms and jibs (applies to both use of manufacturer procedures and employer procedures)), and §1926.1406 (Assembly/Disassembly—employer procedures—general requirements), apply to tower cranes (except as otherwise specified), except that the term “assembly/disassembly” is replaced by “erecting, climbing and dismantling,” and the term “disassembly” is replaced by “dismantling.”

(2) Dangerous areas (self-erecting tower cranes). In addition to the requirements in §1926.1404(b), for self-erecting tower cranes, the following applies: Employees must not be in or under the tower, jib, or rotating portion of the crane during erecting, climbing and dismantling operations until the crane is secured in a locked position and the competent person in charge indicates it is safe to enter this area, unless the manufacturer’s instructions direct otherwise and only the necessary personnel are permitted in this area.

(3) Foundations and structural supports. Tower crane foundations and structural supports (including both the portions of the structure used for support and the means of attachment) must be designed by the manufacturer or a registered professional engineer. (4) Addressing specific hazards. The requirements in §1926.1404(b)(1) through (9) apply. In addition, the A/D director must address the following:

(i) Foundations and structural supports. The A/D director must determine that tower crane foundations and structural supports are installed in accordance with their design.

(ii) Loss of backward stability. Backward stability before swinging self erecting cranes or cranes on traveling or static undercarriages.

(iii) Wind speed. Wind must not exceed the speed recommended by the manufacturer or where manufacturer does not specify this information, the speed determined by a qualified person.

(D) Rail travel brake.

(C) Trolley brake.

(D) Rail travel brake.

(vii) Deadman control or forced neutral return control (hand) levers. (ix) Emergency stop switch at the operator’s station.

(x) Trolley end stops must be provided at both ends of travel of the trolley.

(3) Proper operation required. Operations must not begin unless the devices listed in this section are in proper working order. If a device stops working properly during operations, the operator must safely stop operations. The equipment must be taken out of service, and operations must not resume until the device is again working properly. See §1926.1417(f). Alternative measures are not permitted to be used.

(e) Operational aids.

(1) Section 1926.1416 does not apply to tower cranes.

(2) The devices listed in this section (“operational aids”) are required on all tower cranes covered by this subpart, unless otherwise specified.

(3) Operations must not begin unless the operational aids are in proper working order, except where the employer meets the specified temporary alternative measures. More protective alternative measures specified by the tower crane manufacturer, if any, must be followed. See §1926.1417(i) for additional requirements.

(4) If an operational aid stops working properly during operations, the operator must safely stop operations until the temporary alternative measures are implemented or the device is again working properly. If a replacement part is no longer available, the use of a substitute device that performs the same type of function is permitted and is not considered a modification under §1926.1434.

(5) Category I operational aids and alternative measures. Operational aids listed in this paragraph that are not working properly must be repaired no later than 7 calendar days after the deficiency occurs. Exception: If the employer documents that it has ordered...
Temporary alternative measures:

(A) Option A. The trolley rope must be marked (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the trolley prior to the end stops.

(B) Option B. A spotter who is in direct communication with the operator must be used when operations are conducted within 10 feet of the outer or inner trolley end stops.

(i) Trolley travel limiting device. The travel of the trolley must be restricted at both ends of the jib by a trolley travel limiting device to prevent the trolley from running into the end stops. Temporary alternative measures:

For manufactured towers cranes delivered on or after November 8, 2011, it must be equipped with a device that prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device(s) must prevent such damage at all points where two-blocking could occur. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius, or use a spotter who is in direct communication with the operator to inform the operator when this point is reached.

(ii) Anti two-blocking device. The tower crane must be equipped with a device which automatically prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device(s) must prevent such damage at all points where two-blocking could occur. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius, or use a spotter who is in direct communication with the operator to inform the operator when this point is reached.

(iii) Trolley travel limiting device. The travel of the trolley must be restricted at both ends of the jib by a trolley travel limiting device to prevent the trolley from running into the end stops. Temporary alternative measures:

(A) Option A. The trolley rope must be marked (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the trolley prior to the end stops.

(B) Option B. A spotter who is in direct communication with the operator must be used when operations are conducted within 10 feet of the outer or inner trolley end stops.

The tower crane must be equipped with a device that prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device(s) must prevent such damage at all points where two-blocking could occur. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius, or use a spotter who is in direct communication with the operator to inform the operator when this point is reached.

(iv) Hoist drum lower limiting device. The load speed must be automatically reduced prior to the load reaching the minimum or maximum radius. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the load hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.

(v) Load hoist deceleration device. The load speed must be automatically reduced prior to the load reaching the upper limit. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the load hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.

(vi) Load indicating device. Cranes manufactured after November 8, 2011 must have a hook radius indicator readable from the operator’s station. (C) Temporary alternative measures: Hook radii or boom angle must be determined by measuring the hook radii or boom angle with a measuring device.

(vii) Boom hoist drum positive locking device and control. The hook speed must be automatically reduced prior to the hoist reaching the upper limit. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the hook hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.

(viii) Boom hoist drum positive locking device and control. The load speed must be automatically reduced prior to the load reaching the upper limit. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the load hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.

(v) Wind speed indicator. A device must be provided to display the wind speed and must be mounted above the upper rotating structure on tower cranes. On self-erecting cranes, it must be mounted at or above the jib level. Temporary alternative measures: Use of wind speed information from a properly functioning indicating device on another tower crane on the same site, or a qualified person estimates the wind speed.

(vi) Load indicating device. Cranes manufactured after August 31, 2011 must have a device that displays the magnitude of the load on the hook. Displays that are part of load moment limiting devices that display the load on the hook meet this requirement. Temporary alternative measures: The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer), or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight), or by other equally reliable

The necessary parts within 7 calendar days of the occurrence of the deficiency, the required parts must be completed within 7 calendar days of receipt of the parts.

(A) Trolley travel limiting device. The travel of the trolley must be restricted at both ends of the jib by a trolley travel limiting device to prevent the trolley from running into the end stops. Temporary alternative measures:

(i) Option A. The trolley rope must be marked (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the trolley prior to the end stops.

(ii) Option B. A spotter who is in direct communication with the operator must be used when operations are conducted within 10 feet of the outer or inner trolley end stops.

(B) Anti two-blocking device. The tower crane must be equipped with a device which automatically prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device(s) must prevent such damage at all points where two-blocking could occur. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius, or use a spotter who is in direct communication with the operator to inform the operator when this point is reached.

(C) Trolley travel limiting device. The travel of the trolley must be restricted at both ends of the jib by a trolley travel limiting device to prevent the trolley from running into the end stops. Temporary alternative measures:

(i) Option A. The trolley rope must be marked (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the trolley prior to the end stops.

(ii) Option B. A spotter who is in direct communication with the operator must be used when operations are conducted within 10 feet of the outer or inner trolley end stops.

The tower crane must be equipped with a device which automatically prevents damage from contact between the load block, overhaul ball, or similar component, and the boom tip (or fixed upper block or similar component). The device(s) must prevent such damage at all points where two-blocking could occur. Temporary alternative measures: Clearly mark the cable (so it can be seen by the operator) at a point that will give the operator sufficient time to stop the boom hoist within the minimum and maximum boom radius, or use a spotter who is in direct communication with the operator to inform the operator when this point is reached.

(iv) Hoist drum lower limiting device. The load speed must be automatically reduced prior to the load reaching the upper limit. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the load hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.

(v) Load hoist deceleration device. The load speed must be automatically reduced prior to the load reaching the upper limit. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the load hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.

(vi) Load indicating device. Cranes manufactured after November 8, 2011 must have a hook radius indicator readable from the operator’s station. (C) Temporary alternative measures: Hook radii or boom angle must be determined by measuring the hook radii or boom angle with a measuring device.

(vii) Boom hoist drum positive locking device and control. The hook speed must be automatically reduced prior to the hoist reaching the upper limit. Temporary alternative measures: The employer must post a notice in the cab of the crane notifying the operator that the hook hoist deceleration device is malfunctioning and instructing the operator to take special care to reduce the load speed when approaching the upper limits.
§ 1926.1436 Derricks.

(a) This section contains supplemental requirements for derricks, whether temporarily or permanently mounted; all sections of this subpart apply to derricks unless specified otherwise. A derrick is powered equipment consisting of a mast or equivalent member that is held at or near the end by guys or braces, with or without a boom, and its hoisting mechanism. The mast/equivalent member and/or the load is moved by the hoisting mechanism (typically base-mounted) and operating ropes. Derricks include: A-frame, basket, breast, Chicago boom, gin pole (except gin poles used for erection of communication towers), guy, shearleg, stiffleg, and variations of such equipment.

(b) Operation—procedures.

(1) Section 1926.1417 (Operation) applies except for § 1926.1417(c) (Accessibility of procedures).

(2) Load chart contents. Load charts must contain at least the following information:

(i) Rated capacity at corresponding ranges of boom angle or operating radii.

(ii) Specific lengths of components to which the rated capacities apply.

(iii) Required parts for hoist reeving.

(iv) Size and construction of rope must be included on the load chart or in the operating manual.

(c) Load chart location.

(i) Permanent installations.

For permanently installed derricks with fixed lengths of boom, guy, and mast, a load chart must be posted where it is visible to personnel responsible for the operation of the equipment.

(ii) Non-permanent installations.

For derricks that are not permanently installed, the load chart must be readily available at the job site to personnel responsible for the operation of the equipment.

(iii) Post-erection inspection. In addition to the requirements in § 1926.1412(c), the following requirements must be met:

(i) A load test using certified weights, or scaled weights using a certified scale with a current certificate of calibration, must be conducted after each erection.

(ii) The load test must be conducted in accordance with the manufacturer’s instructions when available. Where these instructions are unavailable, the test must be conducted in accordance with written load test procedures developed by a registered professional engineer familiar with the type of equipment involved.

(iv) Monthly. The following additional items must be included:

(i) Tower (mast) bolts and other structural bolts (for loose or dislodged condition) from the base of the tower crane up or, if the crane is tied to or braced by the structure, those above the upper-most brace support.

(ii) The upper-most tie-in, braces, floor supports and floor wedges where the tower crane is supported by the structure, for loose or dislodged components.

(j) Annual. In addition to the items that must be inspected under § 1926.1412(f), all turntable and tower bolts must be inspected for proper condition and torque.

§ 1926.1436 Guy derricks.

(i) Guy derricks must not be used unless the employer has the following guy information from the manufacturer or a qualified person, when not available from the manufacturer:

(A) The number of guys.

(B) The spacing around the mast.

(C) The size, grade, and construction of rope to be used for each guy.

(2) For guy derricks manufactured after December 18, 1970, in addition to the information required in paragraph (c)(2)(i) of this section, the employer must have the following guy information from the manufacturer or a qualified person, when not available from the manufacturer:

(A) The amount of initial sag or tension.

(B) The amount of tension in guy line rope at anchor.

(iv) The mast base must permit the mast to rotate freely with allowance for slight tilting of the mast caused by guy slack.

(v) The mast cap must:

(A) Permit the mast to rotate freely.

(B) Withstand tilting and cramping caused by the guy loads.

(vi) Be secured to the mast to prevent disengagement during erection.

(vi) Be provided with means for attaching guy ropes.

(iii) The mast must be supported in the vertical position by at least two stifflegs; one end of each must be connected to the top of the mast and the other end securely anchored.

(ii) The stifflegs must be capable of withstanding the loads imposed at any point of operation within the load chart range.

(iii) The mast base must:

(A) Permit the mast to rotate freely (when necessary).

(B) Permit deflection of the mast without binding.

(iv) The mast must be prevented from lifting out of its socket when the mast is in tension.

(v) The stiffleg connecting member at the top of the mast must:

(A) Permit the mast to rotate freely (when necessary).

(B) Withstand the loads imposed by the action of the stifflegs.

(C) Be secured so as to oppose separating forces.

(iii) Gat pole derricks.

(i) Guy lines must be sized and spaced so as to make the gin pole stable in both boomed and vertical positions.

Exception: Where the size and/or
spacing of guy lines do not result in the gin pole being stable in both boomed and vertical positions, the employer must ensure that the derrick is not used in an unstable position.

(ii) The base of the gin pole must permit movement of the pole (when necessary).

(iii) The gin pole must be anchored at the base against horizontal forces (when such forces are present).

(5) Chicago boom derricks. The fittings for stepping the boom and for attaching the topping lift must be arranged to:

(i) Permit the derrick to swing at all permitted operating radii and mounting heights between fittings.

(ii) Accommodate attachment to the upright member of the host structure.

(iii) Withstand the forces applied when stepping in accordance with the manufacturer’s builder’s procedures and within its rated capacity.

(iv) Prevent the boom or topping lift from lifting out under tensile forces.

(D) Anchoring and guying.

(1) Load anchoring data developed by the manufacturer or a qualified person must be used.

(2) Guy derricks.

(i) The mast base must be anchored.

(ii) The guys must be secured to the ground or other firm anchorage.

(iii) The anchorage and guying must be designed to withstand maximum horizontal and vertical forces encountered when operating within rated capacity with the particular guy slope and spacing specified for the application.

(3) Stiffleg derricks.

(i) The mast base and stifflegs must be anchored.

(ii) The mast base and stifflegs must be designed to withstand maximum horizontal and vertical forces encountered when operating within rated capacity with the particular stiffleg spacing and slope specified for the application.

(e) Swingers and hoists.

(1) The boom, swinger mechanisms and hoists must be suitable for the derrick work intended and must be anchored to prevent displacement from the imposed loads.

(2) Hoisting and operating.

(i) Base mounted drum hoists must meet the requirements in the following sections of ASME B30.7–2001 (incorporated by reference, see § 1926.6):

(A) Sections 7–1.1 (“Load ratings and markings”).

(B) Section 7–1.2 (“Construction”), except: 7–1.2.13 (“Operator’s cab”); 7–1.2.15 (“Fire extinguishers”).

(C) Section 7–1.3 (“Installation”).

(D) Applicable terms in section 7–0.2 (“Definitions”).

(ii) Load tests for new hoists. The employer must ensure that new hoists are load tested to a minimum of 110% of rated capacity, but not more than 125% of rated capacity, unless otherwise recommended by the manufacturer. This requirement is met where the manufacturer has conducted this testing.

(iii) Repaired or modified hoists. Hoists that have had repairs, modifications or additions affecting their capacity or safe operation must be evaluated by a qualified person to determine if a load test is necessary. If it is, load testing must be conducted in accordance with paragraphs (e)(2)(i) and (iv) of this section.

(iv) Load test procedure. Load tests required by paragraphs (e)(2)(ii) or (e)(2)(iii) of this section must be conducted as follows:

A. The test load must be hoisted a vertical distance to assure that the load is supported by the hoist and held by the hoist brake(s).

B. The test load must be lowered, stopped and held with the brake(s).

C. The hoist must not be used unless a competent person determines that the test has been passed.

(f) Operational aids.

(1) Section 1926.1416 (Operational aids) applies, except for § 1926.1416(d)(1) (Boom hoist limiting device), § 1926.1416(e)(1) (Boom angle or radius indicator), and § 1926.1416(e)(4) (Load weighing and similar devices).

(2) Boom angle aid. A boom angle indicator is not required but if the derrick is not equipped with a functioning one, the employer must ensure that either:

(i) The boom hoist cable must be marked with caution and stop marks. The stop marks must correspond to maximum and minimum allowable boom angles. The caution and stop marks must be in view of the operator, or a spotter who is in direct communication with the operator; or

(ii) An electronic or other device that signals the operator in time to prevent the boom from moving past its maximum and minimum angles, or automatically prevents such movement, is used.

(3) Load weight/capacity devices.

(i) Derrick manufactured more than one year after November 8, 2010 with a maximum rated capacity over 6,000 pounds must have at least one of the following: load weighing device, load moment indicator, rated capacity indicator, or rated capacity limiter.

Temporary alternative measures: The weight of the load must be determined from a source recognized by the industry (such as the load’s manufacturer), or by a calculation method recognized by the industry (such as calculating a steel beam from measured dimensions and a known per foot weight), or by other equally reliable means. This information must be provided to the operator prior to the lift. See §1926.1417(j) for additional requirements.

(ii) A load weight/capacity device that is not working properly must be repaired no later than 30 days after the deficiency occurs. Exception: If the employer documents that it has ordered the necessary parts within 7 days of the occurrence of the deficiency, and the part is not received in time to complete the repair in 30 days, the repair must be completed within 7 days of receipt of the parts.

(g) Post-assembly approval and testing—new or reinstalled derricks.

(1) Anchorage.

(i) Anchorage, including the structure to which the derrick is attached (if applicable), must be approved by a qualified person.

(ii) If using a rock or hairpin anchorage, the qualified person must determine if any special testing of the anchorage is needed. If so, it must be tested accordingly.

(2) Functional test. Prior to initial use, new or reinstalled derricks must be tested by a competent person with no hook load to verify proper operation. This test must include:

(i) Lifting and lowering the hook(s) through the full range of hook travel.

(ii) Kissing and lowering the boom through the full range of boom travel.

(iii) Swinging in each direction through the full range of swing.

(iv) Actuating the anti two-block and boom hoist limit devices (if provided).

(v) Actuating locking, limiting and indicating devices (if provided).

(3) Load test. Prior to initial use, new or reinstalled derricks must be load tested by a competent person. The test load must meet the following requirements:

(i) Test loads must be at least 100% and no more than 110% of the rated capacity, unless otherwise recommended by the manufacturer or qualified person, but no amount must the test load be less than the maximum anticipated load.

(ii) The test must consist of:

(A) Hoisting the test load a few inches and holding to verify that the load is supported by the derrick and held by the hoist brake(s).

(B) Swinging the derrick, if applicable, the full range of its swing, at
the maximum allowable working radius for the test load.
(C) Booming the derrick up and down within the allowable working radius for the test load.
(D) Lowering, stopping and holding the load with the brackets.
(iii) The derrick must not be used until the competent person determines that the test has been passed.
(a) Documentation. Tests conducted under this paragraph must be documented. The document must contain the date, test results and the name of the tester. The document must be retained until the derrick is re-tested or dismantled, whichever occurs first. All such documents must be available, during the applicable document retention period, to all persons who conduct inspections in accordance with §1926.1414.
(h) Load testing repaired or modified derricks. Derricks that have had repairs, modifications or additions affecting the derrick’s capacity or safe operation must be evaluated by a qualified person to determine if a load test is necessary. If it is, load testing must be conducted and documented in accordance with paragraph (g) of this section.
(i) [Reserved.]
(j) Power failure procedures. If power fails during operations, the derrick operator must safely stop operations. This must include:
(1) Setting all brakes or locking devices.
(2) Moving all clutch and other power controls to the off position.
(k) Use of winch heads. (1) Gudgeon pin for cracks, wear, and distortion.
(i) Foundation supports for cracks, wear, and distortion.
(ii) Anti two-block device.
(2) Positive equipment house lock.
(n) Supervised by a competent person.
(q) Qualification and Training. The employer must train each operator of a derrick on the safe operation of equipment the individual will operate. Section 1926.1427 of this subpart (Operator qualification and certification) does not apply.
§1926.1437 Floating cranes/derricks and land cranes/derricks on barges.
(a) This section contains supplemental requirements for floating cranes/derricks and land cranes/derricks on barges, pontoons, vessels or other means of flotation (i.e., vessel/ flotation device). The sections of this subpart apply to floating cranes/derricks and land cranes/derricks on barges, pontoons, vessels or other means of flotation, unless specified otherwise. The requirements of this section do not apply when using jacked barges when the jacks are deployed to the river, lake, or sea bed and the barge is fully supported by the jacks.
(b) General requirements. The requirements in paragraphs (c) through (k) of this section apply to both floating cranes/derricks and land cranes/derricks on barges, pontoons, vessels or other means of flotation.
(c) Work area control. (1) The requirements of §1926.1424 (Work area control) apply, except for §1926.1424(a)(2)(ii).
(2) The employer must either:
(i) Erect and maintain control lines, warning lines, railings or similar barriers to mark the boundaries of the hazard areas; or
(ii) Clearly mark the hazard areas by a combination of warning signs (such as, “Danger—Swing/Crush Zone”) and high visibility markings on the equipment that identify the hazard areas. In addition, the employer must train each employee to understand what these markings signify.
(d) Keeping clear of the load. Section 1926.1425 does not apply.
(e) Additional safety devices. In addition to the safety devices listed in §1926.1415, the following safety devices are required:
(1) Ballast, pontoon, vessel or other means of flotation and trim device. The safety device must be located in the cab or, when there is no cab, at the operator’s station.
(2) Positive equipment house lock.
(3) Wind speed and direction indicator. A competent person must determine if wind is a factor that needs to be considered; if wind needs to be considered, a wind speed and direction indicator must be used.
(f) Operational aids. (1) An anti two-block device is required only when hoisting personnel or hoisting over an occupied cofferdam or shaft.
(2) Section 1926.1416(e)(4) (Load weighing and similar devices) does not apply to dragline, clamshell (grapple), magnet, drop ball, container handling, concrete bucket, and pile driving work performed under this section.
(g) Accessibility of procedures applicable to equipment operation. If the crane/derrick has a cab, the requirements of §1926.1417(c) apply. If the crane/derrick does not have a cab, the employer must ensure that:
(1) Rated capacities (load charts) are posted at the operator’s station. If the operator’s station is moveable (such as with pendant-controlled equipment), the load charts are posted on the equipment.
(2) Procedures applicable to the operation of the equipment (other than load charts), recommended operating speeds, special hazard warnings, instructions and operators manual, must be readily available on board the vessel/ flotation device.
(h) Inspections. In addition to meeting the requirements of §1926.1412 for inspecting the crane/derrick, the employer must inspect the barge, pontoons, vessels or other means of flotation used to support a floating crane/derrick or land crane/derrick, and ensure that:
(1) Shift. For each shift inspection, the means used to secure/attach the equipment to the vessel/flotation device is in proper condition, including inspection for wear, corrosion, loose or missing fasteners, defective welds, and (when applicable) insufficient tension.
(2) Monthly. For each monthly inspection:
(i) The means used to secure/attach the equipment to the vessel/flotation device is in proper condition, including inspection for wear, corrosion, and, when applicable, insufficient tension.
(ii) The vessel/flotation device is not taking on water.
(iii) The deckload is properly secured.
(iv) The vessel/flotation device is watertight based on the condition of the chain lockers, storage, fuel compartments, and hatchs.
(v) The firefighting and lifesaving equipment is in place and functional.
(3) The shift and monthly inspections are conducted by a competent person, and:

(i) If any deficiency is identified, an immediate determination is made by a qualified person whether the deficiency constitutes a hazard.

(ii) If the deficiency is determined to constitute a hazard, the vessel/flotation device is removed from service until the deficiency has been corrected.

(4) Annual: external vessel/flotation device inspection. For each annual inspection:

(i) The external portion of the barge, pontoons, vessel, or other means of flotation used is inspected annually by a qualified person who has expertise with respect to vessels/flotation devices and that the inspection includes the following items:

(A) The items identified in paragraphs (h)(1) (Shift) and (h)(2) (Monthly) of this section.

(B) Cleats, bitts, chocks, fenders, capstans, ladders, and stanchions, for significant corrosion, wear, deterioration, or deformation that could impair the function of these items.

(C) External evidence of leaks and structural damage; evidence of leaks and damage below the waterline may be determined through internal inspection of the vessel/flotation device.

(D) Four-corner draft readings.

(E) Firefighting equipment for serviceability.

(ii) Rescue skiffs, lifelines, work vests, life preservers and ring buoys are inspected for proper condition.

(iii) If any deficiency is identified, an immediate determination is made by the qualified person whether the deficiency constitutes a hazard or, though not yet a hazard, needs to be monitored in the monthly inspections.

(A) If the qualified person determines that the deficiency constitutes a hazard, the vessel/flotation device is removed from service until it has been corrected.

(B) If the surveyor determines that, though not presently a hazard, the deficiency needs to be monitored, the deficiency is checked in the monthly or annual inspections, as appropriate.

(6) Documentation. The monthly and annual inspections required in paragraphs (h)(2) and (h)(4) of this section are documented in accordance with §§1926.1412(e)(3) and 1926.1412(n)(7), respectively, and that the four-year inspection required in paragraph (h)(5) of this section is documented in accordance with §1926.1412(l)(9), except that the documentation for that inspection must be retained for a minimum of 4 years.

All such documents must be made available, during the applicable document retention period, to all persons who conduct inspections in accordance with §1926.1412.

(i) [Reserved.]

(j) Working with a diver. The employer must meet the following additional requirements when working with a diver in the water:

(1) If a crane/derrick is used to get a diver into and out of the water, it must not be used for any other purpose until the diver is back on board. When used for more than one diver, it must not be used for any other purpose until all divers are back on board.

(2) The operator must remain at the controls of the crane/derrick at all times.

(3) In addition to the requirements in §§1926.1419 through 1926.1422 (Signals), either:

(i) A clear line of sight must be maintained between the operator and tender; or

(ii) The signals between the operator and tender must be transmitted electronically.

(4) The means used to secure the crane/derrick to the vessel/flotation device (see paragraph (n)(5) of this section) must not allow any amount of shifting in any direction.

(k) Manufacturer’s specifications and limitations.

(1) The employer must ensure that the barge, pontoons, vessel, or other means of flotation must be capable of withstanding imposed environmental, operational and in-transit loads when used in accordance with the manufacturer’s specifications and limitations.

(2) The employer must ensure that the manufacturer’s specifications and limitations with respect to environmental, operational, and in-transit loads for the barge, pontoons, vessel, or other means of flotation are not exceeded or violated.

(3) When the manufacturer’s specifications and limitations are unavailable, the employer must ensure that the specifications and limitations established by a qualified person with respect to environmental, operational and in-transit loads for the barge, pontoons, vessel, or other means of flotation are not exceeded or violated.

(l) [Reserved.]

(m) Floating cranes/derricks. For equipment designed by the manufacturer (or employer) for marine use by permanent attachment to barges, pontoons, vessels or other means of flotation:

(1) Load charts.

(i) The employer must not exceed the manufacturer load charts applicable to operations on water. When using these charts, the employer must comply with all parameters and limitations (such as dynamic and environmental parameters) applicable to the use of the charts.

(ii) The employer must ensure that load charts take into consideration a minimum wind speed of 40 miles per hour.

(2) The employer must ensure that the requirements for maximum allowable list and maximum allowable trim as specified in Table M1 of this section are met.

<table>
<thead>
<tr>
<th>Rated capacity</th>
<th>Maximum allowable list (degrees)</th>
<th>Maximum allowable trim (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment designed for marine use by permanent attachment (other than derricks):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 tons or less</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Over 25 tons</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Derricks designed for marine use by permanent attachment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any rated capacity</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

(3) The employer must ensure that the equipment is stable under the conditions specified in Tables M2 and M3 of this section. (Note: Freeboard is the vertical distance between the water line and the main deck of the vessel.)
TABLE M2

<table>
<thead>
<tr>
<th>Operated at</th>
<th>Wind speed (mph)</th>
<th>Minimum freeboard (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated capacity</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>Rated capacity plus</td>
<td>55</td>
<td>1</td>
</tr>
<tr>
<td>25%</td>
<td>60</td>
<td>2</td>
</tr>
<tr>
<td>High boom, no load</td>
<td>60</td>
<td>2</td>
</tr>
</tbody>
</table>

TABLE M3

<table>
<thead>
<tr>
<th>Operated at</th>
<th>Wind speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>For backward stability of the boom: High boom, no load, full back list</td>
<td>90 mph.</td>
</tr>
</tbody>
</table>

(4) If the equipment is employer-made, it must not be used unless the employer has documents demonstrating that the load charts and applicable parameters for use meet the requirements of paragraphs (m)(1) through (3) of this section. Such documents must be signed by a registered professional engineer who is a qualified person with respect to the design of this type of equipment (including the means of flotation).

(5) The employer must ensure that the barge, pontoons, vessel or other means of flotation used:

(i) Are structurally sufficient to withstand the static and dynamic loads of the crane/derrick’s maximum rated capacity with all planned and actual deck loads and ballasted compartments.

(ii) Have a subdivided hull with one or more longitudinal watertight bulkheads for reducing the free-surface effect.

(iii) Have access to void compartments to allow for inspection and pumping.

(n) Land cranes/derricks. For land cranes/derricks used on barges, pontoons, vessels or other means of flotation, the employer must ensure that:

(i) The rated capacity of the equipment (including but not limited to modification of load charts) applicable for use on land is reduced to:

(A) Account for increased loading from list, trim, wave action, and wind.

(ii) Be applicable to a specified location(s) on the specified barge, pontoons, vessel or other means of flotation that will be used, under the environmental conditions expected and encountered.

(iii) The conditions required in paragraphs (n)(3) and (n)(4) of this section are met.

(2) The rated capacity modification required in paragraph (n)(1) of this section is performed by the equipment manufacturer, or a qualified person who has expertise with respect to both land crane/derrick capacity and the stability of vessels/flotation devices.

(3) For list and trim.

(i) The maximum allowable list and the maximum allowable trim for the barge, pontoons, vessel or other means of flotation must not exceed the amount necessary to ensure that the conditions in paragraph (n)(4) of this section are met. In addition, the maximum allowable list and the maximum allowable trim does not exceed the least of the following: 5 degrees, the amount specified by the crane/derrick manufacturer, or, when an amount is not so specified, the amount specified by the qualified person.

(ii) The maximum allowable list and the maximum allowable trim for the land crane/derrick does not exceed the amount specified by the crane/derrick manufacturer, or, when an amount is not so specified, the amount specified by the qualified person.

(4) For the following conditions:

(i) All deck surfaces of the barge, pontoons, vessel or other means of flotation used are above water.

(ii) The entire bottom area of the barge, pontoons, vessel or other means of flotation used is submerged.

(5) Physical attachment, corralling, rails system and centerline cable system meet the requirements in Option (1), Option (2), Option (3), or Option (4) of this section, and that whichever option is used meets the requirements of paragraph (n)(5)(v) of this section.

(i) Option (1)—Physical attachment.

The crane/derrick is physically attached to the barge, pontoons, vessel or other means of flotation. Methods of physical attachment include crossed-cable systems attached to the crane/derrick and vessel/flotation device, bolting or welding the crane/derrick to the vessel/flotation device, strapping the crane/derrick to the vessel/flotation device with chains, or other methods of physical attachment.

(ii) Option (2)—Corralling. The crane/derrick is prevented from shifting by installing barricade restraints (i.e., a corralling system). Employers must ensure that corralling systems do not allow the equipment to shift by any amount of shifting in any direction.

(iii) Option (3)—Rails. The crane/derrick must be prevented from shifting by being mounted on a rail system. Employers must ensure that rail clamps and rail stops are used unless the system is designed to prevent movement during operation by other means.

(iv) Option (4)—Centerline cable system. The crane/derrick is prevented from shifting by being mounted to a wire rope system. The employer must ensure that the wire rope system meets the following requirements:

(A) The wire rope and attachments are of sufficient size and strength to support the side load of crane/derrick.

(B) The wire rope is attached physically to the vessel/flotation device.

(C) The wire rope is attached to the crane/derrick by appropriate attachment methods (such as shackles or sheaves) on the undercarriage, and that the method used will allow the crew to secure the crane/derrick from movement during operation and to move the crane/derrick longitudinally along the vessel/flotation device for repositioning.

(D) Means are installed to prevent the crane/derrick from passing the forward or aft end of the wire rope attachments.

(E) The crane/derrick is secured from movement during operation.

(v) The systems/means used to comply with Option (1), Option (2), Option (3), or Option (4) of this section are designed by a marine engineer, or, when an amount of flotation is specified by the crane/derrick manufacturer, or a qualified person familiar with floating crane/derrick design, or qualified person familiar with floating crane/derrick design.

(6) Exception. For mobile auxiliary cranes used on the deck of a floating crane/derrick, the requirement specified by paragraph (n)(5) of this section to use Option (1), Option (2), Option (3), or Option (4) does not apply when the employer demonstrates implementation of a plan and procedures that meet the following requirements:

(i) A marine engineer or registered professional engineer familiar with floating crane/derrick design develops and signs a written plan for the use of the mobile auxiliary crane.

(ii) The plan is designed so that the applicable requirements of this section are met despite the position, travel, operation, and lack of physical attachment (or corralling, use of rails or cable system) of the mobile auxiliary crane.

(iii) The plan specifies the areas of the deck where the mobile auxiliary crane is permitted to be positioned, travel, and operate, and the parameters and limitations of such movements and operation.

(iv) The deck is marked to identify the permitted areas for positioning, travel, and operation.

(v) The plan specifies the dynamic and environmental conditions that must be present for use of the plan.

(vi) If the dynamic and environmental conditions in paragraph (n)(6)(v) of this section are exceeded, the mobile auxiliary crane is attached physically or corralled in accordance with Option (1),
§ 1926.1438 Overhead & gantry cranes.

(a) Permanently installed overhead and gantry cranes. The requirements of § 1910.179, except for § 1910.179(b)(1), and not the requirements of this subpart CC, apply to the following equipment when used in construction and permanently installed in a facility: overhead and gantry cranes, including semigantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics.

(b) Overhead and gantry cranes that are not permanently installed in a facility.

(1) This paragraph applies to the following equipment when used in construction and not permanently installed in a facility: Overhead and gantry cranes, overhead/bridge cranes, semigantry, cantilever gantry, wall cranes, storage bridge cranes, launch gantry cranes, and similar equipment having the same fundamental characteristics, irrespective of whether it travels on tracks, wheels, or other means.

(2) The following requirements apply to equipment identified in paragraph (b)(1) of this section:

(i) Sections 1926.1400 through 1926.1429; §§ 1926.1432 through 1926.1437; § 1926.1439, and § 1926.1441.

(ii) The following portions of § 1910.179:

(A) Paragraphs (b)(5), (f)(6), (f)(7); (e)(1)(3), (5), (6); (f)(1)(4); (g); (h)(1), (3); (k); and (n) of § 1910.179.

(B) The definitions in § 1910.179(a), except for “hoist” and “load.” For those words, the definitions in § 1926.1401 apply.

(C) Section 1910.179(b)(2), but only where the equipment identified in paragraph (b)(1) of this section (§ 1926.1438) was manufactured before September 19, 2001.

(iii) For equipment manufactured on or after September 19, 2001, the following sections of ASME B30.2–2005 (incorporated by reference, see § 1926.6) apply: 2–1.3.1; 2–1.3.2; 2–1.4.1; 2–1.6; 2–1.7.2; 2–1.8.2; 2–1.9.1; 2–1.9.2; 2–1.11; 2–1.12.2; 2–1.13.7; 2–1.14.2; 2–1.14.3; 2–1.14.5; 2–1.15; 2–1.22; 2–3.2.1.1. In addition, 2–3.5 applies, except in 2–3.5.1(b). "29 CFR 1910.147" is substituted for "ANSI Z244.1."

§ 1926.1439 Dedicated pile drivers.

(a) The provisions of subpart CC apply to dedicated pile drivers, except as specified in this section.

(b) Section 1926.1416(d)(3) (Anti two-blocking device) does not apply.

(c) Section 1926.1416(e)(4) (Load weighing and similar devices) applies only to dedicated pile drivers manufactured after November 8, 2011.

(d) In § 1926.1433, only §§ 1926.1433(d) and (e) apply to dedicated pile drivers.

§ 1926.1440 Sideboom cranes.

(a) The provisions of this standard apply, except § 1926.1402 (Ground conditions), § 1926.1415 (Safety devices), § 1926.1416 (Operational aids), and § 1926.1427 (Operator qualification and certification).

(b) Section 1926.1426 (Free fall and controlled load lowering) applies, except § 1926.1426(a)(2)(i).

(c) Sideboom cranes in which the boom is designed to free fall (live boom) are permitted only if manufactured prior to November 8, 2010.

§ 1926.1441 Equipment with a rated hoisting/lifting capacity of 2,000 pounds or less.

The following paragraphs of this section specify requirements for employers using equipment with a maximum rated hoisting/lifting capacity of 2,000 pounds or less.

(a) The employer using this equipment must comply with the following provisions of this subpart: § 1926.1400 (Scopes); § 1926.1401 (Definitions); § 1926.1402 (Ground conditions); § 1926.1403 (Assembly/disassembly—selection of manufacturer or employer procedures); § 1926.1406 (Assembly/disassembly—employer procedures); §§ 1926.1407 through 1926.1411 (Power line safety);

§ 1926.1412(c) (Post-assembly);

§§ 1926.1413 through 1926.1414 (Wire rope); § 1926.1418 (Authority to stop operation); §§ 1926.1419 through 1926.1422 (Signals); § 1926.1423 (Fall protection); § 1926.1425 (Keeping clear of the load) (except for § 1926.1425(c)(1)(ii) (qualified rigger)); § 1926.1426 (Free fall and controlled load lowering);

§ 1926.1432 (Multiple crane/derrick lifts—supplemental requirements);

§ 1926.1434 (Equipment modifications);

§ 1926.1435 (Tower cranes); § 1926.1436 (Derricks); § 1926.1437 (Floating cranes/derricks and land cranes/derricks on barges); § 1926.1438 (Overhead & gantry cranes).

(b) Assembly/disassembly.

(1) In addition to compliance with §§ 1926.1403 (Assembly/disassembly—selection of manufacturer or employer procedures) and 1926.1406 (Assembly/disassembly—employer procedures), the employer must also comply with § 1926.1441(b)(2)–(3).

(2) Components and configuration.

The employer must ensure that:

(i) The selection of components, and the configuration of the equipment, that affect the capacity or safe operation of the equipment complies with either the:

(A) Manufacturer instructions, recommendations, limitations, and specifications. When these documents and information are unavailable, a registered professional engineer familiar with the type of equipment involved must approve, in writing, the selection and configuration of components; or

(B) Approved modifications that meet the requirements of § 1926.1434 (Equipment modifications).

(ii) Post-assembly inspection. Upon completion of assembly, the equipment is inspected to ensure that it is in compliance with paragraph (b)(2)(i) of...
this section (see §1926.1412(c) for post-assembly inspection requirements).

(3) Manufacturer prohibitions. The employer must comply with applicable manufacturer prohibitions.

(c) Operation—procedures.

(1) The employer must comply with all manufacturer procedures applicable to the operational functions of the equipment, including its use with attachments.

(2) Unavailable operation procedures. The employer must:

(i) When the manufacturer’s procedures are unavailable, develop, and ensure compliance with, all procedures necessary for the safe operation of the equipment and attachments.

(ii) Ensure that procedures for the operational controls are developed by a qualified person.

(iii) Ensure that procedures related to the capacity of the equipment are developed and signed by a registered professional engineer familiar with the equipment.

(3) Accessibility. The employer must ensure that:

(i) The load chart is available to the operator at the control station;

(ii) Procedures applicable to the operation of the equipment, recommended operating speeds, special hazard warnings, instructions, and operator’s manual are readily available for use by the operator.

(iii) When rated capacities are available at the control station only in electronic form and a failure occurs that makes the rated capacities inaccessible, the operator immediately ceases operations or follows safe shut-down procedures until the rated capacities (in electronic or other form) are available.

(d) Safety devices and operational aids.

(1) The employer must ensure that safety devices and operational aids that are part of the original equipment are maintained in accordance with manufacturer procedures.

(2) Anti two-blocking. The employer must ensure that equipment covered by this section manufactured more than one year after November 8, 2010 have either an anti two-block device that meets the requirements of §1926.1416(d)(3), or is designed so that, in the event of a two-block situation, no damage or load failure will occur (for example, by using a power unit that stalls in response to a two-block situation).

(e) Operator qualifications. The employer must train each operator, prior to operating the equipment, on the safe operation of the type of equipment the operator will be using.

(f) Signal person qualifications. The employer must train each signal person in the proper use of signals applicable to the use of the equipment.

(g) [Reserved.]

(h) Inspections. The employer must ensure that equipment is inspected in accordance with manufacturer procedures.

(i) [Reserved.]

(j) Hoisting personnel. The employer must ensure that equipment covered by this section is not used to hoist personnel.

(k) Design. The employer must ensure that the equipment is designed by a qualified engineer.

§1926.1442 Severability.

Should a court of competent jurisdiction hold any provision(s) of subpart CC to be invalid, such action shall not affect any other provision of the subpart.

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Appendix A to Subpart CC of Part 1926—Standard Hand Signals
<table>
<thead>
<tr>
<th>Gesture</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>STOP</strong></td>
<td>With arm extended horizontally to the side, palm down, arm is swung back and forth.</td>
</tr>
<tr>
<td><strong>EMERGENCY STOP</strong></td>
<td>With both arms extended horizontally to the side, palms down, arms are swung back and forth.</td>
</tr>
<tr>
<td><strong>HOIST</strong></td>
<td>With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.</td>
</tr>
<tr>
<td><strong>RAISE BOOM</strong></td>
<td>With arm extended horizontally to the side, thumb points up with other fingers closed.</td>
</tr>
<tr>
<td><strong>SWING</strong></td>
<td>With arm extended horizontally, index finger points in direction that boom is to swing.</td>
</tr>
<tr>
<td><strong>RETRACT TELESOPING BOOM</strong></td>
<td>With hands to the front at waist level, thumbs point at each other with other fingers closed.</td>
</tr>
<tr>
<td><strong>RAISE THE BOOM AND LOWER THE LOAD</strong></td>
<td>With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.</td>
</tr>
<tr>
<td><strong>DOG EVERYTHING</strong></td>
<td>Hands held together at waist level.</td>
</tr>
<tr>
<td><strong>LOWER</strong></td>
<td>With arm and index finger pointing down, hand and finger make small circles.</td>
</tr>
<tr>
<td><strong>LOWER BOOM</strong></td>
<td>With arm extended horizontally to the side, thumb points down with other fingers closed.</td>
</tr>
<tr>
<td><strong>EXTEND TELESOPING BOOM</strong></td>
<td>With hands to the front at waist level, thumbs point outward with other fingers closed.</td>
</tr>
<tr>
<td><strong>TRAVEL/TOWER TRAVEL</strong></td>
<td>With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.</td>
</tr>
</tbody>
</table>
### Appendix B to Subpart CC of Part 1926—Assembly/Disassembly: Sample Procedures for Minimizing the Risk of Unintended Dangerous Boom Movement

1. **Lower The Boom And Raise The Load** — With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.

2. **Move Slowly** — A hand is placed in front of the hand that is giving the action signal.

3. **Use Auxiliary Hoist** (whipline) — With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.

4. **Crawler Crane Travel, Both Tracks** — Rotate fists around each other in front of body; direction of rotation away from body indicates travel forward; rotation towards body indicates travel backward.

5. **Use Main Hoist** — A hand taps on top of the head. Then regular signal is given to indicate desired action.

6. **Crawler Crane Travel, One Track** — Indicate track to be locked by raising fist on that side. Rotate other fist in front of body in direction that other track is to travel.

7. **Trolley Travel** — With palm up, fingers closed and thumb pointing in direction of motion, hand is jerked horizontally in direction trolley is to travel.

The following scenario is an example of how the exception applies: A boom cannot be disassembled on the ground because of aboveground piping (as might be found, for example, in an oil refinery) that precludes lowering the boom to the ground. The boom must therefore be disassembled in the air, and the employees who remove the pins must perform that work from an aerial lift whose base is positioned on one side (the near side) of the boom. To gain access to the pins on the far side, the aerial lift basket must move under the boom, since, due to lack of room, the aerial lift cannot be repositioned on the far side. Due to lack of room, the aerial basket must move under the boom to gain access to the pins on the far side.

To minimize the risk of unintended dangerous movement while the pins are removed, the A/D director uses an assist crane that is rigged to support the boom section that is being detached, using particular care to ensure that the section end that is near the employee(s) removing the pins is well supported. The duration and extent of exposure is minimized by removing the far side pins first, moving the aerial lift basket as soon as possible to the near side so that the employees are no longer under the boom, and then removing the near side pins.

2. **Section 1926.1404(h)(6)(i)** provides that, during assembly/disassembly, the center of gravity of the load must be identified if that is necessary for the method used for maintaining stability. Section 1926.1404(h)(6)(ii) states that, where there is insufficient information to accurately identify the center of gravity, measures designed to prevent unintended dangerous movement resulting from an inaccurate
identification of the center of gravity must be used.
An example of the application of §1926.1404(b)(6)(ii) is as follows: The boom is assembled by lowering boom sections sequentially into place using an assist crane. The A/D director’s plan is to keep the boom sections stable while they are lowered into place by attaching the assist crane hoist line above the center of gravity of each section. However, in assembling the non-symmetrical top section of the boom, the A/D director is not able to determine where to attach the assist crane hoist line so that it is above the center of gravity. In this situation, before raising the section, all personnel are kept clear of the section and the section is first raised a few inches to determine whether it tips when raised (if it did tip, it would indicate it is not rigged over the center of gravity). If this occurs, the hoist line is repositioned and the procedure repeated (with employees kept clear of the section while it is raised) until the A/D director determines that it is rigged over the center of gravity and can be moved into place without dangerous movement.

Appendix C to Subpart CC of Part 1926—Operator Certification: Written Examination: Technical Knowledge Criteria
This appendix contains information for employers, accredited testing organizations, auditors and government entities developing criteria for a written examination to test an individual’s technical knowledge relating to the operation of cranes.
(a) General technical information.
(1) The functions and limitations of the crane and attachments.
(2) Wire rope:
(i) Background information necessary to understand the inspection and removal from service criteria in §1926.1413 and §1926.1414.
(ii) Capacity and when multi-part rope is needed.
(iii) Relationship between line pull and safe working load.
(iv) How to determine the manufacturer’s recommended rope for the crane.
(3) Rigging devices and their use, such as:
(i) Slings.
(ii) Spreaders.
(iii) Lifting beams.
(iv) Wire rope fittings, such as clips, shackles and wedge sockets.
(v) Saddles (softeners).
(vi) Slings (beams).
(vi) The technical limitations of protective measures against electrical hazards:
(i) Grounding.
(ii) Proximity warning devices.
(iii) Insulated links.
(iv) Boom cages.
(v) Proximity to electric power lines, radia, and microwave structures.
(6) The effects of load share and load transfer in multi-crane lifts.
(7) Basic crane terms.
(8) The basics of machine power flow systems:
(i) Mechanical.
(ii) Electrical.
(iii) Pneumatic.
(iv) Hydraulic.
(v) Combination.
(vi) The significance of the instruments and gauge readings.
(9) The effects of thermal expansion and contraction in hydraulic cylinders.
(10) Background information necessary to understand the requirements of pre-operation and inspection.
(11) How to use the safety devices and operational aids required under §1926.1415 and §1926.1416.
(12) The difference between duty-cycle and lifting operations.
(13) How to calculate net capacity for every possible configuration of the equipment using the manufacturer’s load chart.
(14) How to use manufacturer-approved attachments and their effect on the equipment.
(15) How to obtain dimensions, weight, and center of gravity of the load.
(16) The effects of dynamic loading from:
(i) Wind.
(ii) Stopping and starting.
(ii) Impact loading.
(iv) Moving with the load.
(17) The effect of side loading.
(18) The principles of backward stability.
(b) Site information.
(1) How to identify the suitability of the supporting ground/surface to support the expected loads of the operation. Elements include:
(i) Weaknesses below the surface (such as voids, tanks, loose fill).
(ii) Weaknesses on the surface (such as retaining walls, slopes, excavations, depressions).
(2) Proper use of mats, blocking/cribbing, outriggers, stabilizers, or crawlers.
(3) Identification of site hazards such as power lines, piping, and traffic.
(4) How to review operation plans with supervisors and other workers (such as the signal person), including how to determine working height, boom length, load radius, and travel clearance.
(5) How to determine if there is adequate room for extension of crawlers or outriggers/stabilizers and counterweights.
(c) Operations.
(1) How to pick, carry, swing and place the load smoothly and safely on rubber tires and on outriggers/stabilizers or crawlers (where applicable).
(2) How to communicate at the site with supervisors, the crew and the signal person.
(3) Proper procedures and methods of reeving wire ropes and methods of reeving multiple-part lines and selecting the proper load block and/or ball.
(4) How to react to changes in conditions that affect the safe operation of the equipment.
(5) How to shut down and secure the equipment properly when leaving it unattended.
(6) How to know how to apply the manufacturer’s specifications for operating in various weather conditions, and understand how environmental conditions affect the safe operation of the equipment.
(7) How to properly level the equipment.
(8) How to verify the weight of the load and rigging prior to initiating the lift.
(9) How to determine where the load is to be picked up and placed and how to verify the radii.
(10) Know basic rigging procedures.
(11) How to carry out the shift inspection required in this subpart.
(12) Know that the following operations require specific procedures and skill levels:
(i) Multi-crane lifts.
(ii) Hoisting personnel.
(iii) Clamshell/dragline operations.
(iv) Pile driving and extracting.
(v) Concrete operations, including poured-in-place and tilt-up.
(vi) Demolition operations.
(vii) Operations on water.
(viii) Magnet operations.
(ix) Multi-drum operations.
(13) Know the proper procedures for operating safely under the following conditions:
(i) Travelling with suspended loads.
(ii) Approaching a two-block condition.
(iii) Operating near power lines.
(iv) Hoisting personnel.
(v) Using other than full outrigger/crawler or stabilizer extensions.
(vi) Lifting loads from beneath the surface of the water.
(vii) Using various approved counterweight configurations.
(viii) Handling loads out of the operator’s vision (“operating in the blind”).
(ix) Using electronic communication systems for signal communication.
(14) Know the proper procedures for load control and the use of hand-held tag lines.
(15) Know the emergency response procedure for:
(i) Fires.
(ii) Power line contact.
(iii) Loss of stability.
(iv) Control malfunction.
(v) Two-blocking.
(vi) Overload.
(vii) Carrier or travel malfunction.
(16) Know how to properly use outriggers and stabilizers in accordance with manufacturer specifications.
(d) Use of load charts.
(1) Know the terminology necessary to use load charts.
(2) Know how to ensure that the load chart is the appropriate chart for the equipment in its particular configuration and application.
(3) Know how to use load charts. This includes knowing:
(i) The operational limitations of load charts and footnotes.
(ii) How to relate the chart to the configuration of the crane, crawlers, or outriggers/stabilizers extended or retracted, jib erected or offset, and various counterweight configurations.
(iii) The difference between structural capacity and capacity limited by stability.
(iv) What is included in capacity ratings.
(v) The range diagram and its relationship to the load chart.
(vi) The work area chart and its relationship to the load chart.
(vii) Where to find and how to use the “parts-of-line” information.
(4) Know how to use the load chart together with the load indicators and/or load moment devices.

[FR Doc. 2010–17818 Filed 7–28–10; 8:45 am]

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20.1 PURPOSE

This charter describes the function and role of the Hanford Site Hoisting and Rigging Committee (HSHRC). The HSHRC serves as an advisory body to help ensure the safe performance of hoisting and rigging (H&R) activities at the Hanford Site.

20.2 FUNCTION

The HSHRC is established to maintain a single Site-wide H&R program manual and provide technical advice to Hanford Site contractors in development of policy, requirements, and guidance relating to safe implementation of activities. In fulfillment of this mission, the HSHRC will perform the following functions:

1. Review, evaluate, and approve actions necessary to ensure that the Hanford Site Hoisting and Rigging Manual (HSHRM), DOE-RL-92-36, remains current and is consistent with U.S. Department of Energy (DOE) guidance and source standards (e.g., U.S. Occupational Safety and Health Administration (OSHA) regulations, including Title 29 Code of Federal Regulations (CFR) Part 1910 and 29 CFR 1926; and the American Society of Mechanical Engineers (ASME) B30 and B56 series of standards).

2. Act as the preparing body for HSHRM interpretations, and H&R bulletins addressing Hanford Site H&R activities.

3. Practice and promote cooperation between other technical and safety committees or councils in areas of common interest.

4. Review and recommend solutions to H&R safety issues at the Hanford Site arising from incidents, appraisals, assessments, lessons learned, and technical assistance reviews.

5. Conduct special-interest projects. Typical projects include the following:
   a. Analyze Hanford Site H&R accident and incident data to identify trends.
   b. Research and review available code and standard interpretations to assist in the resolution of H&R safety-related issues.
   c. Research available literature and develop recommended solutions for situations where little or no H&R guidance is available.
   d. Perform technical assistance visits to facilities to help evaluate conditions and provide input on H&R matters.

20.3 OPERATION

The following principles will govern the committee’s operation:

20.3.1 Balance of Interests

Activities undertaken by the HSHRC will ensure representation from all disciplines that relate to the subject matter.
20.3.2 Due Process

All individuals or organizations at the Hanford Site who believe that an action or inaction of the HSHRC causes unreasonable hardship or potential harm shall have a fair hearing of their concerns with management from the DOE sponsoring organizations.

20.4 MEMBERSHIP

20.4.1 Member Selection

HSHRC voting members shall be limited to Hanford Site contractors whose contract scope includes activities addressed in the HSHRM. This may include direct participation, management, engineering, or operational direction of H&R operations at the Hanford Site. Members will be appointed by their management on the basis of technical expertise in matters relating to hoisting and rigging and their ability to participate in committee activities. HSHRC membership should, to the greatest extent possible, provide a fair and balanced representation of the entire population of Hanford Site workers.

The representing DOE members have full veto power, but no voting privileges.

20.4.2 Alternate Members

At the option of the responsible organizations, alternate members may be appointed. When a member is unavailable to attend a meeting or vote on a letter ballot, alternate members will have full authority and responsibility of the member, including voting privileges. For voting and meeting participation, when a member is represented by an alternate, the member is not counted absent or “not voting” for purposes of tenure (Section 20.4.5, “Tenure”).

20.4.3 Eligibility

Participation in policy, guidance, and HSHRM development will be open to persons who are directly and materially affected by the activity in question. HSHRC membership shall be open to the following:

1. A member representing each Hanford Site contractor

   NOTE: A contractor may provide more than one representative where contractor operations include multiple projects and/or services.

2. A member representing the Hanford Atomic Metal Trades Council (HAMTC).

3. A member representing the Building and Construction Trades Council, AFL-CIO.


5. A member representing the U.S. Department of Energy, Office of River Protection (ORP).
20.4.4 Member Responsibilities

Members (and alternates) serve on the HSHRC on behalf of their company, project, or appointing organization (herein called their organization). In this capacity, members represent the HSHRC within their organization and shall perform the following functions:

1. Attend and participate in committee meetings, being prepared to act on behalf of their organization
2. Serve as the main communication link between the HSHRC and their sponsoring organization
3. Identify issues of concern for committee consideration
4. Respond in a timely manner to issues placed before the committee by means of the balloting process
5. Keep the HSHRC aware of H&R-related matters of interest within their organization. Matters of interest include the following:
   a. “High visibility lifts” that require extraordinary attention
   b. Accidents and incidents
   c. Near misses
   d. Lessons learned
   e. Unique use of equipment
   f. New technologies
   g. H&R problems experienced by the organization
   h. Assessment results
   i. Recommendations on HSHRM revisions
   j. Other H&R-related issues that may be of interest to the HSHRC or for which the HSHRC may be of assistance to the member and his/her organization.

6. Elevate HSHRC proposals to their organization for comment and resolution when a letter ballot is open for committee consideration. A member’s vote must reflect the technical position of his/her organization. Members should be able to explain the technical basis of proposed HSHRM revisions if questions arise within their organization.

7. Coordinate activities with their organization’s alternate(s), as necessary.

20.4.5 Tenure

There is no maximum term for membership. Members may resign from the HSHRC by notifying the chairperson in writing (e-mail is acceptable). Members may be replaced by organization management. If a member becomes unable to remain active on the HSHRC for any reason, the member should request replacement from his/her sponsoring organization. Members who fail to attend three consecutive monthly committee meetings with no alternate representation or who fail to vote on four consecutive letter ballots with no alternate representation will be removed from the committee roster, with voting privileges revoked. Former members requesting reinstatement will require written request from their manager to the chairperson. (For tenure consideration; members returning letter ballots with an “abstain” vote will be counted as voting.)
20.5 OFFICES

20.5.1 Hanford Site DOE H&R Representative

The Hanford Site DOE H&R representative will ensure that the HSHRC operates in accordance with this charter. The RL H&R committee member is the Authority Having Jurisdiction (AHJ) for the HSHRM. Both RL and ORP shall have a representative on the committee. The ORP interface may be further defined in a memo of understanding between RL and the ORP.

20.5.2 HSHRC Chairperson

The chairperson shall be a contractor employee. The chairperson shall attend DOE, Headquarters, Senior Technical Advisory Committee meetings, and actively participate with ASME code and standards committees involved with the Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings. The chairperson's duties are as follows:

1. Convene and preside over HSHRC meetings.
2. Call special meetings as may be required to resolve matters of immediate concern.
3. Delegate special tasks to HSHRC members and ad hoc subcommittees.
4. Develop and operate a balloting process to allow members to vote on pending proposals (e.g., HSHRM revisions, interpretations, and bulletins). The balloting process will provide a formal voting record while allowing voting members to document their approval, disapproval, or comments on issues before the committee.
5. Ensure that issues and actions brought before the HSHRC are documented and tracked to completion.
6. Arrange for the meeting room and other logistics for regular committee meetings.
7. Prepare and distribute agendas and minutes of regular committee meetings.
8. Maintain the HSHRM and the Hanford Site H&R Intranet web site.
9. Retain a history file of HSHRC activities.

In the event of a permanent chairperson vacancy from the position, the Vice Chairperson and responsible contractors shall convene a session of the HSHRC within 3 working days to initiate the process for selecting a chairperson.
20.5.3 HSHRC Vice Chairperson

The committee shall elect a Vice Chairperson, from the active voting members of the committee, whose company will support the appointment. The Vice Chairperson shall perform as the Chairperson during any absences and shall serve as the Chairperson in the event of a permanent vacancy, until such a time that a new Chairperson is appointed and approved by the HSHRC. The Vice Chairperson shall vote as a member of the committee, except when fulfilling the duties of the Chairperson. The Chairperson shall provide the Vice Chairperson necessary mentoring and access to files to fulfill responsibilities.

20.6 MEETINGS

20.6.1 Frequency

Regular meetings will be planned once each month and will be formally called, via the Sitewide e-mail system, by the chairperson. Meeting frequency may be adjusted based on current activities and/or needs (e.g., special meetings).

20.6.2 Agenda

An agenda will be developed for each meeting based on input from the members, pending assignments, etc. Written notices of the meeting and the agenda will be prepared and communicated to HSHRC members in advance of the meeting.

20.6.3 Subcommittees

For specific tasks, ad hoc subcommittees may be developed. Subcommittee membership and chairmanship shall be approved by a majority vote of the HSHRC. Volunteers will be encouraged. Individuals from outside the committee may be solicited to participate as subcommittee members, but the subcommittee must be chaired by an HSHRC member. Subcommittees will report their findings to the HSHRC. Subcommittee proposals will be subject to HSHRC voting procedures. Subcommittees automatically will dissolve when their assigned task is complete.

20.6.4 Guests

Guests are welcome to attend committee meetings. Guests may accompany members or may attend on their own. Guests will be encouraged to express their opinions on matters before the committee, but cannot vote on committee business.
20.7 VOTING

20.7.1 Regular Meetings

Changes to the HSHRM shall be managed through a letter ballot process. Other issues presented to the HSHRC at the regular meetings may be resolved during the meeting, provided a quorum (50 percent of the HSHRC membership) is present. The chairperson may call a vote of members present to resolve these issues.

1. A count of the votes will be recorded in the meeting minutes. If a member chooses to offer comments to accompany a vote, the member’s name and comments will be included in the minutes.

2. A simple majority approval of members present at the time of the vote is required for an issue to pass during a meeting.

20.7.2 Letter Ballots

The chairperson will seek committee approval to revise the HSHRM and issue HSHRM written interpretations and HSHRC-related bulletins. The following guidelines will govern the letter ballot process:

1. Ballots will be sent via e-mail or plant mail to HSHRC members and alternates. The letter ballot shall have four voting choices:
   a. Approved [ ]
   b. Approved with Comment [ ]*
   c. Disapproved with Comment [ ]*
   d. Abstain [ ]

   *Reason/comment must be stated.

2. Any letter ballot not completed and returned by the established deadline will be documented as “not returned.”

3. Rules for First Ballot Consideration. One or more “disapproved” votes will cause the ballot to fail, unless the “disapproved” vote is changed to “approved” or “approved with comment” during comment resolution. If substantial change is made during comment resolution, a follow-up ballot shall be prepared under the rules for “first ballot consideration.”

4. Rules for Second Ballot Consideration. If a first ballot consideration is disapproved or fails, and no substantial change is made in the balloted document, the matter will move to second ballot consideration. Approval of no less than 90 percent of the members is required for a second ballot to pass.

5. After a letter ballot closes, the chairperson shall issue a ballot status report outlining voting results. This report shall be distributed to HSHRC members, alternates, and other interested parties.
20.8 Funding

All prime contractors signatory to the HSHRM shall share in the funding of the manual administration and chairperson activities, allocating such funds to the appropriate entity. Each contractor’s share of the cost shall be based on their respective contract value.
21.0 REFERENCES AND BIBLIOGRAPHY

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21.1.1 Code of Federal Regulations (CFR) ................................................................. 3
21.1.2 American National Standards Institute (ANSI) .......................................... 3
21.1.3 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) ................................................................. 4
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21.2.8 Washington Administrative Code (WAC) .................................................... 7
21.2.9 Wire Rope Technical Board (WRTB) ............................................................. 7
21.0 REFERENCES AND BIBLIOGRAPHY

NOTE: It is recommended that the most recent ASME standards referenced here be invoked by contract to accompany this standard. However, there may be circumstances where referenced standards are invoked on a periodic basis (e.g., upon award of a site-wide management contract) and not on an ongoing basis (with running updates for each minor site contractor or subcontractor.) This decision is left to the Hanford Program Office’s discretion. Accordingly, this standard does not cite the year of referenced ASME standard to facilitate the site’s ultimate decision in this regard.

21.1 REFERENCES

NOTE: References listed in this section are cited in the document text.

21.1.1 Code of Federal Regulations (CFR)

- 10 CFR 710, Criteria and Procedures for Determining Eligibility for Access to Classified Matter or Special Nuclear Material
- 14 CFR 77, Objects Affecting Navigable Airspace
- 29 CFR 1910, Occupational Safety and Health Administration
  - 1910.27, Fixed Ladders
  - 1910.178, Powered Industrial Trucks
  - 1910.179, Overhead and Gantry Cranes
  - 1910.180, Crawler Locomotive and Truck Cranes
  - 1910.184, Slings

- 29 CFR 1926, Safety and Health Regulations for Construction
  - 1926.106, Working Over or Near Water
  - 1926.251, Rigging Equipment for Material Handling
  - 1926.550, Reserved
  - 1926.1400-Subpart CC, Cranes and Derricks in Construction

- 40 CFR, Federal Motor Carrier Safety Regulations and Regulatory Guidance
  - 40, Procedures for Transportation Workplace Drug Testing Programs
  - 383.5, Definitions
  - 391, Subpart E, Physical Qualification and Examination

21.1.2 American National Standards Institute (ANSI)

- A10.28, Safety Requirements for Work Platforms Suspended from Cranes or Derricks for Construction and Demolition Operations.
- MH27.1, Specifications for Underhung Cranes and Monorail Systems
- N14.6, American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More
- Z241.2, Safety Requirements for Melting and Pouring of Metals in the Metalcasting Industry
21.1.3 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

- B18.15, Forged Eyebolt.

21.1.4 American Society of Mechanical Engineers (ASME)

- B30.2, Overhead and Gantry Cranes Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist
- B30.5, Mobile and Locomotive Cranes
- B30.9, Slings
- B30.10, Hooks
- B30.16, Overhead Hoists (Underhung)
- B30.17, Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
- B30.20, Below-the-Hook Lifting Devices
- BTH-1, Design of Below-the-Hook Lifting Devices
- B30.21, Lever Hoists
- B30.23, Personnel Lifting Systems
- B30.26, Rigging Hardware
- PASE, Portable Automotive Service Equipment

21.1.5 An American National Standard/Industrial Truck Standards Development Foundation (ANSI/ITSDF)

- B56.1 Low Lift and High Lift Trucks
- B56.6 Rough Terrain Forklift Trucks
- B56.10 Manually Propelled High Lift Industrial Trucks


- D1.1, Structural Welding Code – Steel
- D1.2, Structural Welding Code – Aluminum
- D14.1, Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

21.1.7 American Society of Safety Engineers (ASSE)

- A1264-89, Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrails Systems
21.1.8 American Society of Testing and Materials (ASTM)

- A391/A391M, Standard Specification for Grade 80 for Alloy Steel Chain
- A489, Standard Specification for Carbon Steel Eyebolts
- E165, Standard Practice for Liquid Penetrant Inspection Method
- E709, Standard Practice for Magnetic Particle Examination
- F1145, Standard Specification for Turnbuckles, Swaged, Welded, Forged
- F541, Standard Specifications for Alloy Steel Eyebolts

21.1.9 Crane Manufacturer’s Association of America (CMAA)

- 70, Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes

21.1.10 Department of Energy

- DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards
- DOE Order 5480.20A, Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities

21.1.11 Federal Specifications, Defense Printing Department

- MIL-S-24214, Shackles, Steel, General Purpose, and High Strength
- RR-C-271, Chains and Attachments, Welded and Weldless

21.1.12 National Electrical Manufacturer’s Association (NEMA)

- ICS-6, Enclosures for Industrial Control and Systems, ICS-6

21.1.13 National Fire Protection Agency (NFPA)

- 505, Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation
• 70, National Electrical Code

• Article 610, Cranes and Hoists

21.1.14 Society of Automotive Engineers

• SAE J765, Crane Load Stability Test Code

21.2 BIBLIOGRAPHY

NOTE: References that are listed in this section are not cited in the document text, but include sections that relate to topics in this document.

21.2.1 Code of Federal Regulations (CFR)

• 29 CFR 1910, Occupational Safety and Health Administration
  o 1910.181, “Derricks”
  o 1910.183, “Helicopters”

• 29 CFR 1926, Safety and Health Regulations for Construction
  o 1926.106, “Working Over or Near Water”

21.2.2 American National Standards Institute (ANSI)

• A1264.1, Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems

• N14.6, For Radioactive Materials Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More

21.2.3 American Society of Mechanical Engineers (ASME)

• B30.22, Articulating Boom Cranes

• NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

• NUM-1, Rules for Construction of Cranes, Monorails, and Hoist (with bridge or trolley or hoist of the underhung type)

• NQA-1, Quality Assurance Program Requirements for Nuclear Facilities

21.2.4 The Crosby Group

• The Crosby General Catalog, Tulsa, OK.

21.2.5 Construction Safety Association of Ontario

• Mobile Crane Manual

• Rigging Manual
21.2.6 Federal Specifications, Defense Printing Department

- RR-W-410D, *Wire Rope and Strand*

21.2.7 Underwriters’ Laboratories (UL)

- 558, *Standard for Safety Industrial Trucks, Internal Combustion Engine-Powered*
- 583, *Standard for Safety Electric-Battery-Powered Industrial Trucks*

21.2.8 Washington Administrative Code (WAC)

- WAC 296, *Labor and Industries, Dept. of*
  - 296-24, *General Safety and Health Standards*
  - 296-24-240, *Crawler Locomotive and Truck Cranes*
  - 296-155-525, *Cranes and Derricks*
  - Part D, *Materials Handling and Storage, Including Cranes, Derricks, etc., and Rigging*
  - Part L, *Cranes, Derricks, Hoists, Elevators, and Conveyors*

21.2.9 Wire Rope Technical Board (WRTB)

DEFINITIONS AND ACRONYMS

The following specialized terms and acronyms are used regarding hoisting and rigging operations and equipment. Not all of these terms are used in this manual but have been included for general information.

AC--Alternating current.

**Acceleration Stress**--Additional stress imposed by an increase in the load velocity.

ACI--American Concrete Institute.

**Assembly/Disassembly (A/D) Director**--An individual who meets this subpart’s requirements for an A/D director, irrespective of the person’s formal job title or whether the person is non-management or management personnel.

**Administrative or Regulatory Authority**--Governmental agency, or the employer in the absence of governmental jurisdiction.

**Aggregate Strength**--The wire rope strength derived by totaling the individual breaking strengths of the elements of the strand or rope. This strength does not recognize the reduction in strength resulting from the angularity of the elements in the rope or from other factors that may affect efficiency.

AGMA--American Gear Manufacturers Association.

AISC--American Institute of Steel Construction.

AISE--Association of Iron and Steel Engineers.

AISI--American Iron and Steel Institute.

**Albert’s Lay**--Synonymous with lang lay.

**Alternate Lay**--Lay of wire rope in which the strands are alternately regular lay and lang lay.

**Alternator/Generator (eddy current brake)**--When used in conjunction with an eddy current brake, it provides stator excitation in the event of simultaneous loss of power and mechanical brake failure. Provides for a safe lowering of a suspended load after power failure.

**Angle Indicator, boom**--An accessory that measures the angle of the boom base section to the horizontal.

**Angle of Loading**--Inclination of a leg or branch of a sling as measured from the horizontal or vertical plane.

**Annual Condition Report**--An annual report of the current condition of a crane. This report is prepared by a qualified person using maintenance and inspection records from the crane history file to compare the current condition with the original condition and the condition reported in previous years. Operation and performance histories are compared with original performance specifications and actual performance as reported in previous years to identify trends or equipment degradation.

ANS--American Nuclear Society.
ANSI--American National Standards Institute.

**Anti-Two-Block Device**--A device which, when activated, disengages all crane functions whose movement can cause two-blocking. See two-block damage prevention feature and two-block warning feature.

API--American Petroleum Institute.

**Appointed Person**--Person assigned specific responsibilities for an activity.

Armored Rope--See steel clad rope.

**Articulating Crane**--A crane whose boom consists of a series of folding, pin connected structural members, typically manipulated to extend or retract by power from hydraulic cylinders.

ASLE--American Society of Lubrication Engineers.

ASM--American Society of Metals.

ASME--American Society of Mechanical Engineers.

ASNT--American Society for Nondestructive Testing.

**Assembly/Disassembly**--The assembly and/or disassembly of cranes covered under this standard, with the exception of overhead cranes covered by ASME B30.2, B30.11, and B30.17.

**Assist Crane**--A crane used to assist in assembling or disassembling a crane.


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

**Audible Signal**--A signal made by a distinct sound or series of sounds. Examples include, but are not limited to, sounds made by a bell, horn, or whistle.

**Authorized**--Approved by a duly constituted administrator or regulatory authority.

**Authorized Service Center**--An independent service facility designated by the manufacturer to repair and test equipment of their manufacture.

**Auxiliary Hoist**--Supplemental hoisting unit usually smaller and faster than the main hoist.

AWG--American Wire Gage.

AWS--American Welding Society.

**Axis of Rotation**--The vertical axis around which the crane superstructure rotates. Also called center of rotation (obsolete) and swing axis.
**Back-Hitch Gantry**—A fixed- or adjustable-height structure that forms part of the upper structure of a mobile crane, to which the lower spreader (carrying live boom-suspension ropes) is anchored.

**Back Stay**—Guy used to support a boom or mast or that section of a main rope, as on a suspension bridge or cableway leading from the tower to the anchorage.

**Bail**—(a) The U-shaped member of a bucket or load usually used as a lifting point; or (b) A U-shaped portion of a socket, or other fitting used on wire rope.

**Ballast**—Weight added to a crane base to create additional stability; it does not rotate when the crane swings.

**Barrel**—The lagging or body part of a rope drum in a drum hoist.

**Base**—The mounting flanges or feet used to attach a hoist to its supporting structure or foundation.

**Base Mounting**—The structure forming the lowest element of a crane or derrick; it transmits loads to the ground or other supporting surface. For mobile cranes, this is synonymous with carrier or crawler mounting. For tower cranes, the term includes a travel base, knee frame base, or fixed base (footing).

**Base Section**—The lowermost section of a telescopic boom; it does not telescope but contains the boom foot pin mountings and the boom-hoist-cylinder upper end mountings.

**Basic Boom**—The minimum length of sectional latticed boom that can be mounted and operated, usually consisting of a boom base and tip section only.

**Basket of Socket**—The conical portion of a socket into which a splayed rope end is inserted and secured with zinc.

**Bearing Life (rated life)**—The number of revolutions or the number of hours at a constant speed that 90 percent of an apparently identical group of bearings will complete or exceed before the first evidence of fatigue develops; i.e., 10 out of 100 bearings will fail before rated life. **Minimum life** and **L10 life** are also used to mean rated life.

**Becket Line**—That part of the rope in a multi-ply reeving system that is dead-ended on one of the blocks.

**Becket Loop**—A loop of small rope or strand fastened to the end of a large wire rope to facilitate installation.

**Bird Cage**—A colloquial term describing the appearance of wire rope forced into compression. The outer strands form a “cage” and, at times, displace the core.

**Bleeding Line**—A condition caused when wire rope is overloaded, forcing the lubricant in the cable to be squeezed out and run excessively.

**Block**—A term applied to a wire rope sheave (pulley) enclosed inside plates and fitted with some attachment such as a hook or shackle.

**Blocking** (also referred to as “cribbing”)—Wood or other material used to support equipment or a
component and distribute loads to the ground. It is typically used to support lattice boom sections during assembly/disassembly and under outrigger and stabilizer floats.

**Boom Angle**--The angle above or below horizontal of the longitudinal axis of the base boom section.

**Boom Angle Indicator**--A device which measures the angle of the boom relative to horizontal.

**Boom (crane)**--A member, in compression, hinged to the rotating superstructure and used for supporting the hoisting tackle and load.

**Boom Base**--The lowermost section of a sectional latticed boom having the attachment or boom foot pins mounted at its lower end; also called boom butt or butt section.

**Boom Foot Mast**--A component of some mobile-crane boom suspensions. It consists of a frame hinged at or near the boom foot to increase the height of the inboard end of the fixed-boom suspension ropes, thereby increasing the angle the suspension ropes make with the boom while being itself controlled by the boom-hoist ropes. Its purpose is to reduce the axial compressive force on the boom; also called hi-light gantry.

**Boom Guy Line**--A fixed-length rope forming part of the boom-suspension system; also called hog line, boom stay, standing line, or stay rope.

**Boom Head**--The portion of a boom that houses the upper load sheaves.

**Boom Hoist**--The rope drum(s), drive(s), and reeving controlling the luffing motion of the boom.

**Boom-Hoist Cylinder**--Hydraulic ram used instead of a rope boom suspension, the most common means of derricking telescopic booms.

**Boom Hoist Limiting Device**--Includes boom hoist disengaging device, boom hoist shutoff, boom hoist disconnect, boom hoist hydraulic relief, boom hoist kick-outs, automatic boom stop device, or derricking limiter. This type of device disengages boom hoist power when the boom reaches a predetermined operating angle. It also sets brakes or closes valves to prevent the boom from lowering after power is disengaged.

**Boom Hoist Line**--Wire rope that operates the boom hoist system of equipment such as derricks, cranes, deadlines, and shovels.

**Boom Inserts**--Center sections of a sectional latticed boom usually having all four chords parallel.

**Boom Length Indicator**--Indicates the length of the permanent part of the boom (such as ruled markings on the boom) or, as in some computerized systems, the length of the boom with extensions/attachments.

**Boom Line**--A wire rope for supporting or operating the boom on equipment such as derricks, cranes, draglines, and shovels.

**Boom Pendant**--A non-operating rope or strand with end terminations to support the boom.

**Boom Stay**--A fixed-length rope forming part of the boom-suspension system; also called boom guy line, hog line, standing line, or stay rope.

**Boom Stop**--A device intended to limit the maximum angle to which the boom can be raised.
Boom Tip Section--The uppermost section of a sectional latticed boom, which usually includes the weldment mounting the upper load sheaves as an integral part; also called boom point, head section, or tapered tip.

Boom Suspension--A system of rope fittings, either fixed or variable in length, that supports the boom and controls the boom angle.

Brake--A device used for retarding or stopping motion by friction or power means.

Brake, drag--A brake that provides retarding force without external control.

Brake, eddy current--A device for controlling load speed in the hoisting or lowering direction by placing a supplementary load on the motor. This loading results from the interaction of magnetic fields produced by an adjustable or variable direct current in the stator coils and induced currents in the rotor.

Brake, holding or parking--A brake that automatically sets and prevents motion when power is off.

Brake, mechanical load--A friction device, usually using multiple discs or shoes, for controlling load speed in the lowering direction only. The brake prevents the load from overhauling the motor.

Braking, counter torque--See counter torque.

Breaking Strength--The measured tensile load required to cause failure of cable, chain, wire rope, or any other load-bearing element.

Bridge Crane--See cranes, types of.

Bridge Travel--Horizontal travel of the crane parallel with bridge runway rails.

Bridge Trucks--An assembly consisting of wheels, bearings, axles, and structural framework that supports the end reactions of the bridge girders.

Bridle Sling--Sling composed of multiple wire rope legs with a fitting that attaches to the lifting hook.

Bright Rope--Wire rope made of wires that are not coated with zinc or tin.

Brooming--Unlaying and straightening of strands and wires in the end of wire ropes during the process of installing a wire rope socket.

Bull Pole--A pole, generally of steel pipe, which is mounted to project laterally from the base of a derrick mast. It is used to swing the derrick manually.

Bull Ring--The main, large ring of a sling to which sling legs are attached; also called master link.

Bull Wheel--A horizontally mounted circular frame fixed to the base of a derrick mast to receive and guide the ropes used for swinging.

Bumper (buffer)--An energy-absorbing device that reduces impact when two moving cranes or trolleys come into contact or when a moving crane or trolley reaches the end of its permitted travel.
Butt Section--The lowermost section of a sectional latticed boom having the attachment or boom foot pins mounted at its lower end; also called boom butt.

Cab--Operator’s compartment on a crane.

Cab, normal--Operator’s compartment from which a crane is controlled.

Cab, skeleton--Operator’s compartment used for occasional cab operation of a normally floor- or remote-operated crane.

Cable--A term loosely applied to wire ropes, wire strand, and electrical conductors. Wire rope is the preferred term for hoisting and rigging application.

Cable Crowd Rope--Wire rope used to force the bucket of a power shovel into the material being handled.

Cable-Laid Wire Rope--A wire rope consisting of several independent wire ropes wrapped around a fiber or wire rope core.

Cableway--Aerial conveying system for transporting single loads along a suspended track cable.

Cab-Operated Crane--See cranes, types of.

Camber--The slight curvature given to beams and girders to compensate for deflections caused by loading.

Canyon--A descriptive term applied to some building configurations at the Hanford Site, usually process plants, which have an operating floor or level, surrounded by high walls. A typical canyon building is much longer than it is wide.

Canyon Crane--A term used on the Hanford Site to describe a crane, usually an overhead or gantry crane, that is installed above the operating floor in a canyon building. Such cranes typically will have a lift range that extends below the operating floor to piping and equipment located in cells or pits below the operating floor.

Capstan--A spool-shaped revolving drum, manually or power-operated, used for pulling fiber or synthetic rope. Also called a winch head.

Carrier (trolley)--A unit that travels on the bottom flange of a monorail track or a bridge girder to transport a load.

CCTV--Closed circuit television.

CDL--Commercial Driver’s License.

Center of Gravity--The center of gravity of any object is the point in the object around which its weight is evenly distributed. If you could put a support under that point, you could balance the object on the support.

Certified Welder--A person holding a certificate as proof that qualified test welds have been performed and passed in accordance with the governing welding code.

Cheek Plate(s)--The stationary plate that support(s) the pin (axle) of a sheave or load.

Cheek Weights--Overhauling weights attached to the side plates of a lower load block.

Choker--Sling, wire rope with eyes spliced on each end, which is used to lift load.

Choker Hitch--Sling with one end passing under the load and through a loop end attachment on other end of sling.

Class (of load)--See critical service and critical lift.

Clearance--The horizontal or vertical distance from any part of the crane to a point of the nearest obstruction.

Clevis--A U-shaped fitting with holes in each end through which a pin or bolt is run.

Clip--Fitting for clamping two parts of wire rope.

Closed Cell--For the purposes of this manual, access to closed cells is limited during some operating cycles. See hot cell.

Closed Socket--Wire rope end fitting consisting of integral basket and bail.

Closing Line--Wire rope that closes a clamshell or orange-peel bucket, and then operates as a hoisting rope.

Clutch--An electromagnetic, hydraulic, pneumatic, or positive mechanical device for engagement or disengagement of power.

CMAA--Crane Manufacturers Association of America.

CMV--Commercial Motor Vehicle.

Coil--Circular bundle of wire or fiber rope not packed on a reel.

Collector--Contacting device mounted on bridge or trolley for collecting current from conductor system.
Come-Along--Lever-operated chain or wire rope devices designed for pulling, not lifting; also called pullers. Unlike hoists, the tension is held by a releasable ratchet. Much smaller and lighter than hoists of equal capacity, they are not intended nor allowed for lifting, but are suited for activities such as skidding machinery.

Commercial Motor Vehicle--A motor vehicle or combination of motor vehicles used in commerce to transport passengers or property if the motor vehicle:

a. Has a gross combination weight of 11,794 kg (26,001 lb) or more inclusive of a towed unit with a gross vehicle weight rating of more than 4536 kg (10,000 lb), or
b. Has a gross vehicle weight rating of 11,794 kg (26,001 lb) or more, or
c. Is designed to transport 16 or more passengers, including the driver, or
d. Is of any size and is used in the transportation of materials found to be hazardous for the purposes of the Hazardous Materials Transportation Act and which requires the motor vehicle to be placarded under 49 CFR 172, Subpart F, “Hazardous Materials Regulations.”

Competent Person--One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Conductors (bridge or runway)--Electrical conductors located along the bridge girder(s) or runway to provide power and/or control circuits to the crane and trolley.

Conical Drum--Grooved hoisting drum of tapering diameter.

Construction Worksite--The area within the limits necessary to perform the work described in the construction procurement or authorization document. It includes the facility being constructed or renovated along with all necessary staging and storage areas as well as adjacent areas subject to project hazards.

Construction--Combination of erection, installation, assembly, demolition, or fabrication activities involved to create a new facility or to alter, add to, rehabilitate, dismantle, or remove an existing facility. It also includes the alteration and repair (including dredging, excavating, and painting) of buildings, structures, or other real property, as well as any construction, demolition, and excavation activities conducted as part of environmental restoration or remediation efforts.

Continuous Bend--Reeving of wire rope over sheaves and drums so that it bends in one direction, as opposed to reverse bend.

Control Braking Means--A method of controlling hoisting or lowering speed of the load by removing energy from the moving load or by imparting energy in the opposite direction.

Controlled Load Lowering--Lowering a load by means of a mechanical hoist drum device that allows a hoisted load to be lowered with maximum control using the gear train or hydraulic components of the hoist mechanism. Controlled load lowering requires the use of the hoist drive motor, rather than the load hoist brake, to lower the load.

Controller--A device or group of devices that serve to govern, in some predetermined manner, the power delivered to the motor to which it is connected.
Controller, spring return--A controller which, when released, will return automatically to a neutral position.

Controlling Entity--An employer that is a prime contractor, general contractor, construction manager or any other legal entity which has the overall responsibility to DOE for the construction of the project -- its planning, quality and completion.

Control Panel--An assembly of magnetic or static electrical components that govern the flow of power to or from a motor in response to signals from a master switch, push-button station, or remote control.

Core--Core member of wire rope about which the strands are laid. It may be fiber, a wire strand, or an independent wire rope.

Corrosion--Chemical decomposition by exposure to moisture, acids, alkalis, or other destructive agents.

Corrugated--A term used to describe the grooves of a sheave or drum when worn so as to show the impression of a wire rope.

Counter Jib--A horizontal member of a tower crane on which the counterweights and usually the hoisting machinery are mounted; also called counterweight jib.

Counter Torque--A method of control by which the power to the motor is reversed to develop torque in the opposite direction to the rotation of the motor. See braking, counter torque.

Counterweight Jib--Also called counter jib.

Counterweights--Weights added to a crane upper structure to create additional stability. They rotate with the crane as it swings.

Cover Plate--The top or bottom plate of a box girder or junction box.

Crane--A machine for lifting and lowering a load vertically and moving it horizontally with the hoisting mechanism as an integral part of the machine. The term is applicable to fixed and mobile machines and to powered or manually driven machines.

Crane Classification--The CMAA has established six service classes to enable the purchaser to specify the most economical class of crane for a particular installation. It is not economical either to under specify or to over specify when choosing a service class. Specifying a crane with too light a service class will reduce cost but may result in excessive maintenance. A crane with too high a service class may decrease maintenance costs but at an excessive initial investment. See crane service.

Crane Service--Class A (Standby or Infrequent Service)

Class A1 (Standby Service)--This service class covers cranes used in installations such as power houses, public utilities, turbine rooms, nuclear reactor buildings, motor rooms, nuclear fuel handling and transformer stations, where precise handling of valuable machinery at slow speeds with long idle periods between lifts is required.

Class A2 (Infrequent Use)--These cranes are used in installations such as small maintenance shops, pump rooms, testing laboratories, and similar operations where the loads are relatively
light, speeds are slow, and a low degree of control accuracy is required. The loads may vary anywhere from no load to full rated load with a frequency of a few lifts per day or month.

**Crane Service--Class B (Light Service)**--This service covers cranes that may be used in repair shops, light assembly operations, service buildings, or light warehousing, where service requirements are light, and the speed is slow. Loads may vary from no load to occasional full rated loads with two to five lifts per hour, averaging 3 meters (10 feet) per lift.

**Crane Service--Class C (Moderate Service)**--This service covers cranes that may be used in machine shops or paper-mill machine rooms, where service requirements are moderate. In this type of service, the crane will handle loads that average 50 percent of the rated capacity with 5 to 10 lifts per hour, averaging 4.6 meters (15 feet), not over 50 percent of the lifts at rated capacity.

In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour, averaging 4.6 meters (15 feet), not over 65 percent of the lifts at rated capacity.

**Crane Service--Class D (Heavy Service)**--This service covers cranes that may be used in heavy machine shops, foundries, fabricating plants, steel warehouses, container yards, or lumber mills, and standard-duty bucket and magnet operations where heavy-duty production is required.

In this type of service, loads approaching 50 percent of the rated capacity will be handled constantly during the working period. High speeds are desirable for this type of service with 10 to 20 lifts per hour, averaging 4.6 meters (15 feet), not over 65 percent of the lifts at rated capacity.

**Crane Service--Class E (Severe Service)**--This type of service requires a crane capable of handling loads approaching a rated capacity throughout its life. Applications may include magnet, bucket, magnet/bucket combination cranes for scrap yards, cement mills, lumber mills, fertilizer plant, or container handling, with 20 or more lifts per hour at or near the rated capacity.

**Crane Service--Class F (Continuous Severe Service)**--This type of service requires a crane capable of handling loads approaching rated capacity continuously under severe service conditions throughout its life. Applications may include custom-design specialty cranes essential to performing the critical work tasks affecting the total production facility. These cranes must provide the highest reliability with special attention to ease of maintenance features.

**Cranes, types of--**

**Automatic Crane**--A crane that, when activated, operates through a preset cycle or cycles.

**Bridge Crane**--A crane with a single- or multiple-girder movable bridge, carrying a movable trolley or fixed hoisting mechanism, and traveling on an overhead fixed runway structure.

**Cab-Operated Crane**--A crane controlled by an operator in a cab located on the bridge or trolley.

**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.

**Crawler Crane**--A crane consisting of a rotating superstructure with power plant, operating machinery, and boom, mounted on a base, equipped with crawler treads for travel.

Its function is to hoist, lower, and swing loads at various radii.
Double-Girder Crane--A crane having two bridge girders mounted between, and supported from, the end trucks.

Floating Crane--A rotating superstructure, power plant, operating machinery, and boom mounted on a barge or pontoon. The power plant may be installed below decks. The cranes function is to handle loads at various radii.

Floating Cranes/Derricks--Equipment designed by the manufacturer (or employer) for marine use by permanent attachment to a barge, pontoons, vessel or other means of flotation.

Floor-Operated Crane--A power-operated crane that is controlled by an operator from the floor or an independent platform or walkway located in the crane-way, using power control switches or push-buttons on a pendant.

Gantry Crane--A crane similar to an overhead bridge 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, usually 3 meters (10 feet) or more below the bottom of the bridge.

Hammerhead Tower Crane--A lifting machine consisting of a mast with an upper, rotating member to which a jib boom is attached that extends horizontally from the rotating member, with a counter-weighted jib boom extending from the rotating member in the opposite direction, neither of which jib booms are arranged or rigged for luffing. The main jib boom carries a trolley on which the lower load block is suspended. The counterweight jib boom contains the counterweight for the main jib and working load, and sometimes provides the mounting for the hoisting and trolley travel motors and drums.

Interlocking Crane--A crane with an interlock mechanism on one or both ends, enabling it to be mechanically locked to another crane, fixed transfer section, or spur track for the purpose of transferring a carrier from one to another.

Jib Crane--A fixed crane with a vertical rotating member supported at the bottom (also at the 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 mounted on existing structural members (e.g., a wall-mounted jib crane).

Locomotive Crane--A crane consisting of a rotating superstructure with power plant, operating machinery and boom, mounted on a base or car equipped for travel on a railroad track. It may be self-propelled or propelled by an outside source. Its function is to hoist and swing loads at various radii.

Manually Operated Crane--A crane whose hoist mechanism is driven by pulling an endless chain, or whose travel mechanism is driven in the same manner or by manually moving the load.

Mobile Crane--A lifting device incorporating a cable suspended latticed boom or hydraulic telescopic boom designed to be moved between operating locations by transport over the road.

Monorail Crane--A crane or hoist attached to a trolley that runs on the flanges of a structural beam.

Overhead Crane--A crane with a single or multiple girder movable bridge, carrying a movable trolley or fixed hoisting mechanism, and traveling on an overhead fixed runway structure.
Polar Crane--A bridge or gantry crane that travels on a circular runway.

Portable Gantry Crane (A-Frame)—A crane similar to an overhead (underhung) crane, except the bridge beam for the trolleys is supported by four legs usually on casters.

Portal Crane--A type of crane consisting of a rotating upperstructure, hoist machinery, and boom mounted on top of a structural gantry which may be fixed in one location or have travel capability. The gantry legs or columns usually have portal openings in between to allow passage of traffic beneath the gantry.

Power-Operated Crane--A crane whose mechanism is driven by electricity, air, hydraulic, or internal combustion engine, as opposed to hand-operated movements.

Pulpit-Operated Crane--A crane operated from a fixed operator station not attached to the crane.

Remotely Operated Crane--A crane controlled by any method other than with a pendant, rope, or attached cab.

Semi-Gantry Crane--A gantry crane with one end of the bridge rigidly supported by leg(s) that run on a fixed rail or runway and the other end supported by end trucks that run on an elevated rail or runway.

Sideboom Crane--A track-type or wheel-type tractor having a boom mounted on the side of the tractor, used for lifting, lowering or transporting a load suspended on the load hook. The boom or hook can be lifted or lowered in a vertical direction only.

Single-Girder Crane--A crane having one bridge girder mounted between, and supported from the end trucks.

Storage Gantry Crane--A gantry-type crane of long span usually used for bulk storage of material. The bridge girders or trusses are rigidly or nonrigidly supported on one or more legs. It may have one or more fixed or hinged cantilever ends.

Tower Crane--A type of lifting structure which utilizes a vertical mast or tower to support a working boom (jib) in an elevated position. Loads are suspended from the working boom. While the working boom may be of the fixed type (horizontal or angled) or have luffing capability, it can always rotate to swing loads, either by rotating on the top of the tower (top slewing) or by the rotation of the tower (bottom slewing). The tower base may be fixed in one location or ballasted and moveable between locations. Mobile cranes that are configured with luffing jib and/or tower attachments are not considered tower cranes under this section.

Truck Crane--A crane consisting of a rotating superstructure with a power plant, operating machinery, and boom on a truck-type mounting equipped with a power plant for travel. Its function is to hoist, lower, and swing loads at various radii. Some variations of this use a single engine in the truck that also is the power source for the superstructure, or use a single engine in the superstructure, which is also the power source for the truck.

Wall-Mounted Jib--See cranes, types of, jib crane.

Wall Crane--A crane having a jib, with or without a trolley, supported from a side wall or line of columns of a building. It is a traveling-type crane and operates on a runway attached to the side wall or line of columns.
Wheel-Mounted Crane (wagon crane) -- A crane consisting of a rotating superstructure with power plant, operating machinery and boom, mounted on a base or platform equipped with axles and rubber-tired wheels for travel. The base may be propelled by an engine in the superstructure, or with a separate engine controlled from the superstructure. Its function is to hoist, lower, and swing loads at various radii.

Craneway -- The area in length and width served by a crane.

Crawler Frames -- Part of the base mounting of a crawler crane attached to the car body and supporting the crawler treads, the track rollers, and the idler sprockets. Crawler frames transmit crane weight and operational loadings to the ground; also called side frames.

Creep Speed -- A very slow, constant, continuous, fixed rate of motion of the hoist, trolley, or bridge, usually established at 1 to 10 percent of the normal full-load speed.

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 normal position.

Critical Lift -- A hoisting operation utilizing a documented lift plan in which a critical item will be hoisted or moved, or in which a noncritical item will be hoisted or moved in an area where critical items could be affected.

Critical Load or Item -- In accordance with this manual: A part, component, assembly, or piece of equipment (“item”) whose dropping, upset, or collision could cause/result in the following:

a. Damage that would result in serious economic consequences
b. Damage that would result in unacceptable delay to schedule or other significant deleterious programmatic impact (such as loss of vital data)
c. Undetectable damage that would jeopardize future operations or safety of a facility
d. Significant release of radioactive or other hazardous material to the environment or create an undesirable condition
e. Personnel injury or significant adverse health impact, either onsite or offsite.

Large, costly items should be considered critical. Items that require special care in handling because of size, weight, installation in close-tolerance receptors, fragility, high susceptibility to damage or other unusual factors should be considered critical.

Implicit in this definition is the possibility of handling items, which are themselves not critical in nature, over other items that are critical, thus making the lift involved “critical.”

Critical Load -- In accordance with ANSI N14.6: Any lifted load whose uncontrolled movement or release could adversely affect any safety-related system when such system is required for unit safety or could result in potential off-site exposures comparable to the guideline exposures outlined in Code of Federal Regulations, Title 10, Part 100.

Critical Load -- In accordance with ASME NOG-1: Any lifted load whose uncontrolled movement or release could adversely affect any safety-related system when such system is required for unit
safety or could result in potential off-site exposures in excess of the limit determined by the equipment purchaser.

**Critical Service**--The use of equipment or tackle for hoisting, rigging, or handling of critical items, or other items in, around, or above spaces containing critical items.

**Crossover Points**--In multiple-layer spooling of rope on a drum, those points of rope contact where the rope crosses the preceding rope layer.


**Custodian**--An individual designated as having custodial responsibility for equipment. The custodian takes “ownership” of assigned equipment and ensures that required maintenance, inspections, and tests remain current. The custodian will have quick access to the equipment history file.

**Cylindrical Drum**--Hoisting drum of uniform diameter.

**DC**--Direct current.

**D/d RATIO**--A term regarding wire rope. $D =$ Diameter of curvature around which the rope is bent. $d =$ diameter of rope.

**Dead End**--The point of fastening of one rope end in a running rope system, the other end being fastened at the rope drum.

**Dead-Line**--The end of the rotary drilling line fastened to the anchor or dead-line clamp.

**Deadman**--An object or structure, either existing or built for the purpose, used as anchorage for a guy rope.

**Deceleration Stress**--Additional stress imposed on rigging resulting from a decrease in load velocity.

**Deflection**--(a) The sag across a span of a load member caused by the imposed live and/or dead loads, which is usually measured at mid-span as the distance along a straight horizontal line drawn between the supports; (b) any deviation from a straight horizontal line.

**Derrick**--An apparatus for lifting or lowering loads, consisting of a mast or equivalent member held at the head by guys or braces, with or without a boom, for use with hoists and ropes.

**Design Factor**--The conservatism used in design calculations. As a function of design, this factor can be based upon the point of equipment failure, such as crane tipping, and brake stopping capacity, or based upon strength of materials, ultimate, nominal, or yield. Consensus standards and this manual express design factors as a ratio (for example: 5:1, 3:1, 3.5:1) or as a single number (for example: 5, 3, or 3.5, understood to mean the “X” to 1). Although “design factor” is sometimes referred to as a “safety factor”, “design factor” is the preferred term. An inexperienced person may incorrectly assume this factor of design conservatism will make up for such conditions as shock loading, poor rigging, improper equipment selection, and overload conditions.

**Designated**--Selected or assigned by the employer or employer’s representative as being qualified to perform specific duties. See appointed person.
Designated Leader (DL)/ Lift Director--A qualified individual assigned to all hoisting and rigging operations to ensure that the lifting operation is properly performed.

Diameter (wire rope)--The diameter of wire rope is the diameter of the circle that will contain the rope.

Direct Geared--A hoist with drum(s) geared directly to its power source.

Directly Under the Load-- A part or all of an employee is directly beneath the load.

Dismantling-- Includes partial dismantling (such as dismantling to shorten a boom or substitute a different component).

DOE--U.S. Department of Energy.

Dog Leg--Permanent short bend or kink in wire rope caused by improper use.

DOL--U.S. Department of Labor.

DOT--U.S. Department of Transportation.

Dragline--Wire rope used to pull an excavating or drag bucket. Also used as an expression of a particular type of mobile crane using a drag bucket during excavation.

Draw-works—The draw works is the primary hoisting machinery consisting of a drum and countershafts whose main function is to provide a means of raising and lowering the travel blocks through wire ropes.

Drifting--Pulling a suspended load laterally to change its horizontal position.

Drift Point--A point on a travel motion controller that releases the brake while the motor is not energized. This allows for coasting before the brake is set.

Drive--An assembly consisting of motors, couplings, gear, and gear case(s) that is used to propel a bridge, trolley, or hoist.

Drive Girder--Girder on which the bridge drive, cross shaft, walk, railing, and operator's cab are mounted.

Drum--(a) A cylindrical-flanged barrel of uniform (cylindrical drum) or tapering (conical drum) diameter on which cable is wound for operation or storage, which may be smooth or grooved; (b) the cylindrical member around which rope is wound for lifting or lowering the load or boom, or swinging the boom supporting structure.

Drum Capacity, rope--The length of a specific diameter of rope that can be wound on a drum.

Drum Hoist--A hoisting mechanism incorporating one or more rope drums; also called hoist, winch, or hoisting engine.

Drum Rotation Indicator-- A device on a crane or hoist which indicates in which direction and at what relative speed a particular hoist drum is turning.

Dummy Cab--See cab, skeleton.
Dynamic Loading--Loads introduced into the machine or its components by forces in motion.

Dynamic Lowering--A method of control by which the hoist motor is so connected in the lowering direction, that when it is over-hauled by the load, it acts as a generator and forces current through resistors. (NOTE: Feeding back into the line is regenerative braking.)

Efficiency (wire rope)--Ratio of a wire rope’s measured breaking strength and the aggregate strength of all individual wires tested separately, which is usually expressed as a percentage. The breaking strength of wire ropes seldom exceeds 90 percent of the aggregate strength of all the wires, the average being about 82.5 percent.

Elastic Limit--Limit of stress above which a permanent deformation takes place within the material. This limit is approximately 55 to 65 percent of breaking strength of steel wire ropes.

Electrical Contact--Occurs when a person, object, or equipment makes contact or comes in close proximity with an energized conductor or equipment that allows the passage of current.

Encroachment--Where any part of the crane, load line or load (including rigging and lifting accessories) breaches a minimum clearance distance that this subpart requires to be maintained from a power line.

End Control--The operator-control position is located at the end opposite the load end of the truck.

End Penetration--The treatment of the end of a length of wire rope designed primarily as an aid for pulling the rope through a reeving system or tight drum opening. These are not designed for use as a method for making a permanent connection.

End Termination--The treatment at the end or ends of a length of wire rope, which is usually made by forming an eye or attaching a fitting, designed to be the permanent end termination on the wire rope that connects it to the load.

End Tie--A structural member, other than the end truck, that connects the ends of the girders to maintain the squareness of the bridge.

End Truck--An assembly consisting of structural members such as wheels, bearings, and axles that supports the bridge girder(s) or the trolley cross member(s).

Endless Rope--Rope whose two ends are spliced together.

Equalizer--Device used to compensate for unequal length or stretch of a hoist rope and connects two or more systems to a single running block.

Equalizing Thimble--Special type of fitting used as a component part of some wire rope slings.

Equalizing Sheave--The sheave at the center of a rope system over which no rope movement occurs other than equalizing movement. It is frequently overlooked during crane inspections, with disastrous consequences. It can be a source of severe degradation.

Examination--The process of nondestructive testing performed to ensure freedom from harmful hidden defects that could result in catastrophic failure.
Exposed--Applies to hazardous objects not guarded or isolated (capable of being contacted inadvertently).

Extender--A device that increases a jack’s closed length.

Extraflexible Wire Rope--See extrapliable wire rope.

Extrahigh-grade Plow Steel Rope--See grades, rope.

Extrapliable Wire Rope (also called extraflexible)--Wire rope made with either 8 strands of 19 wires each, or 6 strands of 37 wires each, with a fiber core. The wires in this rope are smaller than those used in standard rope and consequently are not as suitable to withstand abrasion.

Eye or Eye Splice--A loop with or without a thimble formed in the end of a wire rope.

Factor of Safety--See design factor.

Fail-Safe--A provision designed to automatically stop or safely control any motion in which a malfunction occurs.

Falls--See parts of line.

Fall Zone--The area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall in the event of an accident.

Fatigue--The phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material.

Fiber Cores--Cords or rope made of vegetable or synthetic fiber used in the core of a wire rope.

Fiddle Block--A block consisting of two sheaves in the same plane held in place by the same cheek plates.

Filler Wire--Small auxiliary wires in a strand used for spacing and positioning other wires.

Fitting--Any accessory used as an attachment for wire rope.

Flange Point--A point of contact between rope and drum flange where the rope changes layers.

Flat Rope--Wire rope made of parallel alternating right-lay and left-lay ropes sewn together by relatively soft wire.

Flattened Strand Rope--A wire rope of either oval or triangular shaped strands that presents a flattened rope surface.

Fleet Angle--The maximum angle between a rope and the line perpendicular to the drum on which it winds.

Fleeting Sheave--Sheave mounted on a shaft parallel to the rope-drum shaft and arranged so that it can slide laterally as the rope spools, permitting close sheave placement without excessive fleet angle.
Flemish Eye--A type or method of making a wire rope eye splice. Same as a “Molly Hogan.”

Floating Crane--See cranes, types of.

Floor-Operated Crane--See cranes, types of.

FO&M--Fleet Operations and Maintenance.

Footblock--A steel weldment or assembly serving as the base mounting for a guy derrick, gin pole, or boom derrick.

Foot-Walk--A walkway with handrail and toeboards, attached to the bridge or trolley for access purposes.

Forklift Truck--A high-lift, self-loading truck, equipped with load carriage and forks for transporting and tiering loads.

FRAM--Functions, Responsibilities, and Authority Manual

Free Fall (of the load line)--Only the brake is used to regulate the descent of the load line (the drive mechanism is not used to drive the load down faster or retard its lowering).

Front-End Attachment--see attachment, fork-lift truck

Gage Points--Permanent marks on a hook that are used to determine any change in the throat-opening dimension.

Galvanized Rope--Wire rope made of galvanized wire.

Galvanized Strand--Strand made of galvanized wire.

Gantry Crane--See cranes, types of.

Generator--See alternator/generator.

Girder, bridge--The principal horizontal beam(s) of the crane, which supports the trolley, is supported by the end trucks, and is perpendicular to the runway.

Girder, drive (Girder “A”)--The bridge girder to which the bridge motor and gear-case(s) are attached. For cranes having a drive on each girder, it is the girder to which the control panels and/or the cab are attached.

Girder, idler (Girder “B”)--The bridge that does not have the bridge drive attached, but usually carries the bridge conductors.

Girder, runway--A horizontal beam attached to the building columns or wall and supporting a runway rail on which the crane travels.

Girder, auxiliary (outrigger)--An additional girder, either solid or latticed, arranged parallel to the bridge girder(s) for supporting the footwalk, control panels, or operator’s cab to reduce the torsional forces such loads might otherwise impose.
Gooseneck Boom--A boom with an upper section projecting at an angle to the longitudinal centerline of the lower section.

Grades, rope--Classification of wire rope by its breaking strength. Listed in order of increasing breaking strengths: iron, traction, mild plow steel, plow steel, improved plow steel, and extra-improved plow steel.

Grooved Drum--Drum with a grooved surface that accommodates and guides the rope.

Grooves--Depressions in the periphery of a sheave or drum used for positioning and supporting a rope.

Ground Conditions--The ability of the ground to support the equipment (including slope, compaction, and firmness).

Gudgeon Pin--The pin at the top of a derrick mast forming pivot for the spider or for the mast of a stiff-leg derrick.

Guy or Guy Line--Strand or rope, usually galvanized steel, for holding a structure in position.

Hammerhead Boom--A boom tip arrangement in which both the boom suspension and the hoist ropes are greatly offset from the boom longitudinal centerline to provide increased load clearance.

HAMTC--Hanford Atomic Metal Trades Council.

Handling Fixture--A cradle, handling structure, shipping fixture, or container designed specifically to support or facilitate component lifting or handling during fabrication, loading, shipping, storage, installation, or use.

Haulage Rope--Wire rope used for pulling cars on a track.

Hazardous (classified) Location--Locations where fire or explosion hazards may exist. Locations are classified depending on the properties of the flammable vapors, liquids, or gases, or combustible dusts or fibers which may be present and the likelihood that a flammable or combustible concentration or quantity is present.

Class I--Locations in which flammable gases or vapors are, 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 flyings are present but not likely to be suspended in quantities sufficient to produce ignitable mixtures.

H&R--Hoisting and rigging.

High Consequence--See critical item, critical lift, and critical service.

HHRC--Hanford Hoisting and Rigging Committee.

HMI--Hoist Manufacturers Institute.
Hoist--A lifting device for raising or lowering loads. Its service area is vertical over its mounting. Hoists may be attached to fixed or moveable structures by an upper hook or bracket and can be either power or manually operated; (b) A power-operated component of a crane or monorail system that provides torque to raise a load or lower it at a controlled speed and hold a load stationary; (c) A power-driven drum or drums capable of lifting and lowering loads.

Hoisting--The act of raising, lowering or otherwise moving a load in the air with equipment covered by this standard. As used in this standard, “hoisting” can be done by means other than wire rope/hoist drum equipment.

Hoist, direct geared--A hoist with a drum(s) geared directly to its power source.

Hoist, drum--A hoist with hoisting drum(s) and with or without a swinger.

Hoist, friction drum--A hoist with drum(s) controlled by friction clutches and brakes and provided with drum ratchets and pawls.

Hoist, lever-operated--A lever-operated, manual device used to lift, lower, or pull a load and to apply or release tension. (See come-along.)

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, Rigging--A hook used as part of tackle. Any hook used in hoisting and rigging that is not the “primary hook” or main “load hook.”

Hook Latch--A mechanical device to bridge the throat opening of a hook.

Hot Cell--A shielded enclosure where the shielding media is composed of concrete, steel, lead or other special materials, specifically designed to protect operating personnel from undue amounts of nuclear radiation. For the purpose of this manual, access to hot cells is minimal or very rarely allowed and most work functions are performed remotely.

HR--Human resources.

Idler--Sheave or roller used to guide or support a rope. It is also used as a slang expression for an equaling sheave.

Improved Plow Steel Rope--See grades, rope.

Inching--See jog.

Inching Drive (micro drive)--A mode of crane operation (usually limited to hoists) that disengages the main drive motor by means of a clutch mechanism and engages a single, nonvariable motor drive at a very low or creep speed.

Independent Wire Rope Core (IWRC)--Wire rope used as the core of a larger rope.

Insulating Link/Device--An insulating device listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with 29 CFR 1910.7.

Internally Lubricated--Wire rope or strand in which all wires are coated with lubricant.
Iron Rope--See grades, rope.

ISO--International Standards Organization.

Jack--A portable hand- or power-operated mechanism with a base and load point designed for controlled linear movement.

Jack, double-acting hydraulic--A jack that is extended and retracted under hydraulic pressure.

Jack, mechanical--A jack using any means other than fluid to move the load.

Jib--An extension attached to the boom point to provide added boom length for lifting specified loads. The jib may be in line with the boom or offset to various angles in the vertical plane of the boom.

Jib Crane--See cranes, types of.

Jib Dtop--(also referred to as a jib backstop); The same type of device as a boom stop but is for a fixed or luffing jib.

Jog (inch)--To move the hook, trolley, or bridge in a series of short, discontinuous increments by momentary operation of a controller.

Kink--Permanent distortion of wires and strands resulting from sharp bends.

L10 life--See bearing life.

Laced Blocks--Passing wire rope through a set of blocks by starting from an outside sheave and following in rotation. Will usually tilt travel block when running empty.

Lagging--External wood covering on a reel to protect the wire rope, strand, or grooved drum.

Lang Lay Rope--Wire rope in which the wires in the strands and the strands in the rope are laid in same direction. Synonymous with Albert’s Lay.

Latch, hook--A device used to bridge the throat opening of a hook.

Latticed Boom--A boom constructed of four longitudinal corner members, called chords, assembled with transverse and/or diagonal members, called lacings, to form a trusswork in two directions. The chords carry the axial boom forces and bending moments, while lacings resist the shears.

Lay (wire rope)--(a) The manner in which the wires in a strand or the strands in a rope are helically laid, or (b) the distance measured parallel to the axis of the rope (or strand) in which a strand (or wire) makes one complete helical convolution about the core (or center). In this connection, lay is also referred to as “lay length” or “pitch”.

Lead Line--That part of a rope tackle leading from the first or fast sheave to the drum.

Lefthand End--A reference to parts or dimensions on the viewer’s left of the centerline of span, established when facing the drive girder side of the crane.
**Left Lay**—(a) strand—strand in which cover wires are laid in a helical pitch, similar to left-hand screw; (b) rope—rope in which strands are laid in a helix having a left-hand pitch, similar to left-hand screw.

**Level Luffing**—An operating technique whereby the crane or derrick hook does not significantly change elevation as the boom is raised or lowered.

**Lift**—(a) Any sequence of operations in which a hoisting device raises an object above the ground, floor, or support, and then places it on the ground, floor, or support; (b) maximum safe vertical distance through which the hook can travel; (c) the hoisting of a load.

**Lift, critical**—See critical lift.

**Lift, ordinary**—Are those lifts that are performed by trained and qualified personnel with conventional equipment using sound hoisting and rigging practices as described in safety handbooks, consensus standards, and in compliance with regulations.

**Lift, special**—Any documented lift not designated as a critical lift or ordinary lift. Special Lift plans do not require the technical rigor of a critical lift and do not have to be performed in a step-by-step sequence.

**Lift Beam**—See spreader beam.

**Lifting Devices**—Devices that are not reeved onto the hoist ropes, such as hook-on buckets, magnets, grabs, load-spreaders bars, and other supplemental units used for ease of handling certain types of loads. The weight of these devices is to be considered part of the working load.

**Lifting Eye**—A point of attachment on the item to be lifted, having a looped head designed to accommodate a hook or shackle. Also called a slinging eye.

**Limiting Devices**—A device that is operated by some part of a power-driven machine or equipment to control motions of the machine or equipment.

**Limit Switch**—An electrical device that is operated by the bridge, trolley, or hoist motion to disconnect the circuit, to establish a new circuit, or to provide a warning.

**Line**—Rope used for supporting and controlling a suspended load.

**Line Pull**—The pulling force attainable in a rope leading off a rope drum or lagging at a particular pitch diameter (number of layers).

**Line Speed**—The speed attainable in a rope leading off a rope drum or lagging at a particular pitch diameter (number of layers).

**Load**—The total superimposed weight or force to be overcome by the hoisting and rigging equipment.

**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 one, where 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 Block, lower--The assembly of hook or shackle, swivel, sheaves, pins, and frame suspended by hoisting ropes.

Load Block, upper--The assembly of sheaves, pins, and frame suspended from the hoisting platform or from the boom in mobile cranes.

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.

Load, critical--See critical load.

Load, dead--The load(s) on a portion of the crane, which remain(s) in a fixed position relative to the member being considered.

Load Float--A control system that enables stepless operation of a hoist in either the lifting or lowering direction for a range of about 0 percent to 5 percent of full-rated speed, as well as permitting the load to be suspended stationary for a very short time with the holding brake(s) released.

Load Jib--The horizontal live load supporting member of a hammerhead-type tower crane having the load falls supported from a trolley that traverses the jib; also called saddle jib.

Load, live--A load that moves or varies relative to the member being considered. For the trolley, the live load consists of the rated load plus the weight of the block. For the bridge, the live load consists of the rated load plus the weight of the trolley.

Load Moment (or rated capacity) Indicator--A system which aids the equipment operator by sensing (directly or indirectly) the overturning moment on the equipment, i.e., load multiplied by radius. It compares this lifting condition to the equipment’s rated capacity, and indicates to the operator the percentage of capacity at which the equipment is working. Lights, bells, or buzzers may be incorporated as a warning of an approaching overload condition.

Load Moment (or rated capacity) Limiter--A system which aids the equipment operator by sensing (directly or indirectly) the overturning moment on the equipment, i.e., load multiplied by radius. It compares this lifting condition to the equipment’s rated capacity, and when the rated capacity is reached, it shuts off power to those equipment functions which can increase the severity of loading on the equipment, e.g., hoisting, telescoping out, or luffing out. Typically, those functions which decrease the severity of loading on the equipment remain operational, e.g., lowering, telescoping in, or luffing in.

Load Point--The point of load application.

Load Point, auxiliary--Any point of load application other than the load point.

Load Point, integral auxiliary--Any nonremovable point of load application other than the load point.

Load Rating, auxiliary--Rated load of the jack, as determined by the manufacturer, when load is applied at the auxiliary load point.
**Load Radius**--Normally, the horizontal distance from the axis of rotation to the center of gravity of a lifted load. In mobile crane practice, this is more specifically defined as the horizontal distance from the projection to the ground of the axis of rotation before loading to the center of a loaded but vertical hoist line.

**Load, rated**--The maximum static vertical load for which a crane or an individual hoist is designed. See rated capacity.

**Load Rating**--Rating in pounds established by the manufacturer.

**Load, safe working (SWL)**--The maximum load a piece of equipment (or tackle) can handle without exceeding the rated capacity (the rated capacity of the lowest capacity item used in the lift). See load, rated.

**Load, working**--The external load, in pounds applied to the crane. For mobile cranes and derricks, the weight of load-attaching equipment is included as part of the working load (e.g., load blocks, hooks, shackles, and slings). In permanently installed cranes such as overhead, gantry, and monorail cranes and hoists, the weight of the load block and hook is not part of the working load.

**Locked coil strand**--Smooth-surfaced strand composed of shaped wires laid in concentric layers around a center of round wires.

**Lowest service temperature (LST)**--A predetermined temperature below which all lifting equipment, assemblies, or fixtures should not be used.

**Luffing**--Changing the boom angle. Also called booming in (out), or topping.

**Luffing Jib Limiting Device**--Similar to a boom hoist limiting device, except that it limits the movement of the luffing jib.

**Machine Resisting Moment**--The moment of the deadweight of the crane or derrick, less boom weight, about the tipping fulcrum; hence, the moment that resists overturning; also called machine moment or stabilizing moment.

**Magnet**--An electromagnetic device carried on a crane hook that picks up loads magnetically.

**Magnetic Controls**--Controls in which acceleration and deceleration are controlled as a master switch or pushbutton is moved from neutral to the forward or reverse positions. A combination of electromagnetically operated contractors and relays that actuate sequentially to vary the motor torque by changing the resistance.

**Magnetic Particle Examination**--A nondestructive test that reveals defects in ferromagnetic materials via detection of leakage fields at discontinuities in magnetic flow paths.

**Main Hoist**--The hoist mechanism provided for lifting the machine's maximum-rated load.

**Main Switch**--A switch controlling the entire power supply to the hoist.

**Man Trolley**--A trolley having an operator’s cab attached.

**Manufacturer/Builder**--The builder/constructor of equipment.
Marine Worksite--A construction worksite located in, on or above the water.

Marlin Spike--Tapered steel pin used in splicing wire rope.

Mast--The upright member of a derrick.

Mast Cap--See spider.

Master Link--Forged or welded steel link used to support all members (legs) of an alloy-steel chain or wire rope sling (includes bull ring, pear link, oblong link, and weldless sling link). Also called bull-ring.

Master Switch--A manual or automatic device that governs the operation of contractors and/or auxiliary devices of an electric control and provides for shutdown of all electric power to a crane or hoist.

Material Elevator--A mechanism consisting of a tower with vertical members, which guide a platform that is lifted and lowered by means of a hoist.

MHI--Material Handling Institute.

Micro Drive--See inching drive.

Mild Plow--See grades, rope.

Milking--The progressive movement of strands along the axis of the rope, resulting from the ropes movement through a restricted passage such as a tight sheave.

Minimum Life--See bearing life.

Molly Hagan--A type or method of making a wire rope eye splice. Same as a “flemish eye”.

Monorail--Usually a series of continuous beams with curves, switches, and stops that carry loads over a predetermined route or routes.

Monthly--Once each calendar month. A maintenance/inspection program should accomplish monthly tasks at approximately the same time each calendar month. To manage such programs, tasks should be scheduled as “due” on a particular date. If a task cannot reasonably be performed on the scheduled “due” date, it should promptly be rescheduled for a date during the same calendar month.

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.

Multi-Purpose Machine--A machine that is designed to be configured in various ways, at least one of which allows it to hoist (by means of a winch or hook) and horizontally move a suspended load. For example, a machine that can rotate and can be configured with removable forks/tongs (for use as a forklift) or with a winch pack, jib (with a hook at the end) or jib used in conjunction with a winch. When configured with the forks/tongs, it is not covered by this subpart. When configured with a winch pack, jib (with a hook at the end) or jib used in conjunction with a winch, it is covered by this subpart.
Multiple Load Line Operation—Simultaneous use of two or more lines reeved over sheaves on a single shaft or multiple shafts of a crane with multiple load drums to lift, rotate, or hold a single load.

Narrow-Aisle Truck—A self-loading truck primarily intended for right-angle stacking in aisles narrower than those normally required by counterbalance trucks of the same capacity.

Nationally Recognized Accrediting Agency—An organization that, due to its independence and expertise, is widely recognized as competent to accredit testing organizations. Examples of such accrediting agencies include, but are not limited to, the National Commission for Certifying Agencies and the American National Standards Institute.

NCR—Nonconformance report.

NDA—Nondestructive assessment.

NDT—Nondestructive test.

NEMA—National Electrical Manufacturers Association.


Nil-Ductility Transition Temperature—The maximum temperature at which a standard drop-weight specimen breaks when tested in accordance with ASTM E-208.

NLGI—National Lubricating Grease Institute.

NLGI Grade number—A grade number defining the consistency of grease in accordance with methods prescribed by the National Lubricating Grease Institute.

Nominal Strength, wire rope—Nominal wire rope strengths as calculated by a standardized industry-accepted procedure. Minimum acceptance strength is 2½% lower than nominal strength. (Re: Wire Rope Users Manual.)

Nonconductive—Because of the nature and condition of the materials used, and the conditions of use (including environmental conditions and condition of the material), the object in question has the property of not becoming energized (that is, it has high dielectric properties offering a high resistance to the passage of current under the conditions of use).

Nondestructive Examination (NDE)—A name applied to a variety of tests which make use of indirect means to locate material discontinuities (e.g., radiography, dye penetrant, magnetic particle, ultrasonic).

Nonrotating Wire Rope—See rotation-resistant rope.

Nonspinning Wire Rope—See rotation-resistant rope.

Normal Operating Conditions—Those conditions during which a crane or carrier is being operated and is performing functions within the scope of the original design. For a cab-operated crane, the operator is at the operating control devices in the cab and no other person is on the crane except those designated. For a floor-operated crane or carrier, the operator is at the operating control devices, which are suspended from the crane but operated with the operator off the crane, and no
person is on the crane. For a remote-operated crane or carrier, the operator is at the operator control devices, which are not attached to any part of the crane, and no person is on the crane.

NRC--U.S. Nuclear Regulatory Commission.

Offset Angle--The angle between the longitudinal centerline of a jib and the longitudinal centerline of the boom on which it is mounted.

OJT--On-the-job training.

Open Socket--Wire rope fitting consisting of a basket and two ears with a pin.

Operating Sectors--Portions of a horizontal circle about the axis of rotation of a mobile crane providing the limits of zones where over-the-side, over-the-rear, and over-the-front ratings are applicable.

Operational Aids--Devices that assist the operator in the safe operation of the crane by providing information or automatically taking control of a crane function. These include, but are not limited to, the devices listed in § 1926.1416 (“listed operational aids”).

Operational Controls--Levers, switches, pedals and other devices for controlling equipment operation.

Operator--A person who is operating the equipment.

OSHA--Occupational Safety and Health Administration (or Act).

Outrigger Lift-Off--The occurrence of an outrigger lifting from the ground is often attributed to the natural flex in the crane’s frame according to the manufacture. This may happen when lifting a load in certain configurations within the capacity limits of the load chart and is not necessarily an indication of an unstable condition.

Outriggers--Extendable arms attached to a crane base mounting, which include the means for relieving the wheels (crawlers) of crane weight; used to increase stability.

Overhauling Weight--Weight added to a load fall to overcome resistance and permit unspooling at the rope drum when no live load is being supported; also called headache ball, cheek weights.

Overhead Crane--See cranes, types of.

Overhead Guard--A framework fitted to a truck over the head of a riding operator.

Overload--Any load in excess of the safe working load or rated capacity of the equipment or tackle.

Overtravel--Movement beyond maximum travel for which the jack was designed.

Overturning Moment--The moment of the load plus the boom weight about the tipping fulcrum. Wind and dynamic effects can be included when appropriate.

Parking Brake--A device to prevent the movement of a stationary vehicle.

Parts of Line--A number of running ropes supporting a load or force, also called parts or falls.
Pawl (dog)--A device for positively holding a member against motion in one or more directions.

Paying Out--Adding slack to a line or relieving load on a line by letting (spooling) out rope.

PCSA--Power Crane and Shovel Association.

Pendants--Both wire and bar types. Wire type: a fixed length of wire rope with mechanical fittings at both ends for pinning segments of wire rope together. Bar type: instead of wire rope, a bar is used. Pendants are typically used in a latticed boom crane system to easily change the length of the boom suspension system without completely changing the rope on the drum when the boom length is increased or decreased.

Pendant Control Station--Controls suspended from an overhead crane, gantry crane, or overhead hoist for operating the unit. (Commonly called the pendant.)

Peening--Permanent distortion of outside wire in a rope caused by pounding.

Periodic Inspection--Daily to yearly inspections.

Pitch Diameter--The distance, measured through the center of a drum or sheave, from center to center of a rope passed about the periphery of the drum or sheave.

Pivoted Luffing Jib--A tower crane jib that in general has pivot points somewhere in the middle area; also called articulated jib.

Plow Steel--See grades, rope.

Plug--To operate a controller in such a manner that the motor line voltage polarity or phase sequence is reversed before the motor rotation has stopped, thereby developing a counter torque that acts as a retarding force.

Plugging--Stopping the forward motion of the bridge or trolley travel by reversing the controller to the opposite direction.

Plugging relay--A current relay that senses current in the motor secondary circuit of an alternating current motor and limits reverse torque of the motor until the motor rotation has stopped. In a direct current control panel, the relay performs the same function by establishing a sensing circuit at the motor armature (also known as the antiplugging relay.)

Polar Crane--See cranes, types of.

Power-Controlled Lowering--A system or device in the power train, other than the load holding brake, that can control the lowering speed of the load hoist mechanism.

Power Lines--Electric transmission and distribution lines.

Powered Industrial Truck--A mobile, power-driven vehicle used to carry, push, pull, lift, stack, or tier material.

Power-Operated Crane--See cranes, types of.
Pre-Engineered Lift--A noncritical lift that management has designated as requiring additional controls by having a qualified individual or engineer independently pre-identify load weight, load center of gravity, lift attachment points, and minimum lifting hardware (slings, below-the-hook lifting devices, shackles, etc.) capacities that will be used for the lift or series of lifts. Pre-identified information shall be provided to the personnel involved in the lift.

Preece Test--A recognized standard of testing the galvanized coating on wire.

Preformed Strand--Strand in which the wires are permanently shaped, before fabrication in the strands, to the helical form they assume in the strand.

Preformed Wire Rope--Wire rope in which the strands are permanently shaped, before fabrication into the rope, to the helical form they assume in the wire rope.

Premise Wiring--Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed.

Pressure Gripping Lifters, friction type--Lifters that grip the load without significant or harmful permanent deformation of the load surfaces.

Pressure Gripping Lifters, indentation type--Lifters that carry the load by applying sufficient force to permanently indent the sides of the load.

Prestressing--Stressing a wire rope or strand before use under such a tension and for such a time that the construction stretch is largely removed.

Preventive Maintenance--A periodic or scheduled program that provides lubrication, adjustments, inspection, and testing as required to keep equipment in safe, operable working conditions.

Primary Load-Bearing Part--See load-bearing parts.

Proof Load--The load applied in performance of a proof test.

Proximity Alarm--A device that provides a warning of proximity to a power line and that has been listed, labeled, or accepted by a Nationally Recognized Testing Laboratory in accordance with 29 CFR 1910.7.

Pullers--Also called come-along.

Pulpit-Operated Crane--See cranes, types of.

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

Qualified Engineer--A person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

Qualified Evaluator--A person who has demonstrated that he/she is competent in accurately assessing whether individuals meet the Qualification Requirements.
Qualified Inspector--One whose competence is recognized by the cognizant manager and whose qualification to perform specific inspection activities has been determined verified and attested to in writing.

Qualified Operator--One whose competence to operate equipment safely and effectively (including the ability to accurately spot and control loads) has been demonstrated by extensive experience or operational tests and whose name has been posted on the Qualification List in the work area by the cognizant manager.

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

Qualified Rigger--a rigger who meets the criteria for a qualified person.

Qualified Safety Representative--A person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

Rail, bridge--The track supported by the bridge girder(s) on which the trolley travels.

Rail, runway--The track supported by the runway beams on which the crane travels.

Rail sweep--A mechanical device attached to the end truck of a bridge or trolley, located in front of the leading wheels, to remove foreign objects from the rail.

Radius (reach)--For mobile equipment, the horizontal distance from the theoretical intersection of the axis of rotating and the vertical center of the hoist line(s).

Range Control Limit Device--A device that can be set by an equipment operator to limit movement of the boom or jib tip to a plane or multiple planes.

Range Control Warning Device--A device that can be set by an equipment operator to warn that the boom or jib tip is at a plane or multiple planes.

Range Diagram--A diagram showing an elevation view of a crane with circular arcs marked off to show the luffing path of the tip for all boom and jib lengths and radial lines marking boom angles. A vertical scale indicates height above ground, while a horizontal scale is marked with operating radii. The diagram can be used to determine lift heights, clearance of the load from the boom, and clearances for lifts over obstructions.

Ratchet--A toothed member, attached to or a part of the drum, for engagement with the pawl.

Rated Capacity (rated load)--(a) The maximum working load permitted by the manufacturer under specified working conditions. Such working conditions typically include a specific combination of factors such as equipment configuration, radii, boom length, and other parameters of use. (b) For a truck equipped with load carriage and forks or attachments it is the weight established by the manufacturer at a required load center that a given truck can transport and stack to an established height.

Rated Life--See bearing life.
Rated Load (hydraulic jacks)--Maximum load, applied at a specified point, for which the jack is designed and built by a manufacturer for its specified travel.

Rated Load, lifting (mechanical jacks)--Maximum load, applied at a specified point, which the jack was designed to lift with the specified operating lever.

Rated Load, sustaining (mechanical jacks)--Maximum load, applied at a specified point, which the jack was designed to sustain.

Rated Lope (line) Pull--The manufacturer's recommended load in pounds (kilograms) applied to the rope attached to the hoist drum.

Reach--Distance from the axis of rotation of a crane or derrick, sometimes used synonymously with radius.

Rerate--To change the rated load (capacity). The rated load may be increased or decreased.

Reel--The flanged spool on which wire rope or strand is wound for storage or shipment.

Reeve--The pattern that a rope forms between sheaves in a hoisting system.

Reeved Blocks--Passing rope through a set of blocks, as opposed to laced blocks, and in such a manner that there are no lines crossed or rubbing each other.

Reeving--A rope system in which the rope travels around drums and sheaves in a prescribed manner.

Reeving Diagram--A diagram showing the path of the rope through a system of sheaves (blocks).

Regenerative--A method of control in which the electrical energy generated by the motor is fed back into the power system.

Regular-Lay Rope--Wire rope in which the wires in the strands and the strands in the rope are laid in opposite directions.

Remote-Operated Crane--See cranes, Types of.

Repetitive Pickup Point--When operating on a short cycle operation, the rope being used on single layer and being spooled repetitively over a short portion of the drum.

Reverse Bend--Reeving of a wire rope over sheaves and drums so that it bends in opposite directions.

Reverse Lay--See alternate lay.

Revolving Superstructure--On a mobile crane, the entire rotating structure less the front end attachment; also called upper superstructure.

Rigger--See qualified rigger and rigging specialist.

Rigging--The act of attaching hoisting equipment to the load.
Rigging Hook--See hook, rigging.

Rigging Specialist--A qualified rigger or recognized rigging authority with at least 5 years hoisting and rigging experience selected by the employer to advise or supervise hoisting and rigging activities. (See qualified rigger.)

Right-Hand End--A reference to parts or dimensions on the viewer's right of the centerline of span, established when facing the drive-girder side of the crane.

Right-Lay--(a) Strand in which the cover wires are laid in a helix having a right-hand pitch, similar to a right-hand screw; (b) Rope in which the strands are laid in a helix having a right-hand pitch, similar to a right-hand screw.

RL--DOE, Richland Operations Office.

Rocker Beam--Beam used for hoisting flimsy trusses or long flimsy loads. Also used to equalize the weight and to keep a load, such as tank plate, from buckling.

Rollers--Relatively small-diameter cylinders or wide-faced sheaves for supporting or guiding ropes.

Rooster--One or more struts at the top of a boom or mast, such as a jib strut, a tower-crane top tower, or the struts at the top of the mast of a mobile crane tower attachment.

Rope--Refers to wire rope unless otherwise specified.

Rope Drum--That part of a drum hoist that consists of a rotating cylinder with side flanges on which hoisting rope is spooled in or out (wrapped).

Rotation-Resistant Rope--A wire rope consisting of an inner layer of strands laid in one direction, covered by a layer of strands laid in the opposite direction. This has the effect of counteracting torque by reducing the tendency of the finished rope to rotate.

Running Wire Rope--A rope that moves over sheaves or drums.

Running Sheave--A pulley-type device that changes location in relation to the hoisting device.

Runway (overhead cranes)--An assembly of rails, girders, and brackets that form a structural support on which a crane operates.

Saddle Jib--The horizontal live-load supporting member of a hammerhead-type tower crane having the load falls supported from a trolley that traverses the jib; also called load jib.

SAE--Society of Automotive Engineers.

Safety Factor--See design factor.

Safe Working Load (SWL)--See rated capacity.

Sag--See deflection.
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 bind securely 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.

Serve--To cover the surface of a wire rope or strand with a wrapping of wire.

Service, normal--That service which involves operation with randomly distributed loads within the rated load limit, or uniform loads of less than 65 percent of the rated load for not more than 15 percent of the time for manually operated hoists and 25 percent of the time for electric- or air-powered hoists, of a single work shift.

Service, heavy--that service which involves operation within the rated load limit which exceeds normal service.

Service, severe--that service which involves normal or heavy service with abnormal operating conditions.

Shackle--A type of clevis normally used for lifting.

Shaft, cross (squaring shaft) (drive shaft)--The shaft(s) extending the length of the bridge, used to transmit torque from the motor to a wheel(s) at each end of the bridge.

Shall--Word indicating that the rule is mandatory and must be followed.

Sheave--A wheel or pulley with a circumferential groove designed for a particular size of wire rope; used to change direction of a running rope.

Shock Loading--Term used to call attention to the application of any sudden, unplanned loading of equipment that would jeopardize the safety of the lift. Typical examples that could result in shock loading are: (a) rapid travel of the burden block without alteration of speed before all slack is removed from the sling(s), (b) unplanned shifting of the load while suspended, (c) fracture of a lifting system component resulting in the application of unknown loading on remaining components.

Should--Word indicating that the rule is a recommendation, the advisability of which depends on the facts in each situation.

Side Frames--Part of the base mounting of a crawler crane attached to the carbody and supporting the crawler treads, the track roller, and the drive and idler sprockets. Crawler frames transmit crane weight and operational loadings to the ground; also called crawler frames.

Side Pull--That portion of the hoist pull acting horizontally when the hoist lines are not operated vertically.

Side Loading--A loading applied at any angle to the vertical plane of the boom.
Siemens-Martin Strand--A grade of galvanized strand.

Signal Person/Flagman – A qualified person whose responsibility is to provide direction for equipment movements to the operator through use of voice signals or standardized hand signals.

Single Galvanized Strand--Strand made in the “common grade” or wiped galvanized wire. See common strand.

Site Supervisor--Exercises supervisory control over the work site on which a crane is being used and over the work that is being performed on that site.

Slewing--A crane or derrick function wherein the boom or load-supporting member rotates about a vertical axis (axis of rotation); also called swing.

Slinging Eye--See lifting eye.

Slings--Wire ropes, chains, or synthetic fabric made into forms, with or without fittings, for handling loads.

Slings, braided--A very flexible sling composed of several individual wire ropes braided into a single sling.

Slings, endless and grommet wire rope--A wire rope made endless from one continuous length of cable-laid rope with the ends joined by one or more metallic fittings.

Slings, four-leg bridle--Sling made with four single-rope legs, secured to a single lifting ring.

Slings, three-leg bridle--Slings made with three single-rope legs, secured to a single lifting ring.

Slings, two-leg bridle--Slings with single-rope legs, equalizing double-rope legs, or multiple-part rope legs.

Slip (motor)--The difference between theoretical, or synchronous, speed and actual speed in an induction motor. Under standard conditions, an induction motor never reaches synchronous speed, at which zero torque is developed.

Smooth Coil Strand--Strand composed entirely of round wires.

Snatch Block--A single- or double-sheave block arranged so one or both cheek plates can be opened, permitting the block to be reeved without having to use a free rope end; also called gate block. (The brand name SKOCUM is also used generically; thus, snatch blocks are also called skocum blocks.)

Socket--Type of wire rope fitting. See bridge sockets, closed sockets, open sockets, and wedge sockets.

Softeners--Anything used to protect the load or the rigging from damage while making a lift. Also, prevents load from slipping.

Span--The horizontal distance center-to-center of runway rails.
Special Flexible--See extraflexible and extrapliable.

Special Hazard Warnings--Warnings of site-specific hazards (for example, proximity of power lines).

Special-Rated Capacity--The maximum hook load that a piece of hoisting equipment or the maximum working load that an industrial truck or piece of rigging tackle is permitted to carry, based on its present condition and the operational conditions as determined by an engineering evaluation, load test, or both. The special-rated capacity may be equal to, but not greater than, the rated capacity of equipment established by the manufacturer.

Spider--A fitting mounted to a pivot (gudgeon pin) at the top of a derrick mast, providing attachment points for guy ropes; also called Mast cap.

Spiral Groove--A continuous helical groove that follows a path on and around a drum face, similar to a screw thread.

Splicing--Interweaving of two ends of ropes to make a continuous or endless length without appreciably increasing the diameter. Also, making a loop or eye in the end or a rope by tucking the ends of the strands.

Spooling (rope)--Winding of rope on a cylindrical drum in evenly spaced, uniform layers.

Spotter -- An assigned person(s) whose sole responsibility is to provide a warning or stop signal during vehicle or equipment operation prior to violation of proximity restrictions or per-determined distance limitations to structures or hazards such as power and communication lines, overhead obstructions, buildings, telephone poles, ground penetrations and etc. (Spotters for mobile cranes require the use of a qualified signalman/flagman as a spotter).

Spreader Bar--A frame, forming part of the boom suspension, supporting sheaves for the live suspension ropes and attached to the fixed suspension ropes (pendants); also called bridle, spreader, live spreader, or flating harness.

Spreader Beam--A fixture made of rigid parts, such as pipe, wide-flange, I-beam, channel, plate, etc., to assist in rigging a load; also called lifting beam.

Stabilizers--Devices for increasing stability of a crane; they are attached to the crane base mounting but are incapable of relieving the wheels (crawlers) of crane weight.

Stabilizing moment--The moment of the dead-weight of the crane or derrick, less boom weight, about the tipping fulcrum; hence, the moment that resists overturning; also called machine moment or machine resisting moment.

Stainless Steel Rope--Wire rope made of low-carbon corrosion-resistant steel.

Standby--A crane or derrick that is not in regular service, but one that is used occasionally or intermittently as required.

Standing Line--A fixed-length line that supports loads without being spooled on or off a drum; a line of which both ends are dead; also called stay rope or pendant.
Standing Rope--See guy line.

Standing Rope (pendant)--A supporting rope that maintains a constant distance between the points of attachment to the two components connected by the rope.

Static Base--Tower-crane support (base mounting) where the crane mast is set on or into a foundation.

Static Controls--Controls that provide a function similar to that of magnetic controls. The accelerating resistors and contactors are replaced with thyristors, silicon-controlled rectifiers (SCRS), and similar static electronic devices. Operating characteristics are similar to those that might be obtained from magnetic control having an infinite number of accelerating contacts between the first and final control points.

Statically Determinate Load--The load or stress in a member that, when determined by arithmetic means, is mathematically accurate.

Statically Indeterminate Load--A load or stress that is determined arithmetically and which has a range of values which cannot be accurately determined mathematically.

Stay Rope--A fixed-length rope forming part of the boom suspension system; also called boom guy line, hog line, boom stay, standing line, or pendant.

Steel-Clad Rope--Rope with individual strands spirally wrapped with flat steel wire. See armored rope.

Stirrup--The U-bolt or eyebolt attachment on a bridge socket.

Stop--A member to physically limit the travel of a trolley or bridge. This member is rigidly attached to a fixed structure and normally does not have energy-absorbing ability.

Strand, wire rope--A plurality of round or shaped wires helically laid about an axis.

Strength Margin--The ratio of structural failure load (or stress) to actual or permitted load (or stress).

Structural competence--The ability of the equipment and its components to support the stresses imposed by operating loads without the stresses exceeding specified limits.

Superstructure--The rotating upper frame structure of a mobile crane and the operating machinery mounted thereon.

Supporting materials--Blocking, mats, cribbing, marsh buggies (in marshes/wetlands), or similar supporting materials or devices.

SUS--Saybolt universal seconds.

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

Swing--Rotation of the superstructure of a mobile crane or derrick boom for movement of loads in a horizontal direction about the axis of rotation.
Swing Axis--The vertical line about which a crane or derrick swings; also called center of rotation (obsolete) or axis of rotation.

Swing Mechanism--The machinery involved in providing rotation of the superstructure or derrick boom.

Swingers--(a) Attached--Reversible drum unit arranged to rotate or swing a derrick mast and boom, or some other structure which supports a load lifting or lowering boom, which is attached to and receives its power from a hoist; (b) Independent--Unit directly geared to its own power for rotating or swinging a derrick mast and boom; (c) Rope--Unit provided with one or two reversible drums for winding the rope used for rotating or swinging a bull wheel of a boom supporting structure.

Switch--A device for making, breaking, or changing the connections in a control circuit. It is also a device for changing directions of a trolley from one monorail system (track) to another.

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 open or close the electrical circuit associated with the machine or equipment.

Switch, main--A switch controlling the entire power supply to the crane, often called the disconnect switch.

Synchronous Speed--The synchronous speed of an alternating current (ac) motor is directly proportional to the supply frequency and inversely proportional to the number of poles. For example, the synchronous speed of a four pole motor operating at 60 Hz is determined by the following equation:

\[ \text{Synchronous Speed} = 120 \times \text{Frequency} \div \# \text{ of Poles} \]

therefore: \( 120 \times 60 \div 4 = 1800 \text{ r/min.} \)

Tackle--Those pieces of rigging such as slings, spreader bars, chokers shackles, thimbles, eyebolts, rings, or other handling fixtures used for attachment of the load to the crane or hoist.

Tag Line--A rope (usually fiber) attached to a lifted load for purposes of controlling load.

Tailing Crane--The crane controlling the base end of the object in a multi-machine operation in which a long object is erected from a horizontal starting position to a vertical final position.

Taking Up--The process of removing slack from a line or drawing (spooling) in on a line; loading a line by drawing in on it.

Tapered Tip--The uppermost section of a sectional latticed boom, which usually includes the weldment mounting the upper load sheaves as an integral part; also called boom point, head section, or boom tip section.

Technical Approver--An individual assigned to review critical lift plans who has technical knowledge and experience applicable to the requirements of this manual, mandatory standards, and equipment identified in the critical lift plan.

Test Load--A load that is periodically applied to hoisting equipment to ensure that it has the ability to safely handle the rated capacity of the equipment. The test load is usually some percentage of the rated load capacity--100 percent to 150 percent of rated load.
Thimble--Grooved-metal fitting designed to prevent crushing or overstressing wire rope at the terminal end which is used to protect the eye of a wire rope or sling.

Third-Party Inspection--An inspection made by an independent party who is a crane and hoist specialist. See qualified inspector.

Tiller Rope--A very flexible operating rope, commonly made by cable laying six 6 x 7 ropes around a fiber core.

Tilt Up or Tilt Down Operation--Raising/lowering a load from the horizontal to vertical or vertical to horizontal.

Tinned Wire--Wire coated with tin.

Tipping Fulcrum--The horizontal line about which a crane or derrick will rotate should it overturn; the point(s) on which the entire weight of a crane or derrick will be imposed during tipping.

Tipping Lift--Refer to boom hoist.

Tipping Load--The load for a particular operating radius that brings the crane or derrick to the point of incipient tipping.

Topping--See derrick.

Torque, locked-rotor--The minimum torque which an induction motor will develop at rest, for all angular positions of the rotor, with rated voltage applied at rated frequency. Not applicable to wound-rotor (slipping motors).

Torque, motor breakdown--The maximum torque that an induction motor will develop with rated voltage applied at rated frequency without an abrupt drop in speed.

Torque, motor full-load--The torque developed by an electric motor (ac or direct current [dc]) to produce its rated horsepower at rated full-load speed.

Torque, motor pull-up--The minimum torque developed by an induction motor during the period of acceleration from rest to the speed at which breakdown torque occurs. For induction motors with 8 percent or greater slip, the pull-up torque, the breakdown torque, and the starting torque are all equal and occur at zero speed.

Traction Steel--A grade of wire rope used in elevator service. See grades, rope.

Tram--The practice of placing punch marks on a hook for gauging use.

Transit--Moving or transporting a mobile crane from one job site to another.

Travel--(a) Movement of a mobile or wheel-mounted crane about a job site under its own power;

(b) Linear extending or retracting movement of a jack.

Travel Base--The base mounting for a wheel-mounted (traveling) tower crane.
**Tread Diameter**--The diameter of a sheave or grooved rope drum measured at the base of the groove. The diameter of a smooth barrel on a rope drum.

**Trolley**--A unit that travels on the bridge rails consisting of frame, end trucks, drive supporting the hoisting mechanism, rope, and load block that supports the load, or a unit that travels on the lower flange of a beam or monorail system supporting a hoist.

**Trolley Girts**--Structural members that are supported on the trolley trucks and contain the upper sheave assemblies.

**Trolley Travel**--The trolley movement.

**Trolley Truck**--An assembly consisting of wheels, bearings, axles, and structural framework that supports the hoist mechanism.

**Turnbuckle**--Device attached to wire rope chain or rods for making limited adjustments in length, which consists of a barrel and right-hand and left-hand threaded bolts.

**Two-Block Damage Prevention Feature**--A system that will stall when two-blocking occurs without causing damage to the hoist rope or crane machinery components. See anti-two-block device.

**Two-Block Warning Feature**--A warning device to alert the operator of an impending two-blocking condition. See anti-two-block device.

**Two-Blocking**--The condition in which the lower load block or ball assembly comes in contact with the upper load block or boom-point sheave assembly.

**UBC**--Uniform Building Code.

**UL**--Underwriters Laboratory.

**Ultimate Strength**--The maximum conventional stress, tensile, compressive, or shear that a material can stand without failure.

**Unavailable Procedure**: Procedures that are no longer available from the manufacturer, or have never been available, from the manufacturer.

**Upperworks**--The revolving frame of equipment on which the operating machinery (and many cases the engine) are mounted along with the operator’s cab. The counterweight is typically supported on the rear of the upperstructure and the boom or other front end attachment is mounted on the front.

**Vangs** (vangs lines)--Tackle attached to each side of a derrick boom near the outer end, and to the base or pontoon at a lateral distance, by means of which the boom is rotated (slewed) from one side to the other.
Verification--A procedure, instruction, report, or document that is checked for validity and signed by one or more parties. The person designated to sign verifies that a specific action has been performed in accordance with specified requirements, usually based on personal observation, certified records, or a direct report.

Wall Crane--See cranes, Types of, - jib crane.

Warrington--A wire rope strand construction in which one layer of wires, usually the outer, is composed of alternating large and small wires.

Weather Crane--To swing with the wind when out of service to expose a minimum area to the wind.

Web Plate--The vertical plate(s) connecting the upper and lower flanges or cover plates of a girder.

Wedge Socket--Wire rope fitting in which the rope end is secured by a wedge.

Wheel Load--Load placed on a bridge or trolley wheel.

Wheel Load, bridge--The vertical force (without impact) produced on any bridge wheel by the sum of the rated load, trolley weight, and bridge weight, with the trolley so positioned on the bridge as to give maximum loading.

Wheel Load, trolley--The vertical force (without impact) produced on any trolley wheel by the sum of the rated load and the trolley weight.

Wheelbase--The distance from center to center of the outermost wheels of the bridge or trolley, measured parallel to the rail.

Whipline (runner or auxiliary line)--A separate hoist rope system usually of a lighter load capacity than provided by the main hoist. Standard Hanford Site terminology is auxiliary hoist.

Winch Head (gypsy head)--A rotatable cylindrical drum with curved end flanges, used for load handling by means of fiber rope coiled about its barrel with hand tension applied to the nonload end. Also called a capstan.

Windlass--A base-mounted machine, usually power-operated, used for hauling in or paying out rope or chain.

Wire Rope--A flexible rope constructed by laying steel wires into various patterns of multi-wired strands around a core system to produce a helically wound rope.

Wire (round)--A 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.

WISHA--Washington Industrial Safety and Health Act.

Wrap--One circumferential turn of wire rope around a rope drum barrel.

Working Load Limit--WLL (see rated capacity).
WSMA--Web Sling Manufacturers Association
ACKNOWLEDGMENTS

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INTRODUCTION

This chapter is a user’s guide to good practices. Its use and application does not absolve the user of responsibilities to comply with the requirements of this manual and referenced Department of Energy (DOE), Occupational Safety and Health Administration (OSHA), and American Society of Mechanical Engineers (ASME) standards. Permission for the use of The Complete Rigger’s Reference Handbook in this manual does not allow reproduction.
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THE COMPLETE

RIGGER’S REFERENCE HANDBOOK

A practical reference for the rigger and crane operator

By Mike Riggs
We at RiggSafe Solutions, Inc. would like to thank you for seeing the value of this riggers reference handbook. We trust its content will help to make your crane and rigging activities efficient and safe. Your comments concerning the Riggers Reference and suggestions for future editions is valued and appreciated.

Please contact RiggSafe Solutions, Inc. at info@riggsafe.com

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Preface

The Complete RIGGER’S REFERENCE Handbook is a practical, well illustrated guide designed as a quick reference tool for the beginning and professional rigger, crane operator, supervisor and others responsible for the safe and proper use and inspection of rigging gear. This handbook is specifically designed to be used in the instruction of crane and rigging activity. It is the product of over 30 years of the author’s personal experience in construction and maintenance rigging, design, development and presentation of crane and rigging training, as well as several years of fabrication experience with the Slingmax® Rigging Solutions organization.

Disclaimer

The information contained in this publication was obtained from sources proven to be reliable at the time of this publication. The contained material does not cover all the regulations or standards used in the crane and rigging industry. Suggested procedures should not be used without securing competent engineering advice for any given application.

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Acknowledgments

No one person has any measure of success without the support of quality people befriended along the way. I would like to give special thanks to the many who have encouraged me and made my efforts successful throughout the years. First, I would like to thank Harley Gist, Dana Morgan, Mike Gelskey Sr., Mark Coyle, Bo Kentner and Scott Fleming for challenging and encouraging me to strive for continued personal growth in the craft of rigging. A special thanks to Dennis St. Germain whose brilliant mind and upbeat attitude has taught me to think practically, while still remaining outside the box, when resolving rigging problems that tend to hinder the everyday rigger. A very special thanks goes to Harley Gist who assisted me with the valuable brainstorming of ideas from conception to the completion of this book. I would be negligent if I did not acknowledge the quality Ironworkers of Local 14 where I first began this journey, and the crane operator’s of Local 280 who willingly helped educate me about what is happening above the hook.

Last but not least, loving appreciation goes to my wife, Connie, and our two daughters, Angela and Amanda, for their understanding and supportive attitude as I spent many nights away from home during my career. With all the help I’ve received throughout my life, nothing good was accomplished but by the grace of God.

I would like also to sincerely thank John Braunbeck, Tom Crane, Tom DeSoo, Matt Lanham, Sandy Porter and Art Zoerner for their critique of the technical components of this project and Kathy Gist, Angela Parris and Amanda Prinz for the grammatical content of this handbook before it went to print.
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Load Control

Center of Gravity (CG)

To enhance the safety and stability of any lift, the Center of Gravity (CG) must first be located and then controlled. The CG is the point where the weight is considered to be concentrated on a load. In other words, the CG is the balance point in all planes.

The laws of physics dictate that the Center of Gravity will always attempt to reach the lowest possible point. In addition, when the load is lifted as a single-point pick, the C/G will always hang directly below the point of suspension.

When the load is suspended, the center of gravity will try to move in two directions: 1) directly below its point of support and 2) to the lowest point possible.
In order to control load movement caused by the effects of the CG, slings and lifting devices must be attached accordingly. For the best control, equal length slings should be attached equal distance from and above the CG. When this is not possible, keep the CG contained within three or more legs. A load with a high CG can rotate in some sling hitch configurations. After taking all these conditions into consideration, the load can be lifted safely with the assurance of controlling the load.

Finding the Center of Gravity

There are several methods to determine the center of gravity (CG). Depending on the load's shape and size, the CG may be easy to determine with the following trial and error method. More unique loads may require one of the mathematical methods to determine its location. If there is ever any doubt as to the location of the CG consult with a qualified person before making the lift.
Method 1: Trial and Error

1. Attach a plumb line to the hoisting hook. Attach the rigging in a configuration that will prevent slippage. Lift load until it is barely suspended and mark a vertical line as designated by the plumb line.
2. Lower load and adjust rigging so that the load will hang in the opposite direction when lifted the second time. Make another vertical mark as designated by the plumb line.
3. The intersection of the two lines will be the CG on that plane. Attach sling accordingly and lift the load level. (Note this method should not be used for large or critical lifts)

Method 2:

The CG of a non-symmetrical load may be identified using load cells or a dynamometer.

1. Lift each end of the load separately.
2. Try to attach rigging at the very end of the lift and make sure the opposite end is cribbed or supported at the extreme end of the lift.

NOTE: The lift must be executed in this order for two reasons - 1) To be sure you include all of the lift weight. 2) Anything extending
past the point of the support could act as a counterweight at the non-lifted end.

After weighing each end, add the two weights together to get the total weight of the lift. Use the distance between the lift points as the total distance. Use the percentage of the weight to determine percentage of distance from the opposite end to the CG.

1) Weight of End A + Weight of End B = Total Weight of Lift
2) Weight of End A divided by Total Weight = % of Weight of End A
3) % of Weight at End A x Total Distance between Lift Points = Distance from Lift Point B to CG

A - Vertical Weight (500 lbs)
B - Vertical Weight (1,500 lbs)
CG - Center of Gravity
TD - Total Distance (20 ft)

CG from A: \( B \div (A + B) \times TD = CG \)
\[ 1,500 \div (500 + 1,500) \times 20 = 15 \text{ Ft.} \]

CG from B: \( A \div (A + B) \times TD = CG \)
\[ 500 \div (500 + 1,500) \times 20 = 5 \text{ Ft.} \]

Follow this process on the other two sides of the load. Then intersect the two CG's to find the combined CG.
Method 3

On loads that have obvious uniform sections, the combined CG can be determined by calculating the size and weight of each section and its CG.

1. Measure the distance (TD) between the CG-1 and CG-2
2. Calculate the weight of each section
3. To determine the combined CG, divide the weight of one of the sections by the total weight (TW) of the combined sections; then multiply by total distance (TD). The resultant will be the distance from the combined CG to the CG of the opposite section of the load.

\[
\text{CG from CG-1: } \frac{\text{Wt. CG-2}}{\text{TW}} \times \text{TD}
\]

\[
4,000 \div 10,000 \times 20 = 8 \text{ ft}
\]

\[
\text{CG from CG-2: } \frac{\text{Wt. CG-1}}{\text{TW}} \times \text{TD}
\]

\[
6,000 \div 10,000 \times 20 = 12 \text{ ft}
\]
Method 4

A fourth method can be accomplished by performing the following steps. These steps can be repeated on all three planes.

1. Calculate the total weight of the load.
2. Establish a baseline on one edge of the load as a reference, in order to establish measurements from the baseline to the CG of each section of the load along a given plane.
3. Multiply the weight of each section of the object by the distance from the baseline to the CG of each section.
4. Add (or subtract, if the section is void) all the sections determined in step 3 and divide by the total weight of the object. The result obtained will provide you with the distance to the CG from the baseline in one plane.

Reinforced Concrete at 150 lbs Cubic Ft.
<table>
<thead>
<tr>
<th>Section</th>
<th>Weight (lbs)</th>
<th>Distance from Baseline</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>37,800 +</td>
<td>× 10.5'</td>
<td>396,900 +</td>
</tr>
<tr>
<td>B</td>
<td>3,600 –</td>
<td>× 5'</td>
<td>18,000 –</td>
</tr>
<tr>
<td>C</td>
<td>2,250 –</td>
<td>× 16'</td>
<td>36,000 –</td>
</tr>
<tr>
<td>D</td>
<td>3,600 –</td>
<td>× 18'</td>
<td>64,800 –</td>
</tr>
</tbody>
</table>

28,350

278,100

278,100 ÷ 28,350 = 9.8 ft.
Single Hook Turning

There are several ways to turn or roll a load. One of the most difficult tasks a rigger faces is to control the Center of Gravity (CG) while turning a load using one hook. The key to a smooth successful turn is to have the crane movement dictate the load's movement, not the CG.

1) The lift point must be above the CG and at a point opposite the direction of the turn. The lower corner diagonally from the lift point will be the turn or pivot point.

2) With the hook over the lift point, lift slowly. Once the load starts to pivot move hook slowly towards the turn point.

3) Continue slowly, moving the hook up and towards the turn point until the lift point is directly over the turn point. In tight places, the load can be lifted off the ground, moved back and lowered to a new bearing point before resuming and completing the turn. At this point, move rigging as required based on load size and shape.
4) Slowly, move through the turn point to the second turn point. Begin to slowly lower the load while slowly moving the load horizontally.

When re-rigged

5) Stop horizontal movement of the hook once the hook is over the placement point and continue to lower load until rigging is slack.

Turning with a Choker Hitch

When turning a load with a choker hitch, use an endless sling or double choker hitch with the eyes pointing in the opposite direction of the turn. Lift, travel and turn into the bite of the hitch. Turning into the bite of the hitch will reduce the hitch's capacity by 50%. Then select the sling size accordingly.

Turn into the bite of the double choker hitch.

NOTE: Slings may need protection from edges and corner.
Load Stability

A load should not be moved unless control of the load's movement, once suspended, is assured. This includes placement of the lift point (over the CG), hitch configurations (vertical, choke, basket, etc.) and number of legs.

Rigging configurations should be planned to control the load's suspended movement in four directions, North-South-East-West (N-S-E-W). A single leg does not offer restriction in a load moving N,S,E, or W. Two-leg rigging configurations inhibit movement in two directions, while three- and four-leg configurations inhibit movement in all four directions (N-S-E-W).
Tagline Use

The safest method for a rigger when controlling a suspended load's spin is by the use of a tag line. When attached properly, a tagline allows the rigger to control load rotation while keeping the rigger away from the load.

1. The main purpose of a tagline is to control load spin (rotation).
2. Rigger's safety is enhanced when a tagline is correctly used. The taglines proper use provides a safe distance between the rigger and the load.
3. Attach taglines as far from the center of gravity as practical.
4. For best control of the load while moving, trail the load.
5. Keep tagline free of knots and loops which can hang-up during load movement.
6. Safely coil up excess line to prevent entanglement with the rigger's feet.
7. Never wrap the tagline around any part of your body or limbs.
Sling Hitches

There are three basic hitches: the vertical hitch, the choker hitch and the basket hitch. All other hitches are a combination or variation of these sling hitches.

Vertical Hitch - A hitch where the sling is used in an eye and eye or straight-pull configuration. The vertical hitch capacity reflects a full 100% of the slings Working Load Limit (WLL). The hitch's efficiency is reduced when used at any angle less than 90° from the horizontal plane.

Choker Hitch - A hitch formed when one end of the sling is passed under or through the load and back up through the sling eye or hardware then is attached to the lifting hook or other device. The choker hitch WLL reflects 75% to 80% of the vertical hitch rating, when the angle of choke is 120° or greater. When the angle of the choke is less than 120°, the hitch efficiency is reduced accordingly.

Basket Hitch - A hitch formed when the sling is passed under or through the load and back up with both ends placed in the hoisting hook or other device. The basket hitch WLL is 200% of the vertical hitch rating as long as both legs of the hitch are within 5° of vertical and the correct D/d ratio for the sling type is achieved. When the legs of the hitch are less than 90°, its efficiency is reduced accordingly.
Bridle Hitch - A hitch where multiple vertical hitches (usually 2 to 4 slings) are attached to a single upper attachment point to facilitate making the lift.

Bridle Sling - A sling where multiple legs are gathered on a master link during fabrication. Bridle sling capacities are based on a specific angle with all legs lifting an equal share of the load weight.

Rendered Choker Hitch - A hitch where the bite of the choke is rendered, to some degree, off to the side of the load. This helps to control a high center of gravity. It is usually used with an opposing hitch.

**Rendered Choke Hitch**

**Rendered Choke Adjustment**

<table>
<thead>
<tr>
<th>Angle of Choke</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 120°</td>
<td>100%</td>
</tr>
<tr>
<td>90° - 120°</td>
<td>87%</td>
</tr>
<tr>
<td>60° - 89°</td>
<td>74%</td>
</tr>
<tr>
<td>30° - 59°</td>
<td>62%</td>
</tr>
<tr>
<td>0° - 29°</td>
<td>49%</td>
</tr>
</tbody>
</table>

Rendered Hitch Capacity = Choker WLL X Angle of Choke Efficiency
Double Wrap Choker Hitch - This hitch has the same rating as a choker hitch that does not have an extra wrap. However, this hitch provides more load control because the extra wrap, around the load, provides $360^\circ$ contact around the load. The double wrap is great for bundled loads and controlling a high center of gravity.

Double Wrap Basket Hitch - This hitch has the same rating as a basket hitch. The extra wrap provides $360^\circ$ contact around the load. The double wrap is great for bundled loads and controlling a high center of gravity.

Double Choker Hitch - This hitch has double the choker hitch capacity when the body of the sling passes through the eyes and back to the hook. Thus allowing for full adjustment of the sling to equalize loading on all parts of the sling.

Inverted Basket Hitch - This hitch has the same rating as a standard basket hitch, less the reduction of a small D/d ratio. It is used to increase the D/d ratio from a vertical basket through a shackle. It also provides continual adjustments when used in conjunction with snatch blocks during tilt up operations. It is possible for the inverted basket to run over the saddle of the hook unless restrained.
Double Basket Hitch - This hitch has the same rating as two basket hitches (with the same angle). This hitch should be used at angles no less than $60^\circ$ from the horizontal plane. A tighter angle may cause the basket part of the hitch to run, making the load unstable. The hitch achieves an equilateral triangle at $60^\circ$.

Adjustable Hitch - This hitch should be used with the choker hitch rating. This hitch is used for loads which have an offset center of gravity. For this hitch to work, the bends in the hitch must be tight. When slack, the hitch should be adjusted to the desired length. Once under load, friction will allow the hitch to stay in place. Rigging hardware should be used in the bite of the hitch.

Endless Choker Hitch - A choker hitch formed with an endless style sling provides a more stable hitch than if formed with an eye and eye style sling. This is because it provides a large base of support under the load.

Endless Basket Hitch - A basket hitch formed with an endless style sling provides a more stable hitch than a basket hitch formed with an eye and eye style sling because it gives a large base of support under the load.
Double Wrap Basket Hitches

Double Wrap Choker Hitches

Endless Sling Vertical Hitches

Rendered Choker Hitch

Two Vertical Hitches

Adjustable Hitch
D/d Ratio - Wire Rope Slings

The diameter of curvature around which a wire rope sling is bent affects its capacity. This is known as the D/d ratio. The upper case D refers to the \textit{diameter of the object} to which the sling hitch is applied. The lower case d represents \textit{the diameter of the wire rope}.

D/d ratio commonly affects the capacity of wire rope slings in a basket hitch configuration. To determine the D/d ratio, divide the diameter of the wire rope sling into the diameter of the load. For example, when the diameter of the load is 15 times the diameter of the wire rope sling the D/d ratio is 15:1. This is an 88% efficiency of the sling's basket hitch capacity.

<table>
<thead>
<tr>
<th>D/d</th>
<th>Efficiency</th>
<th>D/d</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>100%</td>
<td>3.5</td>
<td>73%</td>
</tr>
<tr>
<td>20</td>
<td>92%</td>
<td>3.25</td>
<td>72%</td>
</tr>
<tr>
<td>15</td>
<td>88%</td>
<td>3</td>
<td>71%</td>
</tr>
<tr>
<td>10</td>
<td>86%</td>
<td>2.75</td>
<td>70%</td>
</tr>
<tr>
<td>8</td>
<td>84%</td>
<td>2.5</td>
<td>68%</td>
</tr>
<tr>
<td>6</td>
<td>80%</td>
<td>2.25</td>
<td>67%</td>
</tr>
<tr>
<td>5</td>
<td>78%</td>
<td>2</td>
<td>65%</td>
</tr>
<tr>
<td>4.75</td>
<td>77%</td>
<td>1.75</td>
<td>62%</td>
</tr>
<tr>
<td>4.5</td>
<td>76%</td>
<td>1.5</td>
<td>59%</td>
</tr>
<tr>
<td>4</td>
<td>75%</td>
<td>1.25</td>
<td>55%</td>
</tr>
<tr>
<td>3.75</td>
<td>74%</td>
<td>1</td>
<td>50%</td>
</tr>
</tbody>
</table>

Softeners can be used to improve the radius of contact when using a wire rope sling around a 90° corner. The softener's purpose is to create a contact radius of at least 6 times the wire rope diameter.
When using multi-part wire rope slings, follow the manufacturers requirements for pin size in both the eyes and the body of the sling. D/d ratios are based on component part wire or finished diameter.

<table>
<thead>
<tr>
<th>D/d Ratio</th>
<th>2-1/4</th>
<th>2-1/2</th>
<th>3-3/8</th>
<th>3-1/2</th>
<th>4-1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/16</td>
<td>2</td>
<td>19</td>
<td>33</td>
<td>45</td>
<td>58</td>
</tr>
<tr>
<td>5/8</td>
<td>2-1/2</td>
<td>16</td>
<td>29</td>
<td>39</td>
<td>51</td>
</tr>
<tr>
<td>3/4</td>
<td>3-3/8</td>
<td>23</td>
<td>46</td>
<td>66</td>
<td>89</td>
</tr>
<tr>
<td>7/8</td>
<td>4</td>
<td>33</td>
<td>46</td>
<td>66</td>
<td>89</td>
</tr>
<tr>
<td>1</td>
<td>2-1/2</td>
<td>13</td>
<td>38</td>
<td>66</td>
<td>116</td>
</tr>
</tbody>
</table>

*Rated Capacities based on a D/d ratio of 25 times the component rope diameter. Rated Capacities based on pin diameter no longer than the nominal sling diameter.

D/d ratio is based on component of the multi-part wire rope sling.

Note: Bending radius of the sling body is 5:1 where D is the pin or load and d is the sling body. D/d of loops: 1:1 where D is the pin and d is the sling body diameter.

D/d Ratio is based on the finished diameter of the multi-part wire rope sling.
D/d Ratio - Alloy Chain Slings

According to the National Association Chain of Manufacturers (NACM) testing the diameter of curvature around which an alloy chain sling is bent affects its capacity. This is also known as the D/d ratio. The upper case D refers to the diameter of the object to which the sling hitch is applied. The lower case d represents the diameter of the alloy chain.

D/d ratio commonly affects the capacity of alloy chain slings in a basket hitch configuration. To determine the D/d ration, divide the diameter of the alloy chain sling into the diameter of the load. For example, when the diameter of the load is 4 times the diameter of the alloy chain sling the D/d ratio is 4:1. This is 80% efficiency of the sling's basket hitch capacity.

<table>
<thead>
<tr>
<th>D/d Ratio</th>
<th>Alloy Chain Sling Strength Efficiencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>6:1 or greater</td>
<td>100%</td>
</tr>
<tr>
<td>5:1</td>
<td>90%</td>
</tr>
<tr>
<td>4:1</td>
<td>80%</td>
</tr>
<tr>
<td>3:1</td>
<td>70%</td>
</tr>
<tr>
<td>2:1</td>
<td>60%</td>
</tr>
<tr>
<td>Less than 2:1</td>
<td>Not Recommended</td>
</tr>
</tbody>
</table>

Softeners can be used to improve the radius of contact when using an alloy chain sling around a 90° corner. The softener’s purpose is to protect the chain from gouging and bending around tight corners.
D/d Ratio - Polyester Roundslings

Roundsling strength is affected by the size and diameter of its connecting hardware. The Web Sling & Tie Down Association (WSTDA) directs the users of polyester roundslings to calculate the bearing stress the sling applies to the fitting to determine if the hardware is of the correct size and diameter to use the sling at its full rating. To determine bearing stress we must know two facts about the hardware we are using. The effective bearing surface and the bearing surface diameter.

Straight Bearing Surface

Shackles specifically designed for synthetic slings generally have a flat surface making the effective and actual widths identical.

Curved Bearing Surface

An anchor type shackle's effective inside width is normally 75% of the shackle's actual width.
D/d Ratio - Polyester Roundslings (Cont...)

The WSTDA recommends that the bearing stress on the fitting and sling to not exceed 7,000 pounds.

\[
\text{Sling Loading} \quad \frac{\text{Load Bearing Area}}{} = \text{BEARING STRESS}
\]

Example:

A #3 (RS90) roundsling with a vertical working load limit of 8,400 lbs connected to a 3/4" shackle.

The shackle has a 2" actual inside width with an 1-1/2" effective inside width and a stock diameter of 0.75 (3/4) inches.

The load of 7,500 lbs is applied to the sling. Bearing stress equals 6,667 lbs.

\[
\text{Effective Contact Width} = 0.75 \times 2" = 1.5"
\]

Load Bearing Area

\[
\text{Hardware Thickness} \times \text{Effective Contact Width} = \text{Load Bearing Area}
\]

\[
0.75 \times 1.5 = 1.125
\]

\[
\frac{\text{Sling Loading}}{\text{Load Bearing Area}} = \text{BEARING STRESS} \quad \text{(Not to exceed 7,000 lbs)}
\]

\[
\frac{7,500}{1.125 \text{ inches}} = 6,667 \text{ lbs}
\]
Sling Loading

It is important that slings and associated hardware remain within their rated capacities. The maximum weight a sling can lift is affected by the number of legs used, the sling's share of the load and the angles at which the slings are loaded. As the horizontal angle between a sling and the load is decreased, the sling's ability to lift is decreased.

1-leg carries 100% of the load.

2-legs: each will share 100% of the load.

3-legs: each leg will share 100% of the load.
4-Leg: Anywhere from two to four legs share the total weight of the load.

Worst case scenario: Two legs, from corner to corner, carry the complete load and the other two legs help balance the load.

This type of scenario can happen when the load is rigid, slings are not of equal lengths, all attachment points are not equal distance from the center of gravity or the slings are not attached correctly on the hoist hook. In most cases, all legs share the load but it may not be an equal share. While two legs are sharing 0% to 50% the other two share the remaining 50% to 0% of the load.
4-Leg Solutions

We can rig 4-leg hitches in ways that will assure better load distribution on the four legs. Below are some rigging methods that can be used to ensure loading is better distributed on a four leg hook up.

When four slings are used to lift a load with four individual slings or a 4-leg bridle is used, all lifting conditions must be ideal to assure all four legs are sharing the load.

Consider the following rigging applications when rigging with four legs:
Calculating Share of Load (SOL)

Symmetrical Loads: When lifting points are on the same plane, the load is symmetrical and lift points are equal distance from the Center of Gravity (CG), divide the weight by the number of legs to determine Share of Load (SOL).

\[
\text{Share of Load} = \frac{\text{Wt}}{\# \text{ of legs}} = \text{SOL}
\]

\[
10,000 \div 2 = 5,000 \text{ lbs}
\]

Uneven Loads:

SOL - A: \(D_2 \times \text{WT} \div \text{TD} = \text{SOL for A}\)

\[
\text{TD} = \text{Total Distance} \quad \text{TD} = 10' \\
D_1 = \text{Distance 1} \quad D_1 = 6' \\
D_2 = \text{Distance 2} \quad D_2 = 4' \\
\text{WT} = \text{Total Weight} \quad \text{WT} = 10,000 \text{ lbs}
\]

SOL - A

\[
4 \times 10,000 \div 10 = 4,000 \text{ lbs}
\]

SOL - B

\[
6 \times 10,000 \div 10 = 6,000 \text{ lbs}
\]
Multiple-leg bridle sling capacities are based on all legs lifting an equal share of the load. Double-leg bridles are based on each leg lifting 50% of the load. Three-leg bridles are based on each leg lifting 33-1/3% of the load, while four-leg bridles, except for alloy chain slings, are based on each leg lifting 25% of the load. Alloy chain sling three- and four-leg bridles are based on three-leg capacities.

Multiple-Sling Capacity Calculation

Rated load = 1) vertical rated capacity (VRC) of single-leg multiplied by the number of legs in the bridle; 2) multiplied by the sine (multiplier) of the horizontal angle.

Multipliers:

<table>
<thead>
<tr>
<th>Angle</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>70°</td>
<td>0.939</td>
</tr>
<tr>
<td>60°</td>
<td>0.866</td>
</tr>
<tr>
<td>50°</td>
<td>0.766</td>
</tr>
<tr>
<td>45°</td>
<td>0.707</td>
</tr>
<tr>
<td>40°</td>
<td>0.642</td>
</tr>
<tr>
<td>35°</td>
<td>0.573</td>
</tr>
<tr>
<td>30°</td>
<td>0.500</td>
</tr>
<tr>
<td>25°</td>
<td>0.422</td>
</tr>
</tbody>
</table>

EXAMPLE:

Number of slings: 2
Sling VRC each: 10,000 lbs
Sling horizontal angle: 60°
Multiplier: 0.866 the sine of 60°

10,000 × 2 × .866 = 17,320 lbs Max. load
Calculating Sling Loading

The loading of a sling is affected by the angles at which the sling is loaded. As the horizontal angle between a sling and the load is decreased, the loading of the sling is increased causing the sling's net payload to decrease.

A load of 2,000 lbs. shared by two slings, can result in higher forces in each individual sling leg than their 1,000 lb. share of the load as shown in the above diagram. However, the loading on each leg is doubled when loaded at 30°.

Load Angle Multipliers

Load Angle Multipliers are used in determining the load carried at an angle to the load. When the angle of loading is known, the sling tension can be calculated by using the Load Angle Multipliers shown in the table on this page. Simply determine the share of the load the sling is responsible for and then multiply its share of the load by the angle of loading multiplier.

<table>
<thead>
<tr>
<th>Angle of Loading</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°</td>
<td>1.000</td>
</tr>
<tr>
<td>85°</td>
<td>1.004</td>
</tr>
<tr>
<td>80°</td>
<td>1.015</td>
</tr>
<tr>
<td>75°</td>
<td>1.035</td>
</tr>
<tr>
<td>70°</td>
<td>1.064</td>
</tr>
<tr>
<td>65°</td>
<td>1.104</td>
</tr>
<tr>
<td>60°</td>
<td>1.155</td>
</tr>
<tr>
<td>55°</td>
<td>1.221</td>
</tr>
<tr>
<td>50°</td>
<td>1.305</td>
</tr>
<tr>
<td>45°</td>
<td>1.414</td>
</tr>
<tr>
<td>40°</td>
<td>1.555</td>
</tr>
<tr>
<td>35°</td>
<td>1.742</td>
</tr>
<tr>
<td>30°</td>
<td>2.000</td>
</tr>
<tr>
<td>25°</td>
<td>2.364</td>
</tr>
<tr>
<td>20°</td>
<td>2.924</td>
</tr>
<tr>
<td>15°</td>
<td>3.861</td>
</tr>
<tr>
<td>10°</td>
<td>5.750</td>
</tr>
<tr>
<td>5°</td>
<td>11.49</td>
</tr>
</tbody>
</table>
Calculating Sling Loading (known Angle of Loading)

1) Calculate the sling’s share of the load.
2) Multiply the share of the load by the angle of the corresponding angle multiplier.

EXAMPLE:

\[ \text{SOL} \times \text{LAM} = \text{SL} \]

\[ 1,000 \times 1.305 = 1,305 \text{ lbs} \]

\[
\begin{array}{|c|c|}
\hline
\text{Angle of Loading} & \text{Multiplier} \\
\hline
90^\circ & 1.000 \\
85^\circ & 1.004 \\
80^\circ & 1.015 \\
75^\circ & 1.035 \\
70^\circ & 1.064 \\
65^\circ & 1.104 \\
60^\circ & 1.155 \\
55^\circ & 1.221 \\
50^\circ & 1.305 \\
45^\circ & 1.414 \\
40^\circ & 1.555 \\
35^\circ & 1.742 \\
30^\circ & 2.000 \\
\hline
\end{array}
\]
Calculating Sling Loading (unknown Angle of Loading)

STEP 1: Determine the Share of Load (SOL). Share of Load is the percentage of the total load that the sling is lifting. (see page 25)

STEP 2: 
   a) Determine total sling length (L) including any hardware.
   b) Determine the vertical height (H) from the horizontal plane of the load, to the upper sling attachment point.
   c) Divide the sling-leg length (L) by the height (H). The result is the Load Angle Multiplier (LAM).

STEP 3: Multiply the Load Angle Multiplier (LAM) by the Share of Load (SOL). The sling is responsible for the total tension or loading on the sling leg.

\[ \text{SOL} \times \frac{L}{H} = \text{Sling Loading} \]

\[
\begin{align*}
\text{SOL} &= 2,500 \text{ lbs} \\
\frac{L}{H} &= \frac{12}{8} = 1.5 \text{ (LAM)} \\
2,500 \times \frac{12}{8} &= 3,750 \text{ lbs}
\end{align*}
\]

Sling Loading = 3,750 lbs
Calculating Sling Loading (offset Center of Gravity)

When calculating sling loading on loads with an offset center of gravity (CG) and different sling lengths the following process must be followed to determine the correct share of the load. (shown on page 25)

\[ \begin{align*}
L_1 & = 6.7' \\
L_2 & = 5' \\
H & = 3' \\
D_1 & = 6' \\
D_2 & = 4' \\
TD & = 10' \\
WT & = 10,000 \text{ lbs} \\
SOL & = \text{ Share of Load}
\end{align*} \]

**L_1** Leg:
1) \( D_2 \times WT \div TD = SOL \)  \( 4 \times 10,000 \div 10 = 4,000 \text{ lbs} \)
2) \( L_1 \div H = LAM \)  \( 6.7 \div 3 = 2.233 \)
3) \( LAM \times SOL = \text{ Sling Loading} \)  \( 2.233 \times 4,000 = 8,932 \text{ lbs} \)

**L_2** Leg:
1) \( D_1 \times WT \div TD = SOL \)  \( 6 \times 10,000 \div 10 = 6,000 \text{ lbs} \)
2) \( L_2 \div H = LAM \)  \( 5 \div 3 = 1.666 \)
3) \( LAM \times SOL = \text{ Sling Loading} \)  \( 1.666 \times 6,000 = 9,996 \text{ lbs} \)
Calculating Sling Loading (attached at different elevations)

When slings are attached to the load at different elevations, unexpected stresses are created. The following formulas will correctly calculate the loading on the slings.

\[
\text{Leg L}_1: \quad \frac{W \times D_2 \times L_1}{(D_2 \times H_1) + (D_1 \times H_2)} \\
\text{Leg L}_2: \quad \frac{W \times D_1 \times L_2}{(D_2 \times H_1) + (D_1 \times H_2)}
\]

\[
L_1 = 10' \\
L_2 = 18' \\
H_1 = 9.5' \\
H_2 = 15.6' \\
D_1 = 3' \\
D_2 = 9' \\
TD = 12' \\
WT = 10,000 \text{ lbs}
\]

\[
\begin{align*}
10,000 \times 9' \times 10' & = 900,000 \\
(9' \times 9.5') + (3' \times 15.6') & = 85.5 + 46.8 \\
& = 132.3 \\
\text{Leg L}_1: \quad 6,803 \text{ lbs loading}
\end{align*}
\]

\[
\begin{align*}
10,000 \times 3' \times 18' & = 540,000 \\
(9' \times 9.5') + (3' \times 15.6') & = 85.5 + 46.8 \\
& = 132.3 \\
\text{Leg L}_2: \quad 4,082 \text{ lbs loading}
\end{align*}
\]
Horizontal Load Calculations *(Based on Sling Tension)*

Sling angles that affect sling tension also create horizontal loading causing compression on the load. As the horizontal angle between a sling and the load is decreased, the horizontal force (compression) is increased. When the **Sling Tension (ST) is known**, multiply the sling tension by the ST Horizontal Force Multiplier (STHFM) to determine the horizontal force on the load. \( ST \times STHFM = HF \)

\[
\begin{align*}
ST &= \text{Sling Tension} \\
HF &= \text{Horizontal Force} \\
HSA &= \text{Horizontal Sling Angle} \\
STHFM &= \text{ST Horizontal Force Multiplier}
\end{align*}
\]

<table>
<thead>
<tr>
<th>Horizontal Sling Angle</th>
<th>STHFM Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°</td>
<td>0.000</td>
</tr>
<tr>
<td>85°</td>
<td>0.087</td>
</tr>
<tr>
<td>80°</td>
<td>0.174</td>
</tr>
<tr>
<td>75°</td>
<td>0.259</td>
</tr>
<tr>
<td>70°</td>
<td>0.342</td>
</tr>
<tr>
<td>65°</td>
<td>0.423</td>
</tr>
<tr>
<td>60°</td>
<td>0.500</td>
</tr>
<tr>
<td>55°</td>
<td>0.574</td>
</tr>
<tr>
<td>50°</td>
<td>0.643</td>
</tr>
<tr>
<td>45°</td>
<td>0.707</td>
</tr>
<tr>
<td>40°</td>
<td>0.766</td>
</tr>
<tr>
<td>35°</td>
<td>0.819</td>
</tr>
<tr>
<td>30°</td>
<td>0.866</td>
</tr>
<tr>
<td>25°</td>
<td>0.906</td>
</tr>
<tr>
<td>20°</td>
<td>0.940</td>
</tr>
<tr>
<td>15°</td>
<td>0.966</td>
</tr>
<tr>
<td>10°</td>
<td>0.985</td>
</tr>
<tr>
<td>5°</td>
<td>0.996</td>
</tr>
</tbody>
</table>

**Example:**

- \( ST = 20,000 \text{ lbs} \)
- \( HSA = 30° \)
- \( STHFM = 0.866 \)

\[
ST \times STHFM = HF
\]

\[
20,000 \times 0.866 = 17,320 \text{ lbs}
\]

**NOTE:** To determine total horizontal force on the load created by angular loading, calculation must be done from only one sling.
Horizontal Load Calculations \((Based \ on \ Share \ of \ Load)\)

Sling angles that affect sling tension also create horizontal loading causing compression on the load. As the horizontal angle between a sling and the load is decreased, the horizontal force (compression) is increased. When the \textbf{Share of Load (SOL) is known}, multiply the sling tension by the SOL Horizontal Force Multiplier (SOLHFM) to determine the horizontal force on the load. \(\text{SOL} \times \text{SOLHFM} = \text{HF}\)

\[\text{SOL} = 10,000 \text{ lbs} \]
\[\text{HSA} = 30^\circ \]
\[\text{SOLHFM} = 1.732\]

\[\text{SOL} \times \text{SOLHFM} = \text{HF}\]
\[10,000 \times 1.732 = 17,320 \text{ lbs}\]

\textbf{NOTE:} To determine total horizontal force on the load created by angular loading, calculation must be done from only one share of the load.

<table>
<thead>
<tr>
<th>Horizontal Sling Angle</th>
<th>SOLHFM Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°</td>
<td>0.000</td>
</tr>
<tr>
<td>85°</td>
<td>0.087</td>
</tr>
<tr>
<td>80°</td>
<td>0.177</td>
</tr>
<tr>
<td>75°</td>
<td>0.268</td>
</tr>
<tr>
<td>70°</td>
<td>0.364</td>
</tr>
<tr>
<td>65°</td>
<td>0.467</td>
</tr>
<tr>
<td>60°</td>
<td>0.578</td>
</tr>
<tr>
<td>55°</td>
<td>0.701</td>
</tr>
<tr>
<td>50°</td>
<td>0.839</td>
</tr>
<tr>
<td>45°</td>
<td>1.000</td>
</tr>
<tr>
<td>40°</td>
<td>1.191</td>
</tr>
<tr>
<td>35°</td>
<td>1.427</td>
</tr>
<tr>
<td>30°</td>
<td>1.732</td>
</tr>
<tr>
<td>25°</td>
<td>2.142</td>
</tr>
<tr>
<td>20°</td>
<td>2.749</td>
</tr>
<tr>
<td>15°</td>
<td>3.730</td>
</tr>
<tr>
<td>10°</td>
<td>5.664</td>
</tr>
<tr>
<td>5°</td>
<td>11.444</td>
</tr>
</tbody>
</table>
Calculating Sling Length/Headroom

The Pythagorean Theorem can be used to calculate usable sling length and available headroom. Knowing two sides of a right triangle makes it possible to calculate the third side.

- \( a \) = available headroom
- \( b \) = distance from attachment to CG
- \( c \) = usable sling length

\[
\begin{align*}
  a &= \sqrt{c^2 - b^2} \\
  b &= \sqrt{c^2 - a^2} \\
  c &= \sqrt{a^2 + b^2}
\end{align*}
\]

If distance to CG \( (b) \) is 3' and the sling leg \( (c) \) is 5' the available head room \( (a) \) is 4'.

\[
a = \sqrt{5^2 - 3^2} = \sqrt{25 - 9} = \sqrt{16} = 4'
\]

If distance to CG \( (b) \) is 6' and the available head room \( (a) \) is 8' usable sling leg \( (c) \) is 10'.

\[
c = \sqrt{8^2 + 6^2} = \sqrt{64 + 36} = \sqrt{100} = 10'
\]
Quick Checks

60° Angles

When the sling legs are the same length as the distance between attachment points the sling angle will be 60°. If sling legs are longer, the angle is greater than 60°. If sling legs are shorter, the angle is less than 60°. (Assuming CG is centered.)

To determine approximate sling length for 60°, 45° and 30° multiply the following multipliers by the distance between the sling attachment points.

- 60° - Distance x 1.0
- 45° - Distance x .75 (rounded: .707 exact)
- 30° - Distance x .60 (.577 exact)

If Distance = 10':

- 60° angle: 10 x 1.0 = 10' sling legs
- 45° angle: 10 x .75 = 7.5' sling legs
- 30° angle: 10 x .60 = 6' sling legs
Field Tension Check

Once slings are attached, lift the hook until the sling is snug to the angle formed during the lift then:

1. Measure up from the attachment point until you make a 10" mark on the sling leg.

2. Measure up from the attachment point along the sling leg to the 10" mark.

3. Divide 10" into the measured length (13"). The result will be the load angle multiplier (LAM). Multiply by Share of Load to get sling loading.

$$\frac{13}{10} = 1.3 \text{ (LAM)} \times \text{SOL} = \text{Sling loading}$$
Drifting Loads

The tension on two hoists and their associated rigging while drifting a load can increase the loading enough to severely overload the hoist and rigging. To determine how much tension will be put on the hoist use the following formula:

\[
\text{Tension} = \frac{(WT \times D \times L)}{(H \times TD)}
\]

**Hoist A:**

\[
\text{Tension} = \frac{(2000 \times 5 \times 12)}{(5 \times 16)} = \frac{120000}{80} = 1500 \text{ lbs}
\]

**Hoist B:**

\[
\text{Tension} = \frac{(2000 \times 11 \times 7)}{(5 \times 16)} = \frac{154000}{80} = 1925 \text{ lbs}
\]
Suitable characteristics for both application and the environment must be considered when selecting a rigging block. The included angle formed between the load lines must also be taken into consideration because of the negative effect this has on the block's capacity. The D/d ratio between the sheave pitch diameter and the wire rope diameter should be a minimum of 4:1.

The actual load on a block is usually greater than the weight of the load itself. The weight, number of parts of line and the angle of line pull, must be taken into consideration when determining block and anchorage point load.

<table>
<thead>
<tr>
<th>Angle</th>
<th>Multiplier</th>
<th>Angle</th>
<th>Multiplier</th>
<th>Angle</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°</td>
<td>2.00</td>
<td>60°</td>
<td>1.73</td>
<td>130°</td>
<td>.84</td>
</tr>
<tr>
<td>10°</td>
<td>1.99</td>
<td>70°</td>
<td>1.64</td>
<td>135°</td>
<td>.76</td>
</tr>
<tr>
<td>20°</td>
<td>1.97</td>
<td>80°</td>
<td>1.53</td>
<td>140°</td>
<td>.68</td>
</tr>
<tr>
<td>30°</td>
<td>1.93</td>
<td>90°</td>
<td>1.41</td>
<td>150°</td>
<td>.52</td>
</tr>
<tr>
<td>40°</td>
<td>1.87</td>
<td>100°</td>
<td>1.29</td>
<td>160°</td>
<td>.35</td>
</tr>
<tr>
<td>45°</td>
<td>1.84</td>
<td>110°</td>
<td>1.15</td>
<td>170°</td>
<td>.17</td>
</tr>
<tr>
<td>50°</td>
<td>1.81</td>
<td>120°</td>
<td>1.00</td>
<td>180°</td>
<td>.00</td>
</tr>
</tbody>
</table>
Block Loading

When multiple parts of line are added to a block, there is added mechanical advantage. This requires less line pull to make the lift. The number of lines is determined by the number of lines exiting the traveling block. (Note: examples below are approximate. Resistance due to sheave bearings will add loading to line pull.)

### A

- **Line pull load** A = \( \frac{2,000}{1} \)
  - \( = 2,000 \text{ lbs} \)

### B

- **Line pull load** B = \( \frac{2,000}{4} \)
  - \( = 500 \text{ lbs} \)

**Line pull = Load ÷ Parts of Line**

**Load on Block & Structure = Load Weight + Line Pull**

- **Line pull load** A = \( 2,000 + 2,000 \)
  - \( = 4,000 \text{ lbs} \)

- **Line pull load** B = \( 2,000 + 500 \)
  - \( = 2,500 \text{ lbs} \)
When determining block loading use the Block Loading Multipliers table. (on page 38)

**Line pull**

Weight ÷ Parts of line = Line Pull  
- 5,000 ÷ 2 = 2,500 lbs

**Block A**

Line pull x Multiplier of 0°  
- 2,500 x 2 = 5,000 lbs

**Block B**

Line pull x Multiplier of 40°  
- 2,500 + (2,500 x 1.87) = 7,175 lbs

**Block C**

Line pull x Multiplier of 120°  
- 2,500 x 1 = 2,500 lbs

**Winch**

Winch loading = Line pull  
- Winch loading = 2,500 lbs
Load Movement — Level/Incline Planes

Calculating Pulling Force

<table>
<thead>
<tr>
<th>Legend</th>
<th>Formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>H = Height, vertical distance</td>
<td>Level: ( CF \times W = F )</td>
</tr>
<tr>
<td>R = Run, horizontal distance</td>
<td>Uphill: ([CF \times W \times (R \div L)] + [(H \div R) \times W] = F)</td>
</tr>
<tr>
<td>L = Length, hypotenuse of H &amp; R</td>
<td>Downhill: ([CF \times W \times (R \div L)] - [(H \div R) \times W] = F)</td>
</tr>
<tr>
<td>F = Force required to move load</td>
<td></td>
</tr>
<tr>
<td>CF = Coefficient of friction</td>
<td></td>
</tr>
<tr>
<td>W = Weight of load</td>
<td></td>
</tr>
</tbody>
</table>

Coefficients of Friction

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast iron on steel</td>
<td>.25</td>
</tr>
<tr>
<td>Concrete on concrete</td>
<td>.65</td>
</tr>
<tr>
<td>Continuous lubricated surface</td>
<td>.15</td>
</tr>
<tr>
<td>Load on air</td>
<td>.002</td>
</tr>
<tr>
<td>Load on ice</td>
<td>.01</td>
</tr>
<tr>
<td>Load on wheels</td>
<td>.05</td>
</tr>
<tr>
<td>Metal on concrete</td>
<td>.60</td>
</tr>
<tr>
<td>Steel on steel</td>
<td>.10</td>
</tr>
<tr>
<td>Wood on concrete</td>
<td>.45</td>
</tr>
<tr>
<td>Wood on metal</td>
<td>.30</td>
</tr>
<tr>
<td>Wood on wood</td>
<td>.50</td>
</tr>
</tbody>
</table>

Legend values for following three diagrams.

\[ H = 2 \quad R = 10' \quad L = 10.2 \quad CF = .60 \quad W = 10,000 \text{ lbs} \]

Level

Metal on concrete

\[ CF \times W = F \]

\[ .60 \times 10,000 = 6,000 \text{ lbs} \]
Uphill

\[ [CF \times W \times (R \div L)] + [(H \div R) \times W] = F \]
\[ [.60 \times 10,000 \times (10 \div 10.2)] + [(2 \div 10) \times 10,000] = F \]
\[ [.60 \times 10,000 \times .98] + [.2 \times 10,000] = F \]
\[ 5,880 + 2,000 = 7,880 \text{ lbs} \]

Downhill

\[ [CF \times W \times (R \div L)] - [(H \div R) \times W] = F \]
\[ [.60 \times 10,000 \times (10 \div 10.2)] - [(2 \div 10) \times 10,000] = F \]
\[ [.60 \times 10,000 \times .98] - [.2 \times 10,000] = F \]
\[ 5,880 - 2,000 = 3,880 \text{ lbs} \]

NOTE: More force is needed to start load movement than to maintain its movement.

NOTE: A snub line (hold back) should be used to hold back loads during stopping and downhill movement.
Load Weight Calculation

The weight of a load is calculated by determining the area and/or volume of the load or pieces of the load. The weights of some loads can be calculated easily because of their uniformed shapes and density. The weights of other loads can be difficult to calculate because of the complexity of their shape and/or density.

The weights of fabricated steel such as angle iron, channel and I-beams can be broken down into separate pieces and calculated as individual shapes. These shapes are then added together to determine the weight of the whole object. Once the area or volume is calculated, multiply it by the weight of material to determine the weight of the load.

<table>
<thead>
<tr>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = Area</td>
</tr>
<tr>
<td>V = Volume</td>
</tr>
<tr>
<td>C = Circumference</td>
</tr>
<tr>
<td>L = Length</td>
</tr>
<tr>
<td>w = Width</td>
</tr>
</tbody>
</table>

Calculating Area

**Rectangle:** \( A = L \times w \)

\[ 8 \times 4 = 32 \text{ ft}^2 \]

\[ L = 8' \quad \bullet \quad w = 4' \]
Calculating Area (cont...)

**Circle:** \( A = \pi r^2 \)

\[ 3.14 \times 5^2 = 78.5 \text{ ft}^2 \]

\[ r = 5' \]

OR

**Circle:** \( A = d^2 \times .785 \)

\[ 100' \times .78 = 78.5 \text{ ft}^2 \]

\[ d = 10' \]

**Sphere:** \( A = 4\pi r^2 \)

\[ 4 \times 3.14 \times 5^2 = 314 \text{ ft}^2 \]

\[ r = 5' \]

OR

**Sphere:** \( A = \pi d^2 \)

\[ 3.14 \times 10^2 = 314 \text{ ft}^2 \]

\[ d = 10' \]

**Triangle:** \( A = \frac{bh}{2} \)

\[ \frac{5 \times 6}{2} = \frac{30}{2} = 15 \text{ ft}^2 \]

\[ b = 5' \bullet h = 6' \]
Calculating Area (cont...)

Parallelogram: \( A = bh \)
\[
5 \times 3 = 15 \text{ ft}^2
\]

Trapezoid: \( A = \frac{(a + b)h}{2} \)
\[
\frac{(3 + 5)8}{2} = \frac{8 \times 8}{2} = \frac{64}{2} = 32 \text{ ft}^2
\]

Pipe: \( A = \pi d \times L \)
\[
3.14 \times 2 \times 8 = 50.24 \text{ ft}^2
\]
Calculating Volume

**Cube:** \( V = L \times w \times h \)

\[ 8 \times 4 \times 5 = 160 \text{ ft}^3 \]

**Cylinder:** \( V = 0.785 \times d^2 \times L \)

\[ 0.785 \times 5' \times 5' \times 10' = 196.25 \text{ ft}^3 \]

**Pipe:** 

Pipe: \( V = t \times (d-t) \times \pi \times L \)

\[ 0.5 \times (5 - 0.5) \times 3.14 \times 10' \]

\[ 0.5 \times 4.5' \times 3.14 \times 10' = 70.65 \text{ ft}^3 \]

**OR**

Pipe: \( V = V_{o.d.} - V_{i.d.} \)

\[ 196.25 - 125.60 = 70.65 \text{ ft}^3 \]
Calculating Volume (Cont...)

**Cone:** \( V = \text{Area of base} \times h \div 3 \)

\[
78.5 \times 15 \div 3 = 392.5 \text{ ft}^3
\]

\[
d = 10' \quad h = 15'
\]

**Frustum of Cone:**

\[
V = \text{V of cone } h^2 - \text{V of cone } h^1
\]

\[
392.5 \text{ ft}^3 - 11.77 \text{ ft}^3 = 380.73 \text{ ft}^3
\]

\[
d = 10' \quad d_1 = 3' \quad h_1 = 5' \quad h_2 = 15'
\]

**Pyramid:** \( V = \text{Area of base} \times h \div 3 \)

\[
15 \times 10 \div 3 = 50 \text{ ft}^3
\]

\[
h = 10' \quad \text{Area of base} = 15 \text{ ft}^2
\]
When calculating weights in the field, the rigger often does not have the luxury of a calculator or the availability of formulas. Even though this may be the case, load weight must still be determined. Estimating load weight is not as difficult as it may seem. The rigger should break the load into three simple shapes whose formulas are easy to remember – such as a circle, rectangle and cube. By enlarging irregular shaped portions of the load into simple shapes such as blocks and cylinders and rounding equations changing $\pi$ from (3.14 to 3.2) will ensure that the estimated weight is higher than the actual weight. This process enhances ones ability to estimate the load weight while ensuring that the load is not underestimated.

Example:

Block weight 1 + Cylinder weight + Block weight 2 = ESTIMATED WEIGHT
Displacement

When calculating the weight of a lift in the water the object's "displacement" must be taken into account. Displacement is the load's weight multiplied by the density of the liquid it is submersed in. The Displacement weight is subtracted from the weight of the load to determine its weight while submerged in the liquid. Likewise when you remove a load from a liquid, displacement weight is added to the load.

\[
\text{LW} = \text{Load Wt.} \quad \bullet \quad \text{DV} = \text{Displacement Volume} \quad \bullet \quad \text{DW} = \text{Displacement Wt} \quad \bullet \quad \text{SW} = \text{Submerged Wt.}
\]

Concrete Mooring Block

\[
\text{LW} = 5,400 \text{ lbs} \quad \bullet \quad \text{DV} = 36 \quad \bullet \quad \text{DW} = 2,268 \text{ lbs} \quad \bullet \quad \text{SW} = \text{Submerged Wt.}
\]

\[
\text{LW} - (\text{DV} \times \text{DW}) = \text{SW} \\
5,400 - (36 \times 65) = \text{SW} \\
5,400 - 2,340 = 3,060 \text{ lbs}
\]

Steel Pipe

\[
\text{LW} = \text{Load Wt.} \quad \bullet \quad \text{DV} = 7.36 \quad \bullet \quad \text{DW} = 478.4 \text{ lbs} \quad \bullet \quad \text{SW} = 3,606 \text{ lbs}
\]

\[
\text{SW} + (\text{DV} \times \text{DW}) = \text{LW} \\
3,606.4 + (7.36 \times 65) = \text{LW} \\
3,606.4 + 478.4 = 4,084.8 \text{ lbs}
\]
## Weights of Material

### Weight: Pounds per Square Foot

<table>
<thead>
<tr>
<th>Plate Size (inches)</th>
<th>Steel</th>
<th>Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>5</td>
<td>1.75</td>
</tr>
<tr>
<td>1/4</td>
<td>10</td>
<td>3.50</td>
</tr>
<tr>
<td>1/2</td>
<td>20</td>
<td>7.00</td>
</tr>
<tr>
<td>3/4</td>
<td>30</td>
<td>10.50</td>
</tr>
<tr>
<td>1</td>
<td>40</td>
<td>14.40</td>
</tr>
</tbody>
</table>

### Corrugated Sheet Steel

<table>
<thead>
<tr>
<th>Pounds per Square Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Gauge</td>
</tr>
<tr>
<td>14 Gauge</td>
</tr>
<tr>
<td>16 Gauge</td>
</tr>
</tbody>
</table>

### Weight: Pounds per Cubic Foot

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight</th>
<th>Material</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>49</td>
<td>Hydraulic fluid</td>
<td>54</td>
</tr>
<tr>
<td>Aluminum, solid</td>
<td>165</td>
<td>Ice</td>
<td>58</td>
</tr>
<tr>
<td>Asbestos, solid</td>
<td>153</td>
<td>Iron, cast</td>
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<tr>
<td>Asphalt, crushed</td>
<td>45</td>
<td>Iron, wrought</td>
<td>485</td>
</tr>
<tr>
<td>Brass, cast-rolled</td>
<td>534</td>
<td>Kerosene</td>
<td>50</td>
</tr>
<tr>
<td>Brick, common</td>
<td>120</td>
<td>Lead, cast-rolled</td>
<td>710</td>
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<tr>
<td>Bronze</td>
<td>509</td>
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<td>97</td>
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<tr>
<td>Cement, Portland-loose</td>
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<td>Lumber, fir</td>
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<td>Charcoal</td>
<td>13</td>
<td>Lumber, oak</td>
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<tr>
<td>Clay, compacted</td>
<td>109</td>
<td>Lumber, railroad ties</td>
<td>50</td>
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<tr>
<td>Clay, wet excavated</td>
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<td>Concrete, reinforced</td>
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<td>Motor Oil</td>
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<tr>
<td>Copper, cast-rolled</td>
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<td>Mud, packed</td>
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<tr>
<td>Crushed rock</td>
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<td>Plywood</td>
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<td>52</td>
<td>Rubber</td>
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<td>Earth, dry (loose)</td>
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<td>Sand, loose</td>
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<tr>
<td>Earth, dry (packed)</td>
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<td>Steel</td>
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<td>Earth, wet</td>
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<td>Tar</td>
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<tr>
<td>Glass</td>
<td>161</td>
<td>Water, pure</td>
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</tr>
<tr>
<td>Granite, solid</td>
<td>168</td>
<td>Water, sea</td>
<td>65</td>
</tr>
</tbody>
</table>
### Area

- 144 sq. in. = 1 sq. ft.
- 1,296 sq. in. = 1 sq. yd.
- 9 sq. ft. = 1 sq. yd

### Volume

- 1,728 cu. in. = 1 cu. ft.
- 9 cu. ft. = 1 cu. yd.
- 1 gal. = ?? cu. ft.

### Liquid

- 16 fl. oz. = 1 pint
- 2 fl. pt. = 1 qt.
- 4 fl. qt. = 1 gal.
- 1 gal. = 0.264 Liters
- 1 Liter = 3.785 gal.
- 7.48 gal. in 1 cu. ft.

### Weight

- 1 lb = .454 klg.
- 1 klg = 2.2 lbs.

### Conversion

Convert fractions to decimals by dividing bottom # into top #

**Example:** \( \frac{3}{4}^\text{"} = 3 \div 4 = .75 \)

---

### NOTES

To find decimal equivalent of inches divide the # of inches by 12

**Example:** \( 3^\text{"} \div 12 = .25 \)

Unknown wire rope sling strength can be estimated by squaring rope diameter and multiply x 8 to find estimated strength.
Sling Inspection

Wire Rope Slings (ASME B30.9-2)

Special Considerations

1) Rotation-resistant wire rope shall not be used to fabricate slings.
2) Wire rope clips shall not be used to fabricate slings except where the application prevents the use of prefabricated slings or where the specific application is designed by a qualified person.
3) Malleable clips or knots are not to be used when making wire rope slings.
4) Slings made with six strand and cable-laid wire rope shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves or end fittings, unless approved by a qualified person.
5) Braided slings shall have a minimum clear length of rope 40 times the rope diameter between splices, sleeves or end fittings, unless approved by a qualified person.
6) Grommets and endless slings shall have a minimum circumferential length of 96 times its body diameter, unless approved by a qualified person.

Proof Testing

1) Required proof tests:
   • New swaged & poured sockets. (200% VRC)
   • New turnback eyes & mechanical grommets. (200% VRC)
   • Slings with used or welded fittings. (200% VRC)
Identification

Each wire rope sling shall be marked to show:

1) manufacturer name or trademark
2) rated load for at least one hitch type and the angle it is based on
3) diameter or size
4) number of legs if more than one

Inspection

Wire rope slings shall be inspected before each day's use. At least once every 12 months a documented inspection shall be completed by a designated person. The sling shall be removed from service if one or more of the following conditions are present:

1) missing or illegible sling identification
2) broken wires
   - strand-laid and single-part slings — 10 randomly broken wires in one rope lay, or 5 broken wires in one strand in one rope lay, and for cable-laid slings — 20 broken wires per lay
   - six part braided slings — 20 broken wires per braid
   - for eight or more-part slings — 40 broken wires per braid
3) severe localized abrasion or scraping
4) kinking, crushing, birdcaging or other damage resulting in damage to the rope structure
5) evidence of heat damage
6) end attachments that are cracked, deformed or worn to the extent that the strength of the sling is substantially affected
7) severe corrosion of the rope, end attachments or fittings
8) other conditions, including visible damage that cause doubt as to the continued use of the sling
Special Considerations

1) Fittings on synthetic web slings shall be equal to or greater than the web sling to which they are attached.
2) Fitting surfaces shall be cleanly finished and sharp edges removed.
3) Stitching shall be the only method for fabricating web slings.

Proof Testing

1) Required proof tests:
   - New synthetic web slings incorporating previously used or welded fittings (200% VRC — Vertical Rated Capacity)
   - All repaired slings (200% VRC)

Identification

Each synthetic web sling shall be marked to show:

1) manufacturer's name or trademark
2) manufacturer's code or stock number
3) rated load for at least one hitch type and the angle it is based on
4) type of synthetic web material
5) number of legs if more than one
Synthetic Web Sling Types

Type I (TC)
Sling is made with a triangle fitting on one end and a slotted triangle choker fitting on the other end. It can be used in a vertical, choke or basket hitch.

Type II (TT)
Sling is made with a triangle fitting on both ends. It can be used in a vertical or basket hitch.

Type III (EE)
Sling is made with a flat loop eye on each end with loop eye opening on the same plane as sling body. This sling is often called a flat eye and eye sling. It can be used in a vertical, choke or basket hitch.

Type IV (EE)
Sling is made with a twisted loop eye on each end with loop eye opening at a right angle to the sling body. This sling is often called a twisted eye and eye sling. It can be used in a vertical, choke or basket hitch.
Type V (EN)
This sling is an endless sling sometimes referred to as a grommet. It is a continuous loop formed by joining the ends of the webbing together. It can be used in a vertical, choke or basket hitch.

Type VI (RE)
This sling is a returned-eye (reversed-eye) sling. The sling is made by sewing the body of an endless sling together with wear protection on one or both sides of the sling body to form loop eyes at each end at a right angle to the body. It can be used in a vertical, choke or basket hitch.

Manufacturer Code

**EE2-903**

- **Sling type**
- **Number of plies**
- **Web width**
- **Web class**
Inspection

Synthetic web slings shall be inspected before each day’s use. At least once every 12 months a documented inspection shall be completed by a designated person. The sling shall be removed from service if one or more of the following conditions are present:

1) missing or illegible sling identification
2) acid or caustic burns
3) melting or charring on any part of the sling
4) holes, tears, cuts, or snags
5) excessive abrasive wear
6) knots in any part of the sling
7) discoloration and brittle or stiff areas on any part of the sling, which may mean chemical or ultraviolet (UV)/sunlight damage,
8) fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken (hooks ASME B30.10 — links B30.26)
9) other conditions, including visible damage, that cause doubt as to the continued use of the sling

GENERAL GUIDE ONLY

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>Acids</th>
<th>Aldehydes</th>
<th>Alkalies</th>
<th>Strong Alkalies</th>
<th>Bleaching Agents</th>
<th>Dry Cleaning Solvents</th>
<th>Halogenated Hydrocarbons</th>
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<td>OK</td>
</tr>
<tr>
<td>Polyester</td>
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<td>NO</td>
<td>OK</td>
<td>**</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

*Disintegrated by concentrated sulfuric acid.

**Degraded by strong alkalies at elevated temperatures.
Synthetic Roundslings (ASME B30.9-6)

Synthetic roundslings are single- or multiple-path design usually made from polyester or high performance core fiber with single or double protective covers encasing the core fiber. Follow the manufacturer's instructions when using slings with high performance fiber.

Special Considerations

1) Fittings shall be manufactured to ensure that the rated load shall be at least the same as the synthetic roundsling.

2) Fittings shall have sufficient strength to sustain twice the rated load of the sling without visible permanent deformation.

2) Fitting surfaces shall be cleanly finished and sharp edges removed.

Proof Testing

1) Required proof tests:
   • New synthetic roundslings incorporating previously used or welded fittings. (200% VRC)
   • All repaired slings. (200% VRC)
Identification
Each synthetic roundsling shall be marked to show:
1) manufacturer's name or trademark
2) manufacturer's code or stock number
3) rated load for at least one hitch type and the angle it is based on
4) core material
5) cover material, if different from core material
6) number of legs if more than one

Inspection
Synthetic roundslings shall be inspected before each day’s use. At least once every 12 months a documented inspection shall be completed by a designated person. The sling shall be removed from service if one or more of the following conditions are present:
1) missing or illegible sling identification
2) acid or caustic burns
3) evidence of heat damage
4) holes, tears, cuts, abrasive wear or snags that expose the load fibers
5) broken or damaged load fiber
6) weld splatter that exposes load fiber
7) roundslings tied in knots
8) discoloration and brittle or stiff areas on any part of the sling which may mean chemical or ultraviolet (UV)/sunlight damage

9) fittings that are pitted, corroded, cracked, bent, twisted, gouged or broken

10) other conditions, including visible damage, that cause doubt as to the continued use of the sling

11) Follow manufacturer's instruction when roundslings are equipped with inspection aids such as fiber optics, Tell-Tails™ and Check-Fast®. (For more information on Slingmax® inspection systems go to www.slingmax.com)
Twin-Path® Sling Usage

These instructions are specific for Twin-Path® High Performance Slings with K-Spec® Fiber which is manufactured, tested and repaired exclusively by authorized Slingmax® Dealers. For roundslings other than Slingmax®, contact the manufacturer for usage instructions.

1. Do not put folded and wrinkled sling covers on bearing points.
2. Smooth folds and wrinkles from the covers with your hands.
3. Do NOT fold one path over the other path to fit sling into tight fittings.
4. Squeeze both paths together to fit sling into tight hooks and fittings.

When rigging a basket hitch, do NOT pull slack out of the hitch with the crane.

When rigging a vertical hitch with a long sling don't pull the slack side out with the crane.

Adjust slack out by hand, before lifting with the crane.

Equalize the slack side by hand.
When placing multiple Twin-Path® slings on hardware, place the slings directly on top of each other or side by side.

Do NOT allow the sling to roll over itself and twist at the choker hitch.

Sling paths should be smooth in the choker hitch without any twisting.

Do NOT place the identification tag on the bearing point.

Identification should be placed 18”-24” away from the bearing point and facing away from the load.

When connecting two slings with a shackle, DO NOT place a sling over the pin without protection.

When connecting two slings with a shackle, use sling protection on the pin to protect the sling from cutting.
Alloy Steel Chain Slings (ASME B30.9-1)

Special Considerations

1) Only alloy chain such as Grade 80, Grade 100 or Grade 120 shall be used to fabricate alloy chain slings.

2) Mechanical coupling links shall not be used within the body of an alloy chain sling leg to connect two pieces.

3) When components of the sling have a lower rated capacity than the alloy chain to which it is attached, the sling rated capacity shall reflect the capacity of the lowest rating of its components.

Proof Testing

1) Required proof tests:
   • New alloy chain and components of an alloy chain sling, either individually or as an assembly, shall be proof tested. (200% VRC)
   • All repaired chain or components of a chain sling shall be proof tested. (200% VRC)

Identification

Each alloy chain sling shall be marked to show:

1) manufacturer's name or trademark
2) grade and unique identification (e.g., serial number)
3) nominal chain size
4) rated load for at least one hitch type and the angle it is based on
5) reach (length of sling measured from bearing to bearing point)
6) number of legs (branches)

Inspection

Alloy steel chain slings shall be inspected before each day's use. At least once every 12 months a documented inspection shall be completed by a designated person. The sling shall be removed from service if one or more of the following conditions are present:

1) missing or illegible sling identification
2) cracks or breaks
3) excessive wear, nicks or gouges
4) stretched chain links or components
5) bent, twisted, or deformed chain links or components
6) evidence of heat damage
7) excessive pitting or corrosion
8) lack of ability of chain or components to hinge freely
9) weld splatter
10) fittings that are pitted, corroded, cracked, bent, twisted, gouged or broken
11) other conditions, including visible damage, that cause doubt as to the continued use of the sling
Metal Mesh Slings (ASME B30.9-3)

Special Considerations

1) Manufacturers of non-standard metal mesh slings shall produce specific data as it relates to the material used.
2) Slings used in pairs should be attached to a spreader beam.

Proof Testing

1) Prior to initial use, all new and repaired metal mesh slings shall be proof tested by the sling manufacturer or qualified person. (200% VRC)
2) All repaired metal mesh slings shall be proof tested. (200% VRC)

Identification

Each metal mesh sling shall be marked by the sling manufacturer to show:

1) manufacturer's name or trademark
2) rated loads for the type of hitch(s) used and the angle upon which it is based
3) width and gauge
4) unique identification (e.g. serial number)
Inspection

Metal mesh slings shall be inspected before each day's use. At least once every 12 months a documented inspection shall be completed by a designated person. The sling shall be removed from service if one or more of the following conditions are present:

1) missing or illegible sling identification
2) broken weld or a broken brazed joint along the sling edge
3) broken wire in any part of the mesh
4) reduction in wire diameter of 25% due to abrasion or 15% due to corrosion
5) lack of flexibility due to distortion of the mesh
6) distortion of the choker fitting so the depth of the slot is increased by more than 10%
7) distortion of either end fitting so the width of the eye opening is decreased by more than 10%
8) a 15% reduction of the original cross-sectional area of any point around the hook opening of the end fitting
9) visible distortion of either end fitting out of its plane
10) cracked end fitting
11) slings in which the spirals are locked or without free articulation shall not be used
12) fittings that are pitted, corroded, cracked, bent, twisted, gouged or broken
13) other conditions, including visible damage, that cause doubt as to the continued use of the sling
Measuring Bridle Sling Length

Not all bridle sling lengths are measured the same. Wire rope, synthetic web and synthetic roundslings are measured from the sling's bearing point located on the lower part of the master link to the bearing point of the sling or hardware attached on its opposite end. Alloy chain sling length is measured from bearing point to bearing point, this measurement is known as the Reach. The Reach is measured from the upper bearing point of master link to the bearing point of the sling or hardware attached on its opposite end. See the following examples:
Multiple Lift Slings

Multi-lift rigging (also known as Christmas tree slings) is a lifting assembly that facilitates the attachment of up to five independent loads used in steel erection.

1) A multi-lift sling assembly can have a maximum of five lifting members.

2) Components of a multiple lift assembly shall be specifically designed and assembled with a maximum capacity for the total assembly and for each individual attachment point.

3) The capacity of all components shall be based on a 5:1 design factor on all components.

4) Only beams and similar structural members are lifted.

5) Rigged members shall be rigged at their center of gravity and maintained reasonably level.

6) Members are rigged from the top down.

7) Members are rigged at least 7 feet apart.

8) Members on the multi-lift sling shall be set from the bottom up.

For complete requirements for multi-lift rigging see OSHA 29 CFR 1926.753
Sling Capacities

Slings are made from various types of materials and in various configurations. Rated capacities are based on a variety of factors such as D/d ratio, end fitting efficiencies, material construction, material grades, design factors, hitch types and fabricating technique. The following sling capacities are for planning purposes only. The rated capacities on the sling's identification should always be followed before the ratings of capacity charts and rigging handbooks. If the sling identification is missing contact the manufacturer or a qualified entity to apply proper sling identifications and capacities as required by ASME and the manufacturer.

⚠️ WARNING — Steel Slings

Follow OSHA, ASME B30.9 and manufacturer's guidelines. Slings can fail if damaged, misused or overloaded. Inspect slings before use. Use only if trained. Do not exceed sling's rated capacity. Protect sling from contact with edges. DEATH or INJURY can occur from improper use or maintenance of slings.

⚠️ WARNING — Synthetic Slings

Follow OSHA, ASME B30.9 and manufacturer's guidelines. Slings can fail if damaged, misused or overloaded. Inspect slings before use. Use only if trained. Do not exceed sling's rated capacity. Protect sling from being cut by load edges, corners, protrusions and abrasive surfaces. Avoid exposure to acid, alkali and temperatures over *180°F. DEATH or INJURY can occur from improper use or maintenance of slings.

*Temperature ratings for synthetic slings, depending on the manufacturer or standard, are rated from 180°F to 194°F. Always follow manufacturers requirements.
# Wire Rope Sling Capacities

## Hand Tucked Splice (XIP)

<table>
<thead>
<tr>
<th>Size in Inches</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>2-Leg &amp; Basket Hitch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60°</td>
</tr>
<tr>
<td>1/4</td>
<td>0.54</td>
<td>0.42</td>
<td>1.1</td>
<td>0.94</td>
</tr>
<tr>
<td>3/8</td>
<td>1.2</td>
<td>0.94</td>
<td>2.4</td>
<td>2.0</td>
</tr>
<tr>
<td>1/2</td>
<td>2.0</td>
<td>1.6</td>
<td>4.0</td>
<td>3.5</td>
</tr>
<tr>
<td>5/8</td>
<td>3.1</td>
<td>2.6</td>
<td>6.2</td>
<td>5.3</td>
</tr>
<tr>
<td>3/4</td>
<td>4.3</td>
<td>3.7</td>
<td>8.6</td>
<td>7.4</td>
</tr>
<tr>
<td>7/8</td>
<td>5.7</td>
<td>5.0</td>
<td>11.0</td>
<td>9.8</td>
</tr>
<tr>
<td>1</td>
<td>7.4</td>
<td>6.4</td>
<td>15.0</td>
<td>13.0</td>
</tr>
<tr>
<td>1-1/8</td>
<td>9.3</td>
<td>8.1</td>
<td>19.0</td>
<td>16.0</td>
</tr>
<tr>
<td>*1-1/4</td>
<td>11.0</td>
<td>9.9</td>
<td>23.0</td>
<td>20.0</td>
</tr>
<tr>
<td>*1-3/8</td>
<td>14.0</td>
<td>12.0</td>
<td>27.0</td>
<td>24.0</td>
</tr>
<tr>
<td>*1-1/2</td>
<td>16.0</td>
<td>14.0</td>
<td>32.0</td>
<td>28.0</td>
</tr>
<tr>
<td>*1-5/8</td>
<td>19.0</td>
<td>16.0</td>
<td>38.0</td>
<td>33.0</td>
</tr>
<tr>
<td>*1-3/4</td>
<td>22.0</td>
<td>19.0</td>
<td>44.0</td>
<td>38.0</td>
</tr>
<tr>
<td>*2</td>
<td>28.0</td>
<td>25.0</td>
<td>56.0</td>
<td>49.0</td>
</tr>
<tr>
<td>*2-1/8</td>
<td>32.0</td>
<td>28.0</td>
<td>63.0</td>
<td>55.0</td>
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<tr>
<td>*2-1/4</td>
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<td>31.0</td>
<td>70.0</td>
<td>61.0</td>
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<td>68.0</td>
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<tr>
<td>*2-1/2</td>
<td>43.0</td>
<td>38.0</td>
<td>86.0</td>
<td>74.0</td>
</tr>
</tbody>
</table>

Wire rope: 6 x 19 EIP FC / *6 x 36 XIP FC  **Basket rated capacity based on a diameter of curvature of 15 times the individual rope diameter of points of sling contact with load.
## Wire Rope Sling Capacities
### Mechanical Splice (EIP)

**Wire rope:** 6 x 19 EIP / *6 x 36 EIP IWRC  **Basket rated capacities based on a diameter of curvature of 25 times the individual rope diameter of points of sling contact with load.**

<table>
<thead>
<tr>
<th>Size in Inches</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>2-Leg &amp; Basket Hitch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60°</td>
</tr>
<tr>
<td>1/2</td>
<td>.65</td>
<td>.48</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>3/8</td>
<td>1.4</td>
<td>1.1</td>
<td>2.9</td>
<td>2.5</td>
</tr>
<tr>
<td>1/2</td>
<td>2.5</td>
<td>1.9</td>
<td>5.1</td>
<td>4.4</td>
</tr>
<tr>
<td>5/8</td>
<td>3.9</td>
<td>2.9</td>
<td>7.8</td>
<td>6.8</td>
</tr>
<tr>
<td>3/4</td>
<td>5.6</td>
<td>4.1</td>
<td>11.0</td>
<td>9.7</td>
</tr>
<tr>
<td>7/8</td>
<td>7.6</td>
<td>5.6</td>
<td>15.0</td>
<td>13.0</td>
</tr>
<tr>
<td>1</td>
<td>9.8</td>
<td>7.2</td>
<td>20.0</td>
<td>17.0</td>
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<tr>
<td>1-1/8</td>
<td>12.0</td>
<td>9.1</td>
<td>24.0</td>
<td>21.0</td>
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<tr>
<td>*1-1/4</td>
<td>15.0</td>
<td>11.0</td>
<td>30.0</td>
<td>26.0</td>
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<tr>
<td>*1-3/8</td>
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<td>13.0</td>
<td>36.0</td>
<td>31.0</td>
</tr>
<tr>
<td>*1-1/2</td>
<td>21.0</td>
<td>16.0</td>
<td>42.0</td>
<td>37.0</td>
</tr>
<tr>
<td>*1-5/8</td>
<td>24.0</td>
<td>18.0</td>
<td>49.0</td>
<td>42.0</td>
</tr>
<tr>
<td>*1-3/4</td>
<td>28.0</td>
<td>21.0</td>
<td>57.0</td>
<td>49.0</td>
</tr>
<tr>
<td>*2</td>
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# Wire Rope Sling Capacities**
## Mechanical Splice (IPS)

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*Wire rope: 6 x 19 IPS / *6 x 36 IPS IWRC  **Basket rated capacities based on a diameter of curvature of 25 times the individual rope diameter of points of sling contact with load.
### Wire Rope Sling Capacities**

3 - Part Tri-Flex® Sling (Slingmax®)

6X19 / 6X36 • EIP • IWRC • Design Factor = 5:1 • Rated Capacity in Tons

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<tr>
<th>Finished Diameter (inches)</th>
<th>Rope Diameter (inches)</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>Weight Per Ft Lbs</th>
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</table>

Wire rope component part: 6 x 19 EIP / *6 x 36 EIP IWRC **Basket rated capacities based on a D/d ratio of 5 times the wire ropes finished diameter. Rated capacity based on a pin no larger than natural eye width and no smaller than 1-1/2 times the finished diameter.
### Wire Rope Sling Capacities**

**6 - Part Flat Braided Sling**

6X19 / 6X36 • EIP • IWRC • Design Factor = 5:1 • Rated Capacity in Tons

<table>
<thead>
<tr>
<th>Rope Diameter (inches)</th>
<th>Width of Body (inches)</th>
<th>Thickness of Body (inches)</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
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<td>7/8</td>
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<td>1-11/16</td>
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Wire rope component part: 6 x 19 EIP / *6 x 36 EIP IWRC  **Basket rated capacities based on a D/d ratio of 25 times the component rope diameter. Rated capacity based on a pin no larger than natural eye width and no smaller than nominal sling diameter.
## Wire Rope Sling Capacities**
### 8 - Part Round Braided Sling

6X19 / 6X36 • EPS • IWRC • Design Factor = 5:1 • Rated Capacity in Tons

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<th>Rope Diameter (inches)</th>
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<td>3.3</td>
<td>7.6</td>
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<td>5/16</td>
<td>5.9</td>
<td>5.2</td>
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Wire rope component part: 6 x 19 EIP / *6 x 36 EIP IWRC • Basket rated capacities based on a D/d ratio of 25 times the component rope diameter. Rated capacity based on a pin no larger than natural eye width and no smaller than nominal sling diameter.
## Wire Rope Sling Capacities**
### 9 - Part Laid Sling with Parallel Eyes (Slingmax®)

**Gator-Max™ & Gator-Laid® Slings**

<table>
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<th>Finished Diameter (inches)</th>
<th>Rope Diameter (inches)</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
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</table>

**Wire rope:** 6 x 19 EIP / 6 x 36 EIP IWRC  **Rated capacities based on a diameter of curvature of 5 times the finished diameter of points of sling contact with load.**
# Wire Rope Sling Capacities**

9 - Part Laid Sling with Standard Eyes (Slingmax®)

**Gator-Flex® & T&D Ultra-Flex Slings**

6X19 / 6X36 • EIP • IWRC • Design Factor = 5:1 • Rated Capacity in Tons

<table>
<thead>
<tr>
<th>Finished Diameter (inches)</th>
<th>Rope Diameter (inches)</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
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<tbody>
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</table>

Wire rope: 6 x 19 EIP / *6 x 36 EIP IWRC **Rated capacities based on a diameter of curvature of 5 times the finished diameter of points of sling contact with load.
### Wire Rope Sling Capacities**

*9 - Part Laid Grommet Sling (Slingmax®)*

**Gator-Flex® Grommet Slings**

6X19 / 6X36 • EIP • IWRC • Design Factor = 5:1 • Rated Capacity in Tons

<table>
<thead>
<tr>
<th>Finished Diameter (inches)</th>
<th>Rope Diameter (inches)</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>Weight per Foot</th>
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<td>3/8</td>
<td>22</td>
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<td>44</td>
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<tr>
<td>1-3/4</td>
<td>7/16</td>
<td>29</td>
<td>21</td>
<td>58</td>
<td>6</td>
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<tr>
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<td>1/2</td>
<td>38</td>
<td>27</td>
<td>76</td>
<td>8</td>
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<td>9/16</td>
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<td>34</td>
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<td>5/8</td>
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<td>81</td>
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*Wire rope: 6 x 19 EIP / *6 x 36 EIP IWRC  **Rated capacities based on a diameter of curvature of 5 times the finished diameter at points of sling contacted with load.*
Strand-Laid & Cable-Laid Grommets

EIP • IWRC • Design Factor = 5:1 • Rated Capacity in Tons

<table>
<thead>
<tr>
<th>Size in Inches</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>2-Leg &amp; Basket Hitch</th>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>6.4</td>
<td>18.0</td>
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<tr>
<td>7/8</td>
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<td>8.7</td>
<td>25.0</td>
<td>22.0</td>
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<tr>
<td>1</td>
<td>16.0</td>
<td>11.0</td>
<td>32.0</td>
<td>28.0</td>
</tr>
<tr>
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<td>14.0</td>
<td>41.0</td>
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<tr>
<td>1-1/4</td>
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<td>17.0</td>
<td>50.0</td>
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<tr>
<td>1-1/2</td>
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<td>95.0</td>
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<td>124.0</td>
<td>107.0</td>
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<td>48.0</td>
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<td>154.0</td>
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<td>5.4</td>
<td>17.0</td>
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<td>18.0</td>
<td>56.0</td>
<td>48.0</td>
</tr>
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*Rated capacities based on a diameter of curvature of 5 times the finished diameter at points of sling contacted with load.
Wire Rope Sling Weights

To calculate sling weight multiply weight per foot x sling length plus extras in eyes.

<table>
<thead>
<tr>
<th>Mechanical Splice Standard Sling</th>
<th>9-Part Laid Wire Rope Sling</th>
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<tbody>
<tr>
<td>Finished Diameter (Inches)</td>
<td>Weight of Steel Sleeves and Extra Wire in Eyes (lbs)</td>
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# Wire Rope

## Nominal Strengths and Weights

### 6 x 19 Class – 6 x 36 Class

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<thead>
<tr>
<th>Diameter in Inches</th>
<th>Improved Plow Steel (IPS)</th>
<th>Extra Improved Plow Steel (EIP)</th>
<th>Approximate Weight per Foot in Pounds</th>
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<tbody>
<tr>
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<td>Nominal Strength in Tons of 2,000 Lbs</td>
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<td>IWRC</td>
<td>IWRC</td>
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<td>361.0</td>
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<td>393.0</td>
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<td>458.0</td>
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Nylon Web Sling Capacities

9800# Heavy Duty Stuffer Weave Nylon/Polyester Construction Webbing
Rated Capacity in pounds

Type I & Type II Slings with steel hardware
(*Type II slings have no choke hitch rating)

<table>
<thead>
<tr>
<th>Width (Inches)</th>
<th>Ply</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>Weight (8' base)</th>
<th>Weight per foot</th>
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<tbody>
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9800# Heavy Duty Stuffer Weave Nylon/Polyester Construction Webbing
Rated Capacity in pounds

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<td>Weight per foot</td>
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9800# Heavy Duty Stuffer Weave Nylon/Polyester Construction Webbing
Rated Capacity in pounds

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9800# Heavy Duty Stuffer Weave Nylon/Polyester Construction Webbing
Rated Capacity in pounds

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<th>Weight (8' base)</th>
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## Synthetic Roundsling Capacities

Design Factor = 5:1  ●  Rated Capacity in Pounds

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*Sling color is used by manufacturer's to represent size and/or capacity of roundslings. Manufacturer color/ratings vary from manufacturer to manufacturer. Never determine sling capacity by color ALWAYS use rating on the sling identification tag. If rated capacity is not legible remove the sling from service.*
# Slingmax® Poly Roundsling Capacities with **Check-Fast® Inspection**

![Slingmax Logo](image)

**Design Factor = 5:1  •  Rated Capacity in Pounds**

## Polyester Roundsling with √-Fast® Inspection — Endless and Eye & Eye Type

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<th>Size</th>
<th>*Color</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>Weight per Foot (lbs)</th>
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<tbody>
<tr>
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*Sling color is used by manufacturer's to represent size and/or capacity of roundslings. Manufacturer color/ratings vary from manufacturer to manufacturer. Never determine sling capacity by color ALWAYS use rating on the sling identification tag. If rated capacity in not legible remove the sling from service.*

**See Slingmax® Rigging Solutions — www.slingmax.com**
# Slingmax® High Performance Fiber Slings

Design Factor = 5:1  •  Rated Capacity in Pounds

<table>
<thead>
<tr>
<th>*Twin-Path® Extra — **Single-Path Extra Slings with K-Spec® HPF Fiber</th>
<th>*Twin-Path® Sling</th>
<th>Vertical</th>
<th>Choker</th>
<th>Basket</th>
<th>**Single-Path Sling</th>
<th>2-Leg &amp; Basket Hitch</th>
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<td></td>
<td><strong>Basket</strong></td>
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<td><strong>Basket</strong></td>
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<tr>
<td></td>
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<td>707,000</td>
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</tbody>
</table>

*Twin-Path® Extra Slings can be equipped with Tell-Tail™ or √-Fast® inspection systems and Fiber Optics.

**Single-Path Extra Slings are equipped with the Slingmax® √-Fast® inspection systems

Slingmax® Rigging Solutions — www.slingmax.com
# Slingmax® High Performance Fiber Slings
## Body Widths and Weights

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Approximate Weight per Foot</th>
<th>Nominal Body Width (Inches)</th>
<th>Model No.</th>
<th>Approximate Weight per Foot</th>
<th>Nominal Body Width (Inches)</th>
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<tr>
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<td>TPXC 6000</td>
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<td>TPXC 15000</td>
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### Single-Path Extra Slings with K-Spec® and Fast® Inspection

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<th>Model No.</th>
<th>Approximate Weight per Foot</th>
<th>Nominal Body Width (Inches)</th>
<th>Model No.</th>
<th>Approximate Weight per Foot</th>
<th>Nominal Body Width (Inches)</th>
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## Alloy Chain Sling Capacities

### GRADE 80 / GRADE 100 / GRADE 120 WORKING LOAD LIMITS (POUNDS)

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<th>Grade</th>
<th>Single Leg Sling</th>
<th>Double Leg Slings</th>
<th>Triple &amp; Quad Leg Slings</th>
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<td>6,100</td>
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<td>6,100</td>
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<tr>
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<td>26,000</td>
<td>21,200</td>
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# Wire Mesh Sling Capacities

**TYPE I**

Design Factor = 5:1  •  Rated Capacity in Pounds

**TYPE II**

Type I and *Type II Wire Mesh Slings — Heavy, Medium & Light Duty

## Heavy Duty Wire Mesh — 10 Gauge Carbon Steel

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<th>Nominal Width (inches)</th>
<th>Vertical &amp; *Choker</th>
<th>Vertical Basket</th>
<th>Nominal Width (inches)</th>
<th>Vertical &amp; *Choker</th>
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<td>14</td>
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<td>16</td>
<td>17,600</td>
<td>35,200</td>
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<td>13,200</td>
<td>18</td>
<td>19,800</td>
<td>39,600</td>
</tr>
<tr>
<td>8</td>
<td>8,800</td>
<td>17,600</td>
<td>20</td>
<td>22,000</td>
<td>44,000</td>
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<td>11,000</td>
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## Medium Duty Wire Mesh — 12 Gauge Carbon Steel

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## Light Duty Wire Mesh — 14 Gauge Carbon Steel

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<th>Vertical Basket</th>
<th>Nominal Width (inches)</th>
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<td>2,800</td>
<td>14</td>
<td>7,000</td>
<td>14,000</td>
</tr>
<tr>
<td>4</td>
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<td>8,000</td>
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<td>3,000</td>
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<td>10,000</td>
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</table>

*Type II wire mesh slings can not be used in a choker hitch.
Rigging Hardware

Shackles (ASME B30.26-1)

Special Considerations

1) Shackles are manufactured in three basic configurations: anchor, chain and synthetic shackles. Anchor and chain style shackles can have safety bolt, screw pin or round pins. Synthetic shackles will have safety bolt and screw pins.

2) Round pin shackles should not be used in a general rigging atmosphere. They should be used only in permanent applications.

3) Anchor and chain shackle size is determined by the diameter of the steel in the body (bow) of the shackle.

4) Replacement parts, such as pins, shall meet or exceed the original manufacturer's specification.

Proof Testing

1) Shackles are not required to be proof tested unless specified by the manufacturer. (Up to 150 Ton minimum 200%, maximum 220% WLL — Over 150 Ton, minimum 133%, maximum 200% WLL unless approved by the manufacturer)
Identification
Each new shackle body/pin shall have forged, cast or die stamped markings by the manufacturer to show:

1) manufacturer's name or trademark (body & pin)
2) rated load (body)
3) size (body)
4) grade, material type or load rating (pin)

Inspections
Shackles shall be inspected before each day's use. At least once every 12 months a documented inspection shall be completed by a designated person. 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:

1) missing or illegible manufacturer's name or trademark and/or rated load identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated, cracked or broken load-bearing components
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point around the body or pin
7) incomplete pin engagement
8) excessive thread damage
9) evidence of unauthorized welding
10) other conditions including visible damage that cause doubt as to the continued use of the shackle
Shackles

Shackle working load limits are based on a minimum of a 5:1 design factor for shackles up to 4" and a factor of 4 for shackles larger than 4". Some manufacturers have higher design factors than the minimum.

<table>
<thead>
<tr>
<th>Nominal Size (inches)</th>
<th>Bow Diameter</th>
<th>Carbon Maximum WLL (tonnes)</th>
<th>Alloy Maximum WLL (tonnes)</th>
<th>Inside Width at Pin (inches)</th>
<th>Diameter of Pin (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16</td>
<td>1/3</td>
<td>1/3</td>
<td>—</td>
<td>.38</td>
<td>.25</td>
</tr>
<tr>
<td>1/4</td>
<td>1/2</td>
<td>1/2</td>
<td>—</td>
<td>.47</td>
<td>.31</td>
</tr>
<tr>
<td>5/16</td>
<td>3/4</td>
<td>3/4</td>
<td>—</td>
<td>.53</td>
<td>.38</td>
</tr>
<tr>
<td>3/8</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>.66</td>
<td>.44</td>
</tr>
<tr>
<td>7/16</td>
<td>1-1/2</td>
<td>2.6</td>
<td>2.6</td>
<td>.75</td>
<td>.50</td>
</tr>
<tr>
<td>1/2</td>
<td>2</td>
<td>3.3</td>
<td>3.3</td>
<td>.81</td>
<td>.63</td>
</tr>
<tr>
<td>5/8</td>
<td>3-1/4</td>
<td>5</td>
<td>5</td>
<td>1.06</td>
<td>.75</td>
</tr>
<tr>
<td>3/4</td>
<td>4-3/4</td>
<td>7</td>
<td>7</td>
<td>1.25</td>
<td>.88</td>
</tr>
<tr>
<td>7/8</td>
<td>6-1/2</td>
<td>9.5</td>
<td>9.5</td>
<td>1.44</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>8-1/2</td>
<td>12.5</td>
<td>12.5</td>
<td>1.69</td>
<td>1.13</td>
</tr>
<tr>
<td>1-1/8</td>
<td>9-1/2</td>
<td>15</td>
<td>15</td>
<td>1.81</td>
<td>1.25</td>
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<tr>
<td>1-1/4</td>
<td>12</td>
<td>18</td>
<td>18</td>
<td>2.03</td>
<td>1.38</td>
</tr>
<tr>
<td>1-3/8</td>
<td>13-1/2</td>
<td>21</td>
<td>21</td>
<td>2.25</td>
<td>1.50</td>
</tr>
<tr>
<td>1-1/2</td>
<td>17</td>
<td>30</td>
<td>30</td>
<td>2.38</td>
<td>1.63</td>
</tr>
<tr>
<td>1-3/4</td>
<td>25</td>
<td>*40</td>
<td>2.88</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>35</td>
<td>*55</td>
<td>3.25</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>2-1/2</td>
<td>55</td>
<td>*85</td>
<td>4.13</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td>*3</td>
<td>85</td>
<td>*120</td>
<td>5.00</td>
<td>3.25</td>
<td></td>
</tr>
<tr>
<td>*3-1/2</td>
<td>120</td>
<td>*150</td>
<td>5.25</td>
<td>3.75</td>
<td></td>
</tr>
<tr>
<td>*4</td>
<td>150</td>
<td>*175</td>
<td>5.50</td>
<td>4.25</td>
<td></td>
</tr>
<tr>
<td>*4-3/4</td>
<td>—</td>
<td>*200</td>
<td>7.25</td>
<td>4.75</td>
<td></td>
</tr>
<tr>
<td>*5</td>
<td>—</td>
<td>*250</td>
<td>8.25</td>
<td>5.00</td>
<td></td>
</tr>
</tbody>
</table>

*Bolt Type Anchor Shackle

The Crosby Group®
### Capacity Reductions

#### Side Loading Reduction

<table>
<thead>
<tr>
<th>Sling Loading Angle</th>
<th>% Rated Load Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0^\circ - 5^\circ$</td>
<td>None</td>
</tr>
<tr>
<td>$6^\circ - 45^\circ$</td>
<td>30%</td>
</tr>
<tr>
<td>$46^\circ - 90^\circ$</td>
<td>50%</td>
</tr>
<tr>
<td>Over $90^\circ$</td>
<td>Consult Manufacturer</td>
</tr>
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---

### Working Load Limit (WLL) — "Synthetic Sling Saver" Shackles

<table>
<thead>
<tr>
<th>Roundsling Size (number)</th>
<th>Web Sling Size (inches)</th>
<th>Working Load Limit (Tons)</th>
<th>Width at Top (inches)</th>
<th>Inside Width at Pin (inches)</th>
<th>Diameter of Pin (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; 2</td>
<td>1</td>
<td>3-1/4</td>
<td>1.38</td>
<td>.88</td>
<td>.75</td>
</tr>
<tr>
<td>3 &amp; 4</td>
<td>1.5</td>
<td>6-1/2</td>
<td>1.75</td>
<td>1.25</td>
<td>.88</td>
</tr>
<tr>
<td>5 &amp; 6</td>
<td>2</td>
<td>8-3/4</td>
<td>2.25</td>
<td>1.38</td>
<td>1.00</td>
</tr>
<tr>
<td>7 &amp; 8</td>
<td>3</td>
<td>12-1/2</td>
<td>3.25</td>
<td>1.62</td>
<td>1.25</td>
</tr>
<tr>
<td>9 &amp; 10</td>
<td>4</td>
<td>20-1/2</td>
<td>4.50</td>
<td>2.12</td>
<td>1.50</td>
</tr>
<tr>
<td>11 &amp; 12</td>
<td>5</td>
<td>35</td>
<td>5.50</td>
<td>2.50</td>
<td>2.00</td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>50</td>
<td>6.50</td>
<td>3.00</td>
<td>2.25</td>
</tr>
</tbody>
</table>

The Crosby Group®

www.thecrosbygroup.com
### G-2160 "WIDE BODY" Shackles

<table>
<thead>
<tr>
<th>Working Load Limit (tonnes)</th>
<th><em>Dimensions (inches)</em></th>
<th>Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D (+/- .02)</td>
<td>B (+/- .25)</td>
</tr>
<tr>
<td>7</td>
<td>.88</td>
<td>1.25</td>
</tr>
<tr>
<td>12.5</td>
<td>1.13</td>
<td>1.69</td>
</tr>
<tr>
<td>18</td>
<td>1.38</td>
<td>2.03</td>
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<tr>
<td>30</td>
<td>1.63</td>
<td>2.37</td>
</tr>
<tr>
<td>40</td>
<td>2.00</td>
<td>2.88</td>
</tr>
<tr>
<td>55</td>
<td>2.25</td>
<td>3.25</td>
</tr>
<tr>
<td>75</td>
<td>2.75</td>
<td>4.13</td>
</tr>
<tr>
<td>125</td>
<td>3.15</td>
<td>5.12</td>
</tr>
<tr>
<td>200</td>
<td>4.12</td>
<td>5.91</td>
</tr>
<tr>
<td>300</td>
<td>5.25</td>
<td>7.38</td>
</tr>
<tr>
<td>400</td>
<td>6.30</td>
<td>8.66</td>
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<td>500</td>
<td>7.09</td>
<td>9.84</td>
</tr>
<tr>
<td>600</td>
<td>7.87</td>
<td>10.83</td>
</tr>
<tr>
<td>700</td>
<td>8.46</td>
<td>11.81</td>
</tr>
<tr>
<td>800</td>
<td>9.06</td>
<td>12.80</td>
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<td>900</td>
<td>9.84</td>
<td>13.78</td>
</tr>
<tr>
<td>1,000</td>
<td>10.63</td>
<td>14.96</td>
</tr>
<tr>
<td>1,250</td>
<td>11.81</td>
<td>16.93</td>
</tr>
<tr>
<td>1,550</td>
<td>12.60</td>
<td>18.31</td>
</tr>
</tbody>
</table>

*For dimensions A, C, E, G, J, K, P, & R see [www.thecrosbygroup.com](http://www.thecrosbygroup.com)*
Shackle Applications

A shackle's capacity must be reduced when the included angle between slings is greater than $120^\circ$. Use only screw pin or bolt type shackles.

Crosby heavy lift shackles are shackles with capacities greater then 120 metric tons, must NOT be loaded at an included angle between slings greater than $90^\circ$. 
Shackle Applications (Cont...)

When using shackles to collect multiple slings, the pin end of the shackle goes into the hook. The shackle bow is designed to address the angular loading of multiple slings. Shackle pin spools or washers can be used to stabilize and center the pin on the hook.

Shackle loading should be applied through the center line of the shackle. When the shackle is not loaded through its center line but at an angle, its capacity must be reduced.
Shackle Applications (Cont...)

Never place the shackle pin in the running part of a sling hitch. Never allow the pin to be rotated by the sling action.

When connecting two wide body shackles together, connect them bow to bow, NOT bow to pin.
Shackle Applications (Cont...)

Screw pin shackles shall not be used if the pin can roll under loading and be unscrewed.

If there is not a thimble in a wire rope sling's eye, the diameter of the shackle must be greater than the wire rope. In order to have equal capacity, shackle size will be greater than the wire rope. When screw pin shackles are used in permanent applications, the pin must be tightened ¼ to ½ turn after it is 'hand tight'.

The shackle must be large enough to avoid the pinching of synthetic slings.

Do not replace the shackle pin with a bolt. Only a properly fitted pin from the manufacturer should be used.
Hooks (ASME B30.10)

Special Considerations

1) Rigging hooks are hooks that do not necessarily support the load in a direct-pull configuration. Grab, sorting and sling hooks are rigging hooks that may be attached or fabricated to slings, beams or other below the hook lifting devices.

2) The rated capacity of a rigging hook shall be equal to or exceed the rated load of the chain, wire rope or other suspension member to which it is attached.

Proof Testing

When used rigging hooks are re-used in new fabricated assemblies they shall be proof tested. (200% of vertical rated capacity)

Identification

Each new rigging hook shall have the manufacturer's identification forged or die-stamped on a low stress and non-wearing area of the hook.
Inspection

Rigging hooks shall be inspected before each day's use. At least once every 12 months they shall be inspected as part of the slings to which they are attached. Rigging hooks shall be removed from service if damage such as the following is visible:

1) any visible distortion such as bending or twisting from the plane of the center axis of the hook
2) increase in the throat opening exceeding 5% of original opening not to exceed 1/4"
3) wear in the saddle area of the hook exceeding 10% of the hook original dimensions; wear in the eyelet area 5%
4) nicks, gouges and cracks
5) the hook attachment and securing means for defects
6) latch engagement (if provided)
7) self-locking hooks for proper operation and locking (if provided)
Hook Capacities

Hooks for rigging are made in many different configurations for many different applications. Not all hooks used in rigging applications work in direct pull applications. Be sure to use hooks in the manner for which they are intended.

<table>
<thead>
<tr>
<th>Carbon Maximum WLL (Tons)</th>
<th>Alloy Maximum WLL (Tons)</th>
<th>Throat Opening with Latch (inches)</th>
<th>Thickness Hook Base (inches)</th>
<th>Width of Hook Base (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>1</td>
<td>.89</td>
<td>.73</td>
<td>.63</td>
</tr>
<tr>
<td>1</td>
<td>1-1/2</td>
<td>.91</td>
<td>.84</td>
<td>.71</td>
</tr>
<tr>
<td>1-1/2</td>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
<td>.88</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1.09</td>
<td>1.13</td>
<td>.94</td>
</tr>
<tr>
<td>3</td>
<td>4-1/2 / 5</td>
<td>1.36</td>
<td>1.44</td>
<td>1.31</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>1.61</td>
<td>1.81</td>
<td>1.66</td>
</tr>
<tr>
<td>7-1/2</td>
<td>11</td>
<td>2.08</td>
<td>2.25</td>
<td>1.63</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>2.27</td>
<td>2.59</td>
<td>1.94</td>
</tr>
<tr>
<td>15</td>
<td>22</td>
<td>3.02</td>
<td>3.00</td>
<td>2.38</td>
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<td>3.25</td>
<td>3.62</td>
<td>3.00</td>
</tr>
<tr>
<td>25</td>
<td>37</td>
<td>3.00</td>
<td>4.56</td>
<td>3.19</td>
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<tr>
<td>30</td>
<td>45</td>
<td>3.38</td>
<td>5.06</td>
<td>3.25</td>
</tr>
<tr>
<td>40</td>
<td>60</td>
<td>4.12</td>
<td>6.00</td>
<td>3.91</td>
</tr>
</tbody>
</table>

The Crosby Group®

Suggested Hook Sizes for Multiple-Leg Bridle Slings (EIP Wire Rope)

<table>
<thead>
<tr>
<th>Sling Size (inches)</th>
<th>Hook Size (tons)</th>
<th>Sling Size (inches)</th>
<th>Hook Size (tons)</th>
<th>Sling Size (inches)</th>
<th>Hook Size (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>1-1/2 (C)</td>
<td>7/8</td>
<td>7-1/2 (C)</td>
<td>1-1/2</td>
<td>22 (A)</td>
</tr>
<tr>
<td>1/4</td>
<td>3 (C)</td>
<td>1</td>
<td>10 (C)</td>
<td>1-3/4</td>
<td>30 (A)</td>
</tr>
<tr>
<td>5/8</td>
<td>4-1/2 (A)</td>
<td>1-1/8</td>
<td>15 (A)</td>
<td>2</td>
<td>37 (A)</td>
</tr>
<tr>
<td>3/4</td>
<td>7 (A)</td>
<td>1-1/4</td>
<td>15 (A)</td>
<td>2-1/4</td>
<td>45 (A)</td>
</tr>
</tbody>
</table>
Hook Applications

When using multiple slings in a hook ensure that the included angle is not greater than 90°. If the included angle must be greater than 90° use shackles or master links to collect slings at the hook. Loading beyond 90° reduces the hooks rated capacity and increases the possibility of point loading the hook.

Always be sure that the sling or hardware used to lift the load is supported at the base of the hook. Never allow the load to rest on the latch. The purpose of the latch is to keep the rigging in the hook when in a slack condition.
Hook Applications (Cont...)

Load Rating Efficiency When Loaded Off Center

Balanced Load
100% of Rated Load

1/4 Off Center
86% of Rated Load

1/2 Off Center
80% of Rated Load

3/4 Off Center
70% of Rated Load

Point Loading
40% of Rated Load

No Back Loading

No Tip Loading

No Side Loading
Hook Applications (Cont...)

Sorting hooks, also known as shake out hooks, stab hooks, and pelican hooks, are intended for sorting and laying out pipe, plates, structural steel and other items that allow engagement to the full depth of the hook. The sorting and laying out process includes moving materials close to the ground to allow observation of the load and load connection throughout the duration of the lift. Sorting hooks must be attached to loads in a manner that will maintain a level, balanced and stable condition throughout the lift.

Do not concentrate load on the last two inches of the hook.

Tip loading caused by a sling angle greater than 45° results in a W.L.L. of 2 tons when hook is fully engaged.

W.L.L. at the bottom of the hook is 7-1/2 tons when fully engaged and the sling angle is less than 45°.

NOTE: For sorting hooks of different capacities, follow the manufacturers instructions.
Hook Applications (Cont...)

A horizontal sling angle should be 30° to 45°. Other angles may provide inadequate engagement forces and create tip loading. The load on the hook will vary according to the sling angle. When fully engaged, with a sling angle of 30° to 45°, the working load limit is 7.5 tons. Even when fully engaged, sling angles greater than 45° will create tip loading and will result in a maximum working load limit of 2 tons.

Do not exceed 45° between two sling legs that are on the same edge of a load. Recommended angle between legs is 30° to 45°.
Heavy Lift Hook Applications

Heavy lift hooks, 125 tons or greater, have different use applications than standard rigging or crane hooks. Always follow the hook's manufacturer for proper use. They may differ from manufacturer to manufacturer. The following are general rules for the use of Crosby Heavy Lift Hooks.

Single Point Hook Application

Working load limit is based on sling angles within a $90^\circ$ included angle. ($45^\circ$ vertical angle.)

Master links may bear on one point or two points depending on the size and type of hook. This is acceptable as long as the master link bears within the $120^\circ$ included angle.
Duplex Hook Application

Maximum working load limit of a duplex hook is based on sling angles within a $60^\circ$ included angle. $30^\circ$ vertical angle. Maximum sling angle is $90^\circ$ included angle. $45^\circ$ vertical angle. When angle is greater than $60^\circ$, reduce hook capacity by 10%.

It is always best that loading is equal on each prong.

Depending on block configuration and sling loads, prong loading may allow up to a $55^\circ / 45^\circ$ load distribution.

The shackle whole in the duplex hook is designed for full capacity with a properly sized standard Crosby shackle. G-2140 & G-2160.
Quad Hook Application

Maximum working load limit of a Crosby quad hook is based on sling angles within a 60° included angle. 30° vertical angle. Maximum sling angles is 90° included angle. 45° vertical angle. When angle is greater than 60° reduce hook capacity by 10%.

Quad hook capacities are also based on a maximum 30° oblique (side load) angle.

It is best to have equal loading on each prong. Depending on block configuration and sling loading, prong loading may allow 30° / 20° / 30° /20° load distribution.

When loading two opposite prongs, the total load is to be no more than 60% of total working load limit while limiting loading to 55% / 45%.
**Eyebolts (ASME B30.26-2)**

**Special Considerations**

1) Only shouldered eyebolts shall be used when loading is NOT vertical (90° from horizontal).

2) Non-shouldered eyebolts are only to be loaded in a 90° vertical pull.

**Identification**

Eyebolts shall be marked to show:

1) name or trademark of manufacturer
2) size or rated load
3) grade for alloy eyebolts

**Inspection**

Eyebolts shall be inspected before each day's use. At least once every 12 months they shall be inspected for damage such as the following:

1) missing or illegible identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated or cracked load bearing components
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point
7) excessive thread damage or wear
8) evidence of unauthorized welding or modification
9) other conditions, including visible damage, that cause doubt as to continued use
Eyebolts Capacities

Eyebolts are made in two styles: shouldered and non-shouldered. Shouldered eyebolts capacities are rated for a $90^\circ$ in-line pull or angular loading. Non-shouldered eyebolts are rated for $90^\circ$ in-line pull. Eyebolt rated capacities vary from manufacturer to manufacturer.

### Eyebolt Working Load Limit*

- **Forged Carbon Steel**
- **Angular Loading for Shouldered Eyebolts Only**

<table>
<thead>
<tr>
<th>Diameter (inches)</th>
<th>Generic Working Load Limits (lbs)</th>
<th>Crosby Working Load Limits (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inline Pull Loading</td>
<td>Reduction Angular Loading (ASME B30.26)</td>
</tr>
<tr>
<td>1/4</td>
<td>500</td>
<td>![100% of WLL](100% of WLL)</td>
</tr>
<tr>
<td>5/16</td>
<td>800</td>
<td>![55% of WLL](55% of WLL)</td>
</tr>
<tr>
<td>3/8</td>
<td>1,200</td>
<td>![25% of WLL](25% of WLL)</td>
</tr>
<tr>
<td>1/2</td>
<td>2,200</td>
<td>![25% of WLL](25% of WLL)</td>
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</tr>
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<td>7,200</td>
<td>![25% of WLL](25% of WLL)</td>
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<tr>
<td>1</td>
<td>10,000</td>
<td>![25% of WLL](25% of WLL)</td>
</tr>
<tr>
<td>1-1/4</td>
<td>15,200</td>
<td>![25% of WLL](25% of WLL)</td>
</tr>
<tr>
<td>1-1/2</td>
<td>—</td>
<td>![25% of WLL](25% of WLL)</td>
</tr>
</tbody>
</table>

*Use working load limit by the manufacturer of the eyebolt being used.
Eyebolt Applications

In a tapped blind-hole, the effective thread length shall be at least 1-1/2 times diameter of the bolt for engagement in steel. For machined eyebolts minimum tap depth is the shank length plus 1/2 the nominal diameter of the eyebolt.

When shouldered eyebolts are used for angular loading, the shoulder shall be flush and securely tightened against the load. The plane of the eye shall be aligned with the angle of loading.

A flat washer can be used under the shoulder to position the plane of the eye. Use only a single shim to orientate the eyebolt eye. Do not use washers to take up slack.

<table>
<thead>
<tr>
<th>Eyebolt Size (inches)</th>
<th>Shim Thickness to Rotate 90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>.0125</td>
</tr>
<tr>
<td>5/16</td>
<td>.0139</td>
</tr>
<tr>
<td>3/8</td>
<td>.0156</td>
</tr>
<tr>
<td>1/2</td>
<td>.0192</td>
</tr>
<tr>
<td>5/8</td>
<td>.0227</td>
</tr>
<tr>
<td>3/4</td>
<td>.0250</td>
</tr>
<tr>
<td>7/8</td>
<td>.0278</td>
</tr>
<tr>
<td>1</td>
<td>.0312</td>
</tr>
<tr>
<td>1-1/4</td>
<td>.0357</td>
</tr>
<tr>
<td>1-1/2</td>
<td>.0417</td>
</tr>
</tbody>
</table>
Eyebolt Applications (Cont...)

In a tapped through-hole of one diameter thickness or less, use two nuts. The nut under the load shall be fully engaged and tightened securely against the load.

In a tapped through-hole of more than one diameter thickness, only one nut is required. Tighten hex nut securely against the load.

Result of angular loading non-shouldered or shoulders not flush with the load.

Do not reeve slings through one eyebolt to another. This practice will alter the load and angle of loading on the eyebolt. If sling angle is $60^\circ$ the resultant load on the eyebolts will be equal to a $30^\circ$ angle.
Swivel Eyebolt (RUD Starpoint)

The RUD Starpoint eyebolt is a true swivel eyebolt. A wrench is attached to torque the eyebolt to the load.

As tension is applied to the eyebolt it swivels positioning the angle of loading to the plane of the eye. The Working Load Limit (WLL) indication for the most unfavorable load direction is embossed on the eyebolt at a 4:1 design factor. For further details refer to the product information sheet at www.rud.com

<table>
<thead>
<tr>
<th>Size - UNC (Inches)</th>
<th>Working Load Limit* (Lbs)</th>
<th>Size (Metric)</th>
<th>Working Load Limit* (Kilograms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0°</td>
<td>90°</td>
<td></td>
</tr>
<tr>
<td>3/8 - 16</td>
<td>2,200</td>
<td>800</td>
<td>M8</td>
</tr>
<tr>
<td>1/2 - 13</td>
<td>4,400</td>
<td>1,650</td>
<td>M10</td>
</tr>
<tr>
<td>5/8 - 11</td>
<td>8,820</td>
<td>3,300</td>
<td>M12</td>
</tr>
<tr>
<td>3/4 - 10</td>
<td>13,250</td>
<td>5,070</td>
<td>M16</td>
</tr>
<tr>
<td>7/8 - 9</td>
<td>13,250</td>
<td>5,070</td>
<td>M20</td>
</tr>
<tr>
<td>1 - 8</td>
<td>17,630</td>
<td>7,050</td>
<td>M24</td>
</tr>
<tr>
<td>1 1/4 - 7</td>
<td>26,450</td>
<td>9,920</td>
<td>M30</td>
</tr>
<tr>
<td>1 1/2 - 6</td>
<td>35,270</td>
<td>15,430</td>
<td>M36</td>
</tr>
<tr>
<td>1 3/4 - 5</td>
<td>59,900</td>
<td>19,480</td>
<td>M42</td>
</tr>
<tr>
<td>2 - 4 1/2</td>
<td>70,550</td>
<td>26,500</td>
<td>M48</td>
</tr>
</tbody>
</table>

* Working Load Limits (WLL) are based on a 4:1 Design Factor

www.rud.com
Swivel Hoist Rings (ASME B30.26-2)

Special Considerations

1) When used in a threaded-hole, the effective thread length shall be 1-1/2 times the diameter of the bolt for steel — for other thread engagements in other materials contact a swivel hoist ring manufacturer or a qualified person.

2) When used in a through-hole application, a nut and washer shall be used in accordance with the swivel hoist ring manufacturer's recommendations. The nut shall be fully engaged.

3) The bushing flange shall fully contact the load surface.

4) Spacers or washers shall not be used between the bushing flange and mounting surface of the load being lifted.

5) Swivel hoist rings shall be tightened to torque specifications of the manufacturer.

6) Swivel hoist rings shall be free to rotate and pivot without interference during lifting.

Identification

Swivel hoist rings shall be marked to show:

1) name or trademark of manufacturer
2) rated load
3) torque value
Inspection

Swivel hoist rings shall be inspected before each day's use. At least once every 12 months a documented inspection shall be completed by a designated person. Swivel hoist rings 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:

1) missing or illegible identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated or cracked load bearing components
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point
7) excessive thread damage or wear
8) evidence of unauthorized welding or modification
9) other conditions, including visible damage, that cause doubt as to continued use
10) lack of the ability to freely rotate or pivot
Swivel Hoist Ring Capacities

A swivel hoist rings rated capacity is based on:

- full thread engagement
- the bushing flange in full contact with the load surface
- proper torque
- load applied to the enter of the bail

<table>
<thead>
<tr>
<th>Bolt Diameter (inches)</th>
<th>Working Load Limit (lbs)</th>
<th>Hoist Ring Torque (Ft. lbs)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/16</td>
<td>800</td>
<td>7</td>
</tr>
<tr>
<td>3/8</td>
<td>1,000</td>
<td>12</td>
</tr>
<tr>
<td>1/2</td>
<td>2,500</td>
<td>28</td>
</tr>
<tr>
<td>5/8</td>
<td>4,000</td>
<td>60</td>
</tr>
<tr>
<td>3/4</td>
<td>5,000</td>
<td>100</td>
</tr>
<tr>
<td>7/8</td>
<td>8,000</td>
<td>160</td>
</tr>
<tr>
<td>1</td>
<td>10,000</td>
<td>230</td>
</tr>
<tr>
<td>1-1/4</td>
<td>15,000</td>
<td>470</td>
</tr>
<tr>
<td>1-1/2</td>
<td>24,000</td>
<td>800</td>
</tr>
<tr>
<td>2</td>
<td>30,000</td>
<td>1,100</td>
</tr>
<tr>
<td>2-1/2</td>
<td>50,000</td>
<td>2,100</td>
</tr>
<tr>
<td>3</td>
<td>75,000</td>
<td>4,300</td>
</tr>
<tr>
<td>3-1/2</td>
<td>100,000</td>
<td>6,600</td>
</tr>
</tbody>
</table>

*Ultimate load is based on 5 times working load limit.

**Torque values are based on threads being clean, dry and free of lubrication.

NOTE: The table above may not reflect the ratings and torque value of all swivel hoist rings. Follow torque and capacity from the manufacturer of the swivel hoist ring in use.
Swivel Hoist Rings (Cont...)

The table below are based on American National Taps and Dies values. Hoist ring ratings and torque value are based on engagement in Ferris metals.

<table>
<thead>
<tr>
<th>Thread Size (Inches)</th>
<th>Threads-Coarse per Inch</th>
<th>Tap Drill (Inches)</th>
<th>Tap Decimal Inch</th>
<th>Allen Head Size (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/16</td>
<td>18</td>
<td>F</td>
<td>0.2570</td>
<td>1/4</td>
</tr>
<tr>
<td>3/8</td>
<td>16</td>
<td>5/16</td>
<td>0.3125</td>
<td>3/8</td>
</tr>
<tr>
<td>1/2</td>
<td>13</td>
<td>27/24</td>
<td>0.4219</td>
<td>3/8</td>
</tr>
<tr>
<td>5/8</td>
<td>11</td>
<td>17/32</td>
<td>0.5313</td>
<td>1/2</td>
</tr>
<tr>
<td>3/4</td>
<td>10</td>
<td>21/32</td>
<td>0.6563</td>
<td>5/8</td>
</tr>
<tr>
<td>7/8</td>
<td>9</td>
<td>49/64</td>
<td>0.7656</td>
<td>3/4</td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>7/8</td>
<td>0.8750</td>
<td>3/4</td>
</tr>
<tr>
<td>1-1/4</td>
<td>7</td>
<td>1- 7/64</td>
<td>1.1094</td>
<td>7/8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>6</td>
<td>1-11/32</td>
<td>1.3438</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>4-1/2</td>
<td>1-25/32</td>
<td>1.7813</td>
<td>1-1/2</td>
</tr>
<tr>
<td>2-1/2</td>
<td>4</td>
<td>2-1/4</td>
<td>2.2500</td>
<td>1-3/4</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>2-3/4</td>
<td>2.7500</td>
<td>2-1/4</td>
</tr>
<tr>
<td>3-1/2</td>
<td>4</td>
<td>3-1/4</td>
<td>3.2500</td>
<td>2-3/4</td>
</tr>
</tbody>
</table>
Swivel Hoist Ring Applications

When used in through-hole applications, a nut and washer shall be used in accordance with the swivel hoist ring manufacturer's recommendations. The nut shall be fully engaged and properly torqued.

The bushing flange shall be in full contact with the load surface. Spacers or washers shall not be used between the bushing flange and mounting surface of the load being lifted.

Swivel hoist rings must rotate and pivot without interference during lifting. The swivel hoist ring must be able to align with the sling without interference.

Fittings or hooks used to attached slings to swivel hoist rings shall be the proper shape and size to ensure the fitting seats properly in the bail of the swivel hoist ring.
Shackle-Lok™ Shackle-Style Hoist Ring

Shackle-Lok™ is a useful tool for riggers. It’s unique design allows the rigger to connect slings directly to the hoist ring without the need for additional hardware. It is a very efficient and easy to use below-the-hook lifting device.

Shackle-Lok™ hoist rings are designed to work with numerous thread sizes and engagement depths. See www.jergensinc.com/lifting

<table>
<thead>
<tr>
<th>Thread Size (Inches)</th>
<th>WLL* (Lbs)</th>
<th>Torque** (Lbs Ft)</th>
<th>Hex Size (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-20</td>
<td>550</td>
<td>3</td>
<td>5/32</td>
</tr>
<tr>
<td>5/16-18</td>
<td>800</td>
<td>5</td>
<td>5/32</td>
</tr>
<tr>
<td>3/8-16</td>
<td>1,000</td>
<td>7</td>
<td>5/32</td>
</tr>
<tr>
<td>1/2-13</td>
<td>2,500</td>
<td>23</td>
<td>1/4</td>
</tr>
<tr>
<td>5/8-11</td>
<td>4,000</td>
<td>46</td>
<td>1/4</td>
</tr>
<tr>
<td>3/4-10</td>
<td>5,000</td>
<td>69</td>
<td>3/8</td>
</tr>
<tr>
<td>7/8-9</td>
<td>8,000</td>
<td>130</td>
<td>7/16</td>
</tr>
<tr>
<td>1-8</td>
<td>10,000</td>
<td>185</td>
<td>7/16</td>
</tr>
<tr>
<td>1 1/4-7</td>
<td>15,000</td>
<td>345</td>
<td>1/2</td>
</tr>
<tr>
<td>1 1/2-6</td>
<td>24,000</td>
<td>660</td>
<td>3/4</td>
</tr>
<tr>
<td>2-4 1/2</td>
<td>30,000</td>
<td>1,100</td>
<td>3/4</td>
</tr>
<tr>
<td>2 1/2-4</td>
<td>50,000</td>
<td>2,300</td>
<td>1</td>
</tr>
</tbody>
</table>

*Stated load capacity based on recommended thread torques as shown in chart.
**It is recommended that these torques be used when installing hoist rings.

www.jergensinc.com
**Turnbuckles** (ASME B30.26-2)

**Special Considerations**

1) Open and pipe body type turnbuckles can have jaw, eye or hook ends.

2) Hook end turnbuckle capacities are less than jaw and eye end turnbuckles.

3) Turnbuckle end fitting threads shall be fully engaged in the body threads.

4) If locking nuts are used they shall be compatible with the threads of the turnbuckle end. Lock nuts should not be used during overhead lifting.

**Identification**

Turnbuckles shall be marked to show:

1) name or trademark of manufacturer

2) size or rated load
Inspection

Turnbuckles shall be inspected before each day's use. At least once every 12 months a written documented inspection shall be completed by a designated person. Turnbuckles 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:

1) missing or illegible identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated or cracked frame members or end fittings
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point
7) excessive thread damage or wear
8) evidence of unauthorized welding or modification
9) other conditions, including visible damage, that cause doubt as to continued use

Check end fittings for damage and parts.

Check for cracks and deformation.

Check for thread damage and bent rods.
Turnbuckles Capacities

Turnbuckles are made with several different types of end fittings, eyes, clevis, stubs or hooks. Turnbuckles may have any combination of end fittings. Those with hook ends will have lower capacities than counter parts of the same size.

<table>
<thead>
<tr>
<th>End Fitting Stock Diameter (Inches)</th>
<th>WLL of any combination of JAW, EYE and STUB END Fittings (lbs)</th>
<th>WLL of Turnbuckles with HOOK END Fittings (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>500</td>
<td>400</td>
</tr>
<tr>
<td>5/16</td>
<td>800</td>
<td>700</td>
</tr>
<tr>
<td>3/8</td>
<td>1,200</td>
<td>1,000</td>
</tr>
<tr>
<td>1/2</td>
<td>2,200</td>
<td>1,500</td>
</tr>
<tr>
<td>5/8</td>
<td>3,500</td>
<td>2,250</td>
</tr>
<tr>
<td>3/4</td>
<td>5,200</td>
<td>3,000</td>
</tr>
<tr>
<td>7/8</td>
<td>7,200</td>
<td>4,000</td>
</tr>
<tr>
<td>1</td>
<td>10,000</td>
<td>5,000</td>
</tr>
<tr>
<td>1-1/4</td>
<td>15,200</td>
<td>---</td>
</tr>
<tr>
<td>1-1/2</td>
<td>21,400</td>
<td>---</td>
</tr>
<tr>
<td>1-3/4</td>
<td>28,000</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>37,000</td>
<td>---</td>
</tr>
<tr>
<td>2-1/2</td>
<td>60,000</td>
<td>---</td>
</tr>
<tr>
<td>2-3/4</td>
<td>75,000</td>
<td>---</td>
</tr>
</tbody>
</table>
Turnbuckle Applications

Turnbuckle rated capacities are based on inline loading. When turnbuckles are eccentrically (side) loaded their component parts are easily damaged putting the rigger at risk.

When turnbuckles are used in applications where vibration is present, the end fitting should be secured to the frame with lock pins or wires. This will prevent turning and loosening.

Lock nuts (jam nuts) should not be used for overhead lifting. The lock nut can significantly increase the stresses imposed upon the turnbuckles threads putting the rigger at risk.
Links/Rings — Master Links (ASME B30.26-3)

Hoisting links/rings are used to gather multiple sling legs at a single point for multiple leg bridle slings. Links/rings are oblong, pear or round shaped.

**Special Considerations**

1) Links/rings shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures that the manufacturer has specified.

**Proof Testing**

1) Prior to initial use, welded links and rings shall be proof tested by the manufacturer or qualified person. (200% VRC)

2) When used links/rings are re-used in new fabricated assemblies they shall be proof tested. (200% VRC)

**Identification**

Each new link/ring shall be marked by the manufacturer to show the following:

1) name or trademark of manufacturer

2) size or rated load

3) grade if required to identify rated load
Inspection

Links/rings shall be inspected before each day's use. At least once every 12 months a written documented inspection shall be completed by a designated person. When attached to slings they shall be inspected as part of the slings to which they are attached. Links/rings 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:

1) missing or illegible identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated or cracked frame members or fittings
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point
7) evidence of unauthorized welding or modification
8) and other conditions, including visible damage, that cause doubt as to continued use
Rings (Master Links)

Rings (Master Links) are used to gather multiple sling legs at a single point for multiple leg bridle slings. Master Links come in three shapes; oblong, pear or round. Oblong links are the most common. Pear links are directional for proper use and round links are the weakest of the three.

Oblong Master Link  Pear Master Link  Round Master Link

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Capacity</th>
<th>B</th>
<th>C</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2W</td>
<td>7,400</td>
<td>2.80</td>
<td>5.00</td>
<td>1.30</td>
</tr>
<tr>
<td>5/8</td>
<td>9,000</td>
<td>3.00</td>
<td>6.00</td>
<td>1.52</td>
</tr>
<tr>
<td>3/4W</td>
<td>9,900</td>
<td>3.20</td>
<td>6.00</td>
<td>2.00</td>
</tr>
<tr>
<td>7/8W</td>
<td>15,200</td>
<td>3.75</td>
<td>6.38</td>
<td>3.30</td>
</tr>
<tr>
<td>1W</td>
<td>26,000</td>
<td>4.30</td>
<td>7.50</td>
<td>6.10</td>
</tr>
<tr>
<td>1-1/4W</td>
<td>39,100</td>
<td>5.50</td>
<td>9.50</td>
<td>12.00</td>
</tr>
<tr>
<td>1-1/2W</td>
<td>61,100</td>
<td>5.90</td>
<td>10.50</td>
<td>18.60</td>
</tr>
<tr>
<td>1-3/4</td>
<td>84,900</td>
<td>6.00</td>
<td>12.00</td>
<td>25.22</td>
</tr>
<tr>
<td>2</td>
<td>102,600</td>
<td>7.00</td>
<td>14.00</td>
<td>37.04</td>
</tr>
<tr>
<td>2-1/4</td>
<td>143,100</td>
<td>8.00</td>
<td>16.00</td>
<td>54.10</td>
</tr>
<tr>
<td>2-1/2</td>
<td>160,000</td>
<td>8.38</td>
<td>16.00</td>
<td>67.75</td>
</tr>
<tr>
<td>2-3/4</td>
<td>216,900</td>
<td>9.50</td>
<td>16.00</td>
<td>87.70</td>
</tr>
<tr>
<td>3</td>
<td>228,000</td>
<td>9.00</td>
<td>18.00</td>
<td>115.00</td>
</tr>
<tr>
<td>3-1/4</td>
<td>262,200</td>
<td>10.00</td>
<td>20.00</td>
<td>145.00</td>
</tr>
</tbody>
</table>

*Design Factor – 5:1  www.thecrosbygroup.com  2009
### Crosby A-341 Alloy Pear Links*

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Capacity</th>
<th>D</th>
<th>E</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>7,000</td>
<td>4.00</td>
<td>3.00</td>
<td>.55</td>
</tr>
<tr>
<td>5/8</td>
<td>9,000</td>
<td>5.00</td>
<td>3.75</td>
<td>1.10</td>
</tr>
<tr>
<td>3/4</td>
<td>12,300</td>
<td>6.00</td>
<td>4.50</td>
<td>1.76</td>
</tr>
<tr>
<td>7/8</td>
<td>14,000</td>
<td>7.00</td>
<td>5.25</td>
<td>2.82</td>
</tr>
<tr>
<td>1</td>
<td>24,360</td>
<td>8.00</td>
<td>6.00</td>
<td>4.22</td>
</tr>
<tr>
<td>1-1/8</td>
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<td>8.75</td>
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*Design Factor – 5:1  www.thecrosbygroup.com

### Crosby S-643 Round Rings*

<table>
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<tr>
<th>Diameter</th>
<th>Capacity</th>
<th>B</th>
<th>Weight</th>
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<td>10.12</td>
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</tbody>
</table>

*Design Factor – 6:1  www.thecrosbygroup.com
Master Link Applications

Master Links or Rings shall always be of the proper shape and size to ensure that it seats properly in the hook or other lifting device. Multiple slings or rigging hardware gathered in a link or ring shall not exceed a 120° included angle.

<table>
<thead>
<tr>
<th><strong>Sling Size</strong> (inches)</th>
<th>2–Leg</th>
<th>3–Leg</th>
<th>4–Leg</th>
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<td>3/4</td>
<td>7/8</td>
</tr>
<tr>
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</tr>
<tr>
<td>3/4</td>
<td>1</td>
<td>1-1/4</td>
<td>1-1/2</td>
</tr>
<tr>
<td>7/8</td>
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<td>1-1/2</td>
<td>1-1/2</td>
</tr>
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<td>1-1/2</td>
<td>1-3/4</td>
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<td>2-1/4</td>
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<td>2-1/4</td>
<td>2-3/4</td>
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</tr>
<tr>
<td>2-1/4</td>
<td>2-3/4</td>
<td>3-1/2</td>
<td>4</td>
</tr>
</tbody>
</table>

*Sizes based on Crosby capacities. If not Crosby – Verify Link WLL
**EIP Wire Rope
Master Link Applications (Cont...)

Oblong Links

Oblong links are to be loaded in-line through the vertical length of the link. Always match the links capacity to the total vertical rated capacity for the size and number of slings used in the link.

Correct in-line loading of oblong link.  
Never horizontally load oblong links.

Pear Links

Pear links are to be loaded in-line through the vertical length of the link. Always match the links capacity to the total vertical rated capacity for the size and number of slings used in the link. When more than one sling leg is used, Legs must go on widest end of the link.
Swivels (ASME B30.26-3)

Swivels are positioning hardware. They reduce the torque action on the rigging attachments as the load is being lifted.

Special Considerations
1) Swivels are not to be used to swivel suspended loads.
2) Swivels shall have sufficient ductility to permanently deform before losing the ability to support the load at the temperatures that the manufacturer has specified.

Proof Testing
1) Prior to initial use, welded links and rings shall be proof tested by the manufacturer or qualified person. (200% VRC)
2) When used links/rings are re-used in new fabricated assemblies they shall be proof tested. (200% VRC)
Identification

Each new swivel shall be marked by the manufacturer to show the following:

1) name or trademark of manufacturer
2) size or rated load
3) and grade if required to identify rated load

Inspection

Swivels shall be inspected before each days use. At least once every 12 months inspection shall be completed by a designated person. When attached to slings they shall be inspected as part of the slings to which they are attached. Swivels 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:

1) missing or illegible identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated or cracked frame members or end fittings
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point
7) evidence of unauthorized welding or modification
8) lack of ability to freely rotate when not loaded,
9) loose or missing nuts, bolts, cotter pins, snap rings or other fasteners and retaining devices
10) other conditions, including visible damage, that cause doubt as to continued use
Swivel Capacities

Swivels are positioning hardware used to reduce the torque action on rigging attachments as loading is applied to the rigging. NEVER use this type of swivel to position a suspended load, they will fail. Swivels come in three types of configurations: chain, regular and jaw/eye swivels. All three are always to be loaded in line with itself.

<table>
<thead>
<tr>
<th>Size (inches)</th>
<th>Chain Swivel</th>
<th>Regular Swivel</th>
<th>Eye/Jaw Swivel</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>WLL (lbs)</td>
<td>Weight (lbs)</td>
<td>WLL (lbs)</td>
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<tr>
<td>1/4</td>
<td>850</td>
<td>.13</td>
<td>850</td>
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<td>5/16</td>
<td>1,250</td>
<td>.25</td>
<td>1,250</td>
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<tr>
<td>3/8</td>
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<td>7,200</td>
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<tr>
<td>7/8</td>
<td>—</td>
<td>—</td>
<td>10,000</td>
</tr>
<tr>
<td>1</td>
<td>—</td>
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<td>12,500</td>
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</tr>
<tr>
<td>1-1/2</td>
<td>—</td>
<td>—</td>
<td>45,200</td>
</tr>
</tbody>
</table>
**Wire Rope Clips** *(ASME B30.26-3)*

Wire rope clips come in two styles, U-bolt and double saddle.

---

**Special Considerations**

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.

2) **Wire rope clip ratings** are based on the manufacturer's requirements for number of clips, spacing and torque for wire rope size. **Properly assembled clips tensile strength** will be 80% of the wire ropes minimum breaking strength. **Re-torque clip assembly** after the initial load application.

3) **Slings made with wire rope clips** shall not be used in a choke hitch.

---

**Identification**

Each new wire rope clip saddle shall have forged or die stamped markings by the manufacturer to show the following:

1) name or trademark of manufacturer

2) size
Inspection

Wire rope clips shall be inspected before each day's use. At least once every 12 months inspection shall be completed by a designated person. Clips 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:

1) missing or illegible identification
2) indications of heat damage including weld splatter or arc strikes
3) excessive pitting or corrosion
4) bent, twisted, distorted, stretched, elongated or cracked frame members or end fittings
5) excessive nicks or gouges
6) a 10% reduction of the original or catalog dimension at any point
7) evidence of unauthorized welding or modification
8) unauthorized replacement components
9) insufficient number of wire rope clips
10) improperly tightened wire rope clips
11) indications of damaged wire rope slippage
12) improper assembly or other conditions including visible damage that may cause doubt as to their continued use

NOTE: Remember clip orientation by the phrase never saddle a dead horse.
Wire Rope Clips Ratings

Wire rope clips shall be of sufficient strength that failure of the rope will occur before failure of the clip. Only drop forged clips shall be used in lifting applications. When using wire rope clips, be sure that the manufacturer's recommendations for number of clips, torque and installation are followed.

Clip Installation

STEP 1

Apply first clip one base width from dead end. Use torque wrench to tighten nuts evenly, alternating from one nut to the recommended torque.

STEP 2

Apply second clip as near the base of the thimble as possible. Use torque wrench to tighten nuts evenly, alternating from one nut to the recommended torque.

STEP 3

Apply third and additional clips evenly between the first two. Use torque wrench to tighten nuts evenly, alternating from one nut to the recommended torque.

STEP 4

Apply first load of equal or greater weight than the loads expected in use. Next, check and use torque wrench to re-tighten to recommended torque.
Clip Installation (Cont...)  

<table>
<thead>
<tr>
<th>Clip Size (inches)</th>
<th>U-Bolt Clips</th>
<th>Double Saddle Clips</th>
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<tbody>
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<td>1-1/2</td>
<td>8</td>
<td>54</td>
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</tbody>
</table>

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CORRECT

CORRECT

CORRECT

CORRECT
**Wedge Sockets (ASME B30.26-3)**

**Special Considerations**

1) Wedge sockets should not be side loaded.

2) Impacts can dislodge the wedge from the body.

**Inspection**

Wedge sockets shall be inspected before each day's use. At least once every 12 months inspection shall be completed by a designated person. Wedge sockets 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:

1) missing or illegible identification

2) indications of heat damage including weld splatter or arc strikes

3) excessive pitting or corrosion

4) bent, twisted, distorted, stretched, elongated or cracked frame members or end fittings

5) excessive nicks or gouges

6) a 10% reduction of the original or catalog dimension at any point

7) evidence of unauthorized welding or modification

8) unauthorized replacement components

9) improperly tightened wire rope clips

10) indications of damaged wire rope slippage

11) improper assembly or other conditions, including visible damage, that cause doubt as to their continued use
Wedge Socket Installations
Always use the correct wedge with the correct socket.

Installation

CORRECT APPLICATIONS

INCORRECT APPLICATIONS
Manual Operated Chain Hoists

Manually operated chain hoists come in two configurations: 1) Hand chain operated hoists, commonly called a chainfall and 2) lever operated chain hoists, commonly called a come-along.

Hand Chain Hoist

- The chainfall is designed for vertical or near vertical lifts. All loading is to be in-line with the hoist.
- Must be used right side up.
- Designed so that when the actuating force is removed, it will automatically stop and hold a load up to 125% of its rated capacity.

Lever Chain Hoist

- The lever chain hoist is designed for vertical lifting, lifting at angles, pulling and to be used upside down. All loading is to be in-line with the hoist.
- Hoist is equipped with an integral activated load-controlling mechanism.
- Can be equipped with a load controlling mechanism that will automatically stop and hold up to 125% of its rated capacity.
Markings

The rated capacity shall be permanently marked on the hoist or load block. The manufacturer's name and its model or serial number shall be on the hoist.

Hoist Operation

- Do not exceed the hoist's rated capacity.
- Do not wrap the load chain around the load.
- Do not apply the load to the tip of the hoist hook.
- Keep upper and lower hooks in-line with each other.
- Avoid hoisting at angles (chainfall).
- Ensure that the hoist anchorage and structure will support the hoist and its load.
- Only one operator shall pull on a single hand chain at one time (chainfall).
- Do not use a cheater bar or handle extension (lever hoist).
- Have good footing before operating the hoist.
- Do not stand under the load.
- Ensure that the load chain is properly seated in wheels and sprockets before lifting.
Rigging Practices

Regardless of the type of sling, rigging hardware, or below-the-hook lifting device being used, the following practices shall be observed to prevent accidents, injury or death.

- Slings shall not be shortened or lengthened by knotting or twisting.
- Edges, corners or protrusions in contact with a sling must be padded with material of sufficient strength, thickness or construction to protect the sling.
- Rigging hardware and sling fittings should not come in contact with corners.
- Shock and dynamic loading should be avoided.
Rigging Practices (cont...)

Loads should not be set on slings or rigging hardware trapping the slings between the load, blocking or ground. Likewise, slings or hardware should not be pulled from under a load when it is resting on the sling or hardware.

When basket hitches are used, the slings should contain or support the load from the sides, above the Center of Gravity, so that the load remains under control.

Basket hitches should be rigged in such a way as to balance the load and prevent slippage during lifting.
Rigging Practices (cont...)

The choke point of a choker hitch should be on the sling's body, NOT on the splice, fitting, hardware or tag.

When the "angle of choke", of a choker hitch, is less than 120° the sling's capacity must be reduced accordingly. (see page 13)

Slings should not be constricted, bunched or pinched by the load, hook or any fitting.
Rigging Practices (cont...)

The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook.

A hook or pin in the eye of a synthetic web sling should be no wider than 1/3 the length of the eye. The eye of a wire rope sling should be no wider than 1/2 the length of the eye. This prevents damage to the splice or the eye under load.

Avoid bending fittings around a hook.
Rigging Practices (cont...)

Secure unused legs of multi-leg bridle slings.

Do not drive the bite of the choke down once tension is applied to the sling. This will result in severe overloading at the point of the hitch and can damage the sling.

Be sure the hoist lift point is over the load's Center of Gravity before lifting.

Brace unstable loads before applying or removing rigging.
**Sling Protection**

All slings, regardless of type, must be protected from cutting or damage. Wire rope slings from kinking, deformation and abrasion. Alloy chain and mesh slings from gouges, deformation and abrasion. Synthetic web and roundslings must be protected from corners, protrusions, rough surfaces and in some cases when used with rigging hardware.

Load edges have varying degrees of danger. Remember, what is good for the sharp (damaging) edge is also best for the rounded edge so protect slings from all edges. This practice removes all subjectivity for determining protection. All edges can cut or damage slings.

Three different types of protection are necessary for synthetic slings and they are mutually exclusive. When selecting protection it has to be determined whether abrasion protection, cut protection or load protection is needed.

**Cut Protection Pads**

- **Slingmax® Cornermax® Pad**
  - Separation
  - Rating: 25,000 lbs per inch of width.

- **Linton Sling Protector**
  - Toughness
  - Rating: 12,500 lbs per inch of width.

Cut protection requires a pad that is not susceptible to cutting either because of toughness or separation.
A mistake often made by riggers is the use of abrasion protection pads for cut protection. Though some abrasion (wear) pads provide limited cut protection for the sling, it is very dangerous to rely on them to protect slings from cutting.
All edges on a load, including those that are not the primary load bearing areas, need to be protected.

A synthetic sling placed on the pin of a shackle must be protected from exposed threads on the pin or pinch points where the pins go through the ears of the shackle to prevent cutting of the sling.

Inspection

Before each use inspect sling protection for:

- cuts, tears or damage that may prevent protection of the sling
- unprotected bars, plates, rods or mesh used in sling protection that can damage the sling or load
- be sure protection is the correct size and type to protect the sling
Knots, Bends and Hitches

Knots and bends reduce the ropes strength by half (50%). Hitches have a better efficiency, reducing rope strength by 25%.

Square Knot (Reef Knot)

The square knot can be used for tying two ropes of the same diameter together. Both the live and dead ends of the ropes must come out of the loops on the same side.

Clove Hitch

The clove hitch is used to tie a rope to round or near round objects such as rings, posts or pipes. When tying the hitch at the end of a rope, the end should be half hitched to the standing part since the hitch has a tendency to slip when at the end of the rope.
Bowline
This knot is a general purpose knot that can be used in most situations. It is commonly used for putting a loop in the end of a line. When tied properly it does not slip or jam, yet is easily untied.

Running Bowline
The running bowline is a type of slip knot. It runs freely on the standing part of the rope and is easily untied.
Half Hitch

The half hitch is normally used when securing an object for a right angle pull. This is a temporary hitch that must have constant tension maintained.

1

Unsafe

2

Good

Double Half Hitch

The double half hitch is simply a half hitch tied twice. It is easily tied and can be used in most situations.

Sheepshank

A sheepshank is used for shortening a rope or removing the tension from a weak point in the rope. It is a good hitch to tighten when securing a load with a rope.
Carrick Bend
The carrick bend is used for joining two ropes of equal diameter together. When tension is applied it is easier to untie than most knots. It is a strong knot that will not jam under load and will always draw up tight.

Sheet Bend
The sheet bend is used for tying two different ropes of different diameters together.
Lifting & Spreader Beams

**Lifting** beams are rigid beams designed to support the complete load at one central lifting point. It is great for low headroom applications.

**Spreader** beams are designed so that the upper rigging shares the load with the lower rigging.
Equalizer Beams

**Equalizer** beams are often used when multiple cranes or hooks lift a single load. An equalizer beam does not allow the loading on the cranes to change when the beam angle changes.

![Diagram of Equalizer Beams]

Loads in A & B do not change when beam angle changes.

![Diagram of Equalizer Beams with loads]

Markings

Beams SHALL be provided with identification displaying the following:

- rated Capacity
- manufacturer's name and address
- serial number
- beam weight if over 100 lbs
**Lift Planning**

No lift should be made without a lift plan. The plan does not have to be formal or documented in many cases. In other cases it can take hours, days or even weeks to develop and execute a lift plan. Usually more complicated lift plans require signatures, drawings, multiple calculations, safety analyses and consent forms. No matter how detailed the plan, the following questions should be answered before each lift.

1) Who is the competent person responsible for the lift?
2) Is the lift equipment and rigging gear in good condition?
3) Are the rigging gear capacities known and are they adequate for the weight of the load, the hitches required for the lift and the angles being used?
4) Is the load rigged to the Center of Gravity?
5) Are softeners or cut protection needed to protect the slings or the load?
6) Is a tagline needed?
7) Are the appropriate sling hitches being used?
8) Are proper rigging techniques being used?
9) Is there adequate load control?
10) Are all personnel clear of the load?
11) Are there any unusual loading or environmental conditions?
12) Is the load weight known?
13) Are all personnel involved qualified to perform their task?

Before any lift, all personnel involved should be part of a pre-lift meeting to review their responsibilities for the lift. Hazards that may be involved with the lift and the lifting sequence should also be discussed.
Crane Signals

Personnel acting as signalers during crane operations shall be clearly identified to the crane operator. In cases where the crane operator cannot see the signaler, a second person to relay the signals shall be stationed where he/she can see both the signaler and the crane operator. The relay signaler shall also be clearly identified. Where voice communication is used, the signaler shall also be clearly identified and he/she shall communicate directly with the operator.

The appropriate signals adopted by ASME are to be used. If compliance with these hand signals are impractical for the job being performed, other hand signals shall be agreed upon by the operator and signal person before proceeding with work.

No crane movement shall be made unless signals are clearly understood. The operator shall respond to signals only from the designated signal person. However, a stop signal shall be obeyed regardless of who gives it.

Standard Mobile Crane Hand Signals

**Use Main Hoist**
Tap fist on head; then use regular signals.

**Use Whip Line**
(Auxiliary Hoist) Tap elbow with one hand; then use regular signals.

**Hoist**
With forearm vertical, forefinger pointing up, move hand in small horizontal circles.
With forearm extended downward, forefinger pointing down, move hand in small horizontal circles.

Arm extended, fingers closed, thumb pointing upward.

Arm extended, fingers closed, thumb pointing downward.

Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly is shown)

With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.

With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.

Arm extended point with finger in direction of swing of boom.

Both arms extended, palm down, move arm back and forth horizontally.

Arm extended, palm down, move arm back and forth horizontally.
Standard Mobile Crane Hand Signals (Cont...)

**Travel**
Arm extended forward, hand open and slightly raised, make a pushing motion in direction of travel.

**Dog Everything**
Clasp hands in front of body.

**Travel (Both Tracks)**
Use both fists in front of body, making a circular motion around each other, indicating direction of travel forward or backward.

**Travel (One Track)**
Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body.

**Extend Boom (Telescoping Booms)**
Both fists in front of body with thumbs pointing outward.

**Retract Boom (Telescoping Booms)**
Both fists in front of body with thumbs pointing toward each other.

**Extend Boom (Telescoping Booms)**
One Hand Signal. One fist in front of chest with thumb tapping chest.

**Retract Boom (Telescoping Booms)**
One Hand Signal. One fist in front of chest, thumb pointing outward and heel of the fist tapping chest.
Standard Overhead Crane Hand Signals

**Hoist**
With forearm vertical, forefinger pointing up, move hand in small horizontal circles.

**Lower**
With forearm extended downward, forefinger pointing down, move hand in small horizontal circles.

**Bridge Travel**
Arm extended forward, hand open and slightly raised, make a pushing motion in direction of travel.

**Trolley Travel**
Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.

**Stop**
Arm extended, palm down, move arm back and forth horizontally.

**Emergency Stop**
Both arms extended, palm down, move arm back and forth horizontally.

**Multiple Trolley**
Hold up one finger for block "1" and two fingers for block marked "2". Regular signals follow.

**Move Slowly**
Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly is shown)

**Magnet Is Disconnected**
Crane operator spreads both hands apart – palms up.
Standard Tower Crane Hand Signals

**Hoist**
With forearm vertical, forefinger pointing up, move hand in small horizontal circles.

**Lower**
With forearm extended downward, forefinger pointing down, move hand in small horizontal circles.

**Tower Travel**
Arm extended forward, hand open and slightly raised, make a pushing motion in direction of travel.

**Trolley Travel**
Palm up, fingers closed, thumb pointing in direction of motion, jerk hand horizontally.

**Stop**
Arm extended, palm down, move arm back and forth horizontally.

**Emergency Stop**
Both arms extended, palm down, move arm back and forth horizontally.

**Swing**
Arm extended point with finger in direction of swing of boom.

**Move Slowly**
Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly is shown)

**Dog Everything**
Clasp hands in front of body.
Standard Voice Signals

Many times communication between the signaler and the crane operator is done by voice communication using radios and other such electronic devices. When voice communication is used the following should be adhered to:

- Before any lifting operation using voice signals (radio communication) the signals shall be discussed and agreed upon by the crane operator and the signaler.
- Communication devices shall be tested before the lifting operation begins. If devices are battery operated extra batteries should be readily accessible.
- All directions given to the crane operator shall be given from the operator's direction perspective.
- Each series of signals shall contain the following elements stated in the following order:
  1) function and direction
  2) distance and/or speed
  3) function stop

Example of voice communication:
- swing right 50', 25', 15, 10', 2', swing stop
- load down 100', 50', 30', 10',...2', load stop
- load up slow, slow, slow, load stop

If communication is broken the crane operator shall stop crane movement. The crane operator should continue only when communication is re-established.
Crane Set-up

Crane set-up is critical to the success of any lift. The crane must be in good condition, the operator qualified and the crane manufacturer's procedures followed to ensure a safe lift.
Outrigger Blocking

Even if outrigger beams are fully extended, the crane is level and the cranes tires are clear of the ground, without proper blocking under the outrigger pads the support area may be compromised. The cranes float or pontoons may not provide an adequate footprint to support the weight of the crane plus the load. In many cases steel plates, wood beams or even crane mats may be required for the ground pressure generated by mobile cranes. If there are questions or doubts about the crane support system, consult the crane manufacturer, a lift engineer or other qualified personnel.

Good Blocking
(full support of outrigger pad)

Poor Blocking
(span blocking of outrigger pad)

Poor Blocking
(corner blocking of outrigger pad)
Electrical Hazards

Electrocution is one of the most common killers in the crane and rigging industry. Therefore, OSHA 29 CFR 1926.1400 gives three options for working near power lines up to 350 kV.

1) Confirm from the utility owner/operator that the power line has been de-energized and visibly grounded at the work site.

2) **Ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer than 20 feet.**

3) Determine line's voltage and the minimum approach distance permitted under Table A.

Table A minimum distance from energized power lines are as follows:

- up to 50 kV — 10 ft.
- over 50 kV to 200 kV — 15 ft.
- over 200 kV to 350 kV — 20 ft.
- over 350 kV to 500 kV — 25 ft.
- over 500 kV to 750 kV — 35 ft.
- over 750 kV to 1,000 kV — 45 ft.
- over 1,000 kV — (as established by the utility owner)

For power lines over 350 kV to 1,000 kV, a minimum distance shall be 50 feet. For power lines over 1,000 kV, the minimum 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.
Electrical Hazards (Cont...)

When traveling under or near power lines with no load the OSHA requires taking the following steps.

1) Boom/mast and boom/mast support system are lowered sufficiently.
2) Follow clearances in Table T.
3) Consider the effects of speed and terrain so as to not violate the minimum clearances of Table T.
4) If any part of the equipment while traveling will get closer than 20 feet to the power line have a dedicated spotter who is in continuous contact with the driver/operator.
5) When traveling at night, or in conditions of poor visibility, as well as previous requirements ensure that the power lines are illuminated or another means of identifying the location of the lines used and a safe path of travel is identified and used.

Table T — Minimum clearance distance while traveling with no load.

- up to 0.75 kV — 4 ft.
- 0.75 kV to 50 kV — 6 ft.
- over 50 kV to 345 kV — 10 ft.
- over 345 kV to 750 kV — 16 ft.
- over 750 kV to 1000 kV — 20 ft.

Power Line Guidelines

- **Always** contact the owners of power lines or the nearest utility before beginning work.
- Maintain a safe operating distance and observe the absolute limit of approach.
- All power lines must be considered as energized.
• All personnel, except the operator, must stay away from the crane when it is near the limit of the approach.

• Increase the limit of approach and use of an additional spotter should be assigned to warn operator as boom approaches lines.

• Slow crane operation near power lines.

In the event of contact with power lines:

• Operator should remain inside the cab after contact until the power has been disconnected. DO NOT PANIC.

• Move the crane off the wire if possible.

• Keep everyone away.

• If the operator must get off the crane:

1) Operator must dismount the crane so that both feet are touching together and operator has no contact with anything else.

2) With the operator's feet continually in contact, the operator, shall bunny hop or shuffle away from the crane until the operator is completely out of the energized area.

3) During entire process the operator's feet must remain in contact with each other to prevent the operator from being the conductor between a high and low voltage area.
Block Reeving

ALWAYS follow the manufacturer’s recommendation when reeving or replacing rope on any crane or hoisting device.

Tips when reeving blocks:

- Even parts of line dead end at the boom point and odd parts of line dead end at the block.
- Odd parts of lines may lead to more torque at the block.
- Putting backturns in the rope can help make the block hang straight. However, never install more than two backturns before hoisting and lowering the block or ball. This allows torque to bleed to the entire rope.
- Do not hoist a block or ball to the ground. Boom the block or ball down at least the last two feet to avoid slack rope in the drum.
- Never beat on the wedge socket with a hammer or other object to set or loosen the wedge. The wedge socket is made of a dropped forged material therefore, it can easily crack.

The wedge socket is often dropped or slammed against the block, headache ball or other objects to loosen the wedge. This is not a good practice because it can damage the wedge socket sometimes causing radial cracks in the ears of the socket. Instead, use a long punch and hammer to remove the wedge from the socket and pull tension to set the wedge.
Wire Rope Installation

When winding rope onto the drum or another reel be sure the bends are in the same direction.

OVERWOUND

UNDERWOUND

REVERSE BENDING
Wire Rope Installation (Cont...)

Under load the rope wants to unwind thus roll towards the flange.

Lay of rope should be towards the clamp end of the drum. (right lay rope shown)

If the rope is attached on the wrong end of the drum its lays will open up and the wire will jam.

The sudden release of jammed rope during crane operation causes impact loading on the crane.
Wire Rope Installation (Cont...)

To easily determine the proper procedure for applying left-and right-lay rope on a smooth drum one may use his hand and index finger. Holding hands behind the drum extend the index finger. Display palm up for underwound and palm down for overwound, using your left hand for left-lay and right hand for right-lay, the rope should be attached on the thumb side of the drum.

![Diagram of overwound and underwound rope on drums]

**OVERWOUND**
- Right Lay Overwound
- Left Lay Overwound

**UNDERWOUND**
- Left Lay Underwound
- Right Lay Underwound

**VIEW FROM BEHIND DRUMS**
Crane Limitations

Radius

**Radius** is the horizontal distance between the crane's center of rotation and the center of gravity of the suspended load. Increasing the radius will decrease the crane's lifting capacity while increasing ground pressure applied by the crane.

Crane functions that cause an increase in radius are:

- Extending the boom.
- Lowering the boom.
- Trolleying out. (Tower Crane)
- Rapid swing causing casting out of the load, headache ball or block past the boom tip increasing the working radius.
- Sudden stop of lower boom action causing the load, headache ball or block past the boom tip increasing the working radius.
- Uncompensated boom deflection will increase the load radius beyond the intended radius when the load leaves the ground.

Boom Angle

**Boom angle** is the horizontal angle of the crane boom to the ground. Booming down increases the load radius and reduces the crane's lifting capacity while raising the boom reduces the load radius and increases the crane's capacity. The longer the boom and the lower the boom angle will increase boom deflection causing bowing in the boom.
Load Drift

**Load drift** is the result of the loads continued movement after the stop booming, swinging, or trolleying. This action is caused when these actions are stopped too quickly, causing an increased radius and/or side loading of the boom.

Compensation for load drift is accomplished by booming the boom tip down or up, swinging left or right over the load at its outward apex to stop its motion. On a tower crane the operator may need to trolley in or out to catch the load at the apex of its movement.

It is important to begin booming, swinging or trolleying slowly and to allow enough time to slow the movement down before stopping.

Two-Blocking

**Two-Blocking** is a condition in which the load block exceeds the upper limit of its travel and comes in contact with the boom point or other structural limitations, thereby preventing further upward travel. Many cranes are equipped with anti two-blocking devices. However, an anti two-block device should never be used to intentionally limit two-blocking. Crane functions should be stopped before these devices are needed.

The following crane functions can cause two-blocking:
- Extending the boom.
- Booming down.
- Hoisting.
Boom Deflection

**Boom Deflection** is created when a load is applied to the crane. When the load is applied the boom starts to deflect or bends down as it lifts the load. If boom deflection is not compensated for when lifting, the load will swing out from the crane causing a greater radius and an unsafe condition for the rigger.

Boom deflection is compensated for by adjusting the boom point location before its load leaves the ground. To compensate for the boom's deflection and load swing out, the signaler starts hoisting up on the load until the boom starts to bend down; stop the hoist motion and raise boom to place boom point back over the loads center of gravity. The signaler needs to repeat this action until the load is safely clear of the ground.

![Boom up as required to keep lift point over the loads center of gravity.](image)

Boom deflection also has to be compensated for when placing a load. When placing the load, its weight is removed from the crane's boom causing the boom to straighten out. If the boom is at a high angle it can straighten back into its boom stops (if equipped), causing them to bend.
Dynamic Loading

**Dynamic Loading** is an adverse condition created by sudden movement or stopping of the load creating a dynamic increase of loading/stress to the crane. This added stress/weight can adversely affect the stability and/or structural integrity of the crane. The dynamic load applied to the crane can be several times the actual weight of the planned load. This type of loading can cause structural damage and/or stability that can cause the crane to fail or the boom to collapse.

**DYNAMIC LOADING CHART**

Dynamic loading is caused by rapid acceleration (highball), sudden stopping while lowering a load (hoisting or booming). A sudden loss of load while hoisting can cause instability of the crane causing it's boom to go over backwards.
Side Loading

**Side Loading** causes a dangerous twisting of the boom that can cause structural damage or even failure of the boom. Side loading is caused by several different situations.

- Rapid swinging or stopping of boom swing.
- A load being lifted without the boom point over its center of gravity.
- Duty cycle loading when the load weight is near the crane's capacity.
- Gusting winds or high winds with large loads. Wind can also cause other dangers such as the load coming in contact with the boom, greater difficulty in containing load rotation and load swing, as well as an increased danger to ground personnel.
Crane Capacity Restrictions

**Crane capacity** is based on several different conditions. The cranes rated capacity is the maximum allowable load that can be applied at a given radius, boom angle or quadrant of operation. As the radius increases and/or as the boom angle decreases the crane capacity decreases. Crane capacity is also affected by the number of wire rope parts a crane and block are reeved with. The more parts of wire rope the higher the cranes capacity within the manufacturer's specifications.

### TRUCK MOUNTED CRANE BOOM CAPACITY

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Notice the lower capacity over the side as compared to over the rear of the truck mounted crane.
Quadrants of Operation

The **Quadrant of Operation** can dramatically affect the crane's stability. Normally cranes work in four quadrants: over the front, over the rear, and over both sides.

Generally the most stable quadrant for a truck mounted crane is over the rear, a crawler mounted and rough terrain cranes are over the front. The least stable quadrant is over the side.

**TRUCK MOUNTED CRANE**

Lifting in the front quadrant is not allowed, unless otherwise indicated by crane manufacturer.
CRAWLER MOUNTED CRANE

Most Stable

Least Stable

Over Rear

Over Side

Over Front

Center of Rotation

Most Stable
ROUGH TERRAIN CRANE

Over Side

Over Rear

Least Stable

Center of Rotation

Most Stable

Over Front
Suspended Personnel Platforms

The following is a short summary for the use of suspended personnel platforms. This summary is NOT exhaustive. For complete rules and regulations on the use of these platforms refer to OSHA 29 CFR 1926.550 and ASME B30.23.

Design

Platforms shall be designed with a minimum factor of 5 based on its stated rating. It shall be designed by a qualified engineer or qualified person competent in structural design.

The suspension system shall have a design factor based on the maximum intended resultant stress in the suspension system.

- one-leg system – design factor of seven
- two or more leg system – design factor of 5 for each leg with only two legs under stress

1-leg system - Required Design Factor of 7.  
2-leg system - Design Factor of 5 for each leg with only two legs under stress.  
4-leg system - Design Factor of 5 for each leg with only two legs under stress.
Testing

New platforms, suspension systems and attachment points shall be tested as per ASME B30.23-2.2

Platforms shall be tested to 125% for a period of 5 minutes prior to hoisting people in the personnel platform.

After any structural repair or modification, a platform shall be proof tested to 150% of the platforms rated capacity.

Management

Management shall designate a qualified individual as the "Personnel Lift Authorizer" to verify: the need for a personnel lift, that it is done to the appropriate standards and to appoint a "Personnel Lift Supervisor".

The Personnel Lift Supervisor shall hold a pre-lift meeting, verify all inspections have been completed, supervise the lift operation, verify the operator is physically and mentally fit to perform.

Crane Operator

The operator shall be qualified to operate the lift equipment and is responsible for hoisting equipment capability, rated load constraints, operational limitations, confirming all hoist equipment passes required inspections.

The operator should refuse to lift personnel if he/she does not feel well enough to perform operation, has worked more than 10 hours or did not have 8 hours off prior to the lift or has doubt as to the safety of the lift.

Platform Occupants

- Are trained to recognize hazards.
- Shall be instructed in procedures & precautions.
- Participate in a pre-lift meeting.
• Shall maintain stable and even loading.
• Keep all parts of body inside platform during raising, lowering, and positioning except when acting as the signaler.

The following requirements for crane set-up, platform fabrication and rigging requirements are not complete. Refer to OSHA 1926.550 and ASME B30.23 standards for complete rules for the lifting of personnel.
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Glossary of Terms

ABRASION – The mechanical wearing of surface resulting from frictional contact with materials or objects.

ACCELERATION STRESS – Additional stress imposed by an increase in the load velocity.

ANGLE, INCLUDED –

ANGLE, HORIZONTAL –

ANGLE, VERTICAL –

ANGLE OF CHoke – The angle formed at the bite of a choker hitch. Angles less than 120° decrease the choker hitch efficiency. (see page 13)

ANGLE OF LOADING – Inclination of a leg or branch of a sling as measured from the horizontal or vertical plane.
ARAMID – A group of lightweight, strong, heat-resistant synthetic aromatic polyamide materials that are fashioned in fibers, filaments or sheets for use in textiles, plastics and slings.

ABRASION – Damage to slings or rigging hardware due to the abrading of the sling or hardware against each other or the load.

AUDIBLE SIGNAL – A signal made by a distinct sound or series of sounds. Examples include, but are not limited to, sounds made by a bell, horn, or whistle.

AUXILIARY HOIST – Supplemental hoisting unit usually of less capacity and a higher speed than the main hoist.

BASKET HITCH – A sling configuration where the sling is passed under the load and has both ends on the hook, shackle or master link. (see page 12)

BECKET – See wedge socket.

BIRD CAGING – A colloquial term describing the appearance of wire rope forced in compression. The outer strands form a “cage” and, at times, display the core.

BLOCK – A term applied to a wire rope sheave (pulley) enclosed inside plates and fitted with some attachment such as a hook or shackle. (See page 38)

BLOCKING – Material used to support equipment or a component and distribute loads to the ground. The blocking is also referred to as cribbing, dunnage or hay.

BREAKING STRENGTH – The total force applied to a sling or rigging hardware before it fails. The breaking strength can be expressed in
pounds, tons or kilograms and is usually four to seven times the rated capacity.

BRIDLE SLING – Sling composed of multiple legs fabricated into a ring (master link) that attaches to the lifting hook. (see page 13)

CABLE CLAMP – See clip

CABLE-LAID WIRE ROPE – A wire rope consisting of several independent wire ropes wrapped around a fiber or wire rope core.

CAMBER – The slight curvature given to beams and girders to compensate for deflections cause by loading.

CENTER OF GRAVITY (CG) – The point on a load where the weight is considered to be concentrated. Simply, the balance point. (see page 1)

CHAIN FALL – A manually operated chain activated hoist with an internal activated friction brake. (see page 142)

CHECK-FAST® – A Slingmax® pass/fail inspection system with an External Warning Indicator (EWI) of the internal load bearing core yarn for Single- and Twin-Path® roundslings. (see page 60)

CHOKER – Slang for a lifting sling. Normally for wire rope slings, but may refer to synthetic or chain slings as well.

CHOKER HITCH – A hitch formed when one end of the sling is passed under or through the load and back up through the sling eye body or hardware and is then attached to the lifting hook or other device. (see page 12)

CLIP – Fitting for clamping two parts of wire rope (also known as a cable clamp). (see page 136)

COEFFICIENTS OF FRICTION – The resulting restrictive force of one object moving across or through another object. (see page 41)
COME-ALONG – A lever-operated wire rope device designed for pulling; also called PULLERS. Unlike hoists, the tension is held by a releasable ratchet. Much lighter than hoists of equal capacities, they are not intended for lifting. Also slang for a lever chain hoist.

COMPETENT PERSON – One who is capable of identifying existing and predictable hazzards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them.

CORE – Core member of wire rope about which the strands are laid. It may be fiber, strand or an independent wire rope (IWRC).

CORROSION – Chemical decomposition by exposure to moisture, acids, alkalis or other destructive agents.

CRANE – A machine for lifting and lowering a load vertically and moving it horizontally with the hoisting mechanism as an integral part of the machine. The term is applied to fixed and mobile machines and to powered or manually driven machines.

CREEP – A term to describe non-recoverable stretch.

CRIBBING – Timbers placed beneath a load to support it while jacks are reset and to reduce the distance of a fall in the event of jack slippage.

CRITICAL LIFT – A hoisting operation in which a critical item will be hoisted or moved, or in which a non-critical item will be hoisted or moved in an area where critical items could be affected.
D/d RATIO – The ratio of the diameter around which a sling or wire rope is bent (D) divided by the sling or rope body diameter (d). (see page 17)

DEAD END – The point of fastening one rope end in a running rope system, the other end being fastened at the rope drum.

DECELERATION STRESS – Additional stress imposed on rigging due to decrease in load velocity.

DEFLECTION – a) Sag across a span of a load member, caused by the imposed live or dead loads, which is usually measured at mid-span as the distance along a straight horizontal line drawn between the supports; b) Any deviation from a straight horizontal line.

DESIGN FACTOR – An industry term generally denoting the conservatism used in design calculations associated with the rated capacity of lifting slings and hardware. The design factor is generally expressed as a ratio (example 5:1) usually determined by dividing the desired ratio into the ultimate strength of a lifting device to determine working load limit.

DESIGNATED PERSON – A person selected or assigned by an employer or an employer’s representative as being qualified to perform specific duties.

DRIFTING – Pulling a suspended load laterally to change its horizontal position. (see page 37)

DUNNAGE – See blocking

DYNAMIC LOADING – Loads introduced into rigging or equipment by forces of motion.

EIP – Extra Improved Plow Steel – a grade of wire rope. XIP is also used to denote Extra Improved Plow Steel.
ELASTIC LIMIT – Limit of stress above which a permanent deformation takes place within a given material.

ELONGATION – The measurement of stretch, expressed as a percentage of the finished length.

FALL ZONE – The area (including but not limited to the area directly beneath the load) in which it is reasonably foreseeable that partially or completely suspended materials could fall in the event of an accident.

FATIGUE – The phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material.

FITTING – Any accessory used as an attachment for slings.

FREQUENT INSPECTION – Inspection performed by the user or designated person each day or shift the rigging is used (does not require documentation).

FIBER CORE – Cords or rope made of vegetable or synthetic fiber used in the core of a wire rope.

FIBER OPTIC INSPECTION – An inspection device to assist in determining internal damage of a synthetic round sling. If crushing, cutting, heat or chemical damage has occurred, the damage to the fiber optic cable will destroy its ability to transmit light from one end to the other. (see page 60)

GEAR – A general term used for ropes, blocks, hardware, tackle, etc.

HIGH PERFORMANCE FIBER (HPF) – Synthetic fiber that has grams per denier of 15 or more (example: K-Spec®, Technora®, Spectra®, Dyneema®, etc.). Its strength is more than twice the strength of polyester or nylon.
HITCH – A sling arrangement used to attach a load to a lifting device.

HOIST – a) A lifting device for raising or lowering loads. Its service area is vertical over its mounting. Hoists may be attached to fixed or moveable structures by an upper hook or bracket and can be either power or manually operated. b) A power-operated component of a crane or monorail system that provides torque to raise a load or lower it at a controlled speed or hold a load stationary. c) Verb: the action of raising a load. d) A power-driven drum or drums capable of lifting and lowering loads.

HOIST, LEVER – A manually operated, lever activated chain hoist with an integral activated load-controlling mechanism. (see page 142)

HOIST, MAIN – The hoist mechanism provided for lifting the machine’s maximum rated load.

HOisting – The act of raising, lowering or otherwise moving a load in the air with equipment.

HOOK LATCH – A mechanical device used to bridge the throat opening of a hook.

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

HOOK, RIGGING – Any hook used in hoisting and rigging that is not the “primary hook” or main “load hook”. (see page 102)
HORIZONTAL FORCE – The compressive force applied to a suspended load due to the sling tension when loaded at an angle. (see page 33)

INDEPENDENT WIRE ROPE CORE (IWRC) – Wire rope used as the core of a larger rope.

JACK – A portable lifting device for raising loads through a short distance.

KINK – Permanent distortion of wires and strands resulting from tight bends.

K-SPEC® FIBER – A tenacity composite fiber for load bearing tension members as found in Slingmax® high performance fiber slings.

LAM – Load Angle Multiplier. (see page 27)

LAY LENGTH – The lengthwise distance on a wire rope in which a strand makes a complete turn around the rope.

LIFTING BEAM – A fixture made of rigid parts such as channel, I-beam, plate, etc. to assist in rigging the load. Lifting beams are designed for the beam to support the complete load at one central lifting point. Normally used in low headroom situations. (see page 156)

LIFTING DEVICES – Devices that are not reeved onto the hoist ropes, such as magnets, grabs, spreader bars, lifting beams and other supplemental units. Used for the ease of handling certain types of loads.
LIFTING EYE – A point of attachment on the item to be lifted, having a looped head designed to accommodate a hook or shackle.

LINE PULL – The pulling force attainable in a rope leading off a rope drum or lagging at a particular pitch diameter (number of layers).

LINE SPEED – The speed attainable in a rope leading off a rope drum or lagging at a particular pitch diameter (number of layers).

LOAD – The total superimposed weight or force to be overcome by the hoisting and rigging equipment.

LOAD ANGLE MULTIPLIER – The multiplier, based on sling angle, used to multiply the share of a particular sling leg to determine the actual tension applied to a sling, shackle, eyebolt, turnbuckle, etc. during the lift. (see page 27)

LOAD BEARING PART – Any part of a material-handling device in which the induced stress is influenced by the hook load. A primary load-bearing part where the failure of which could result in dropping, upset or uncontrolled motion of the load.

LOAD BLOCK, LOWER – The assembly of hook or shackle, swivel, sheaves, pins and frame suspended by hoisting rope.

LOAD BLOCK, UPPER – The assembly of hook or shackle, swivel, sheaves, pins and frame suspended from the hoisting platform or from the boom in mobile cranes.

LOAD RATED CHAIN – Alloy chain meeting the requirements for overhead lifting.

LOAD, SAFE WORKING LOAD (SWL) – See working load limit.
MASTER LINK – A forged or welded steel link/ring (oblong, pear or round shaped) to which slings are attached. (see page 127)

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.

OPERATOR – A person who is operating the equipment.

OVERLOAD – A load in excess of the working load limit or rated capacity of the equipment or rigging.

PARTS OF LINE – A number of running ropes supporting a load or force, also called parts or falls. (see page 170)

PERIODIC INSPECTION – A complete documented inspection for damage of rigging performed by a designated person at least once every twelve months or sooner depending on conditions and environment in which the rigging is used.

PADDING – See softeners

PROOF LOAD – The specific load applied in performance of a proof test.

PROOF TEST – A nondestructive load test made to a specific multiple of the rated load of the sling.

QUALIFIED EVALUATOR (not a third party) – A person employed by the signal person's employer who has demonstrated that he/she is competent in accurately assessing whether individuals meet qualification requirements of CFR 1926.1400 for a signal person.
QUALIFIED PERSON (third party) – An entity that, due to its independence and expertise, has demonstrated that it is competent in accurately assessing whether individuals meet the qualification requirements in CFR 1926.1400 for a signal person.

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

QUALIFIED RIGGER – A rigger who meets the criteria for a qualified person.

RATED CAPACITY – The manufacturer’s capacity of a crane, hoist or monorail system. It is also the load that a piece of hoisting equipment is designed to safely carry. Rated capacity, load rating, Working Load Limit (WLL) and Safe Working Load (SWL) are frequently used interchangeably. Also see Working Load Limit.

REEVING – A rope system in which the rope travels around drums and sheaves in a prescribed manner. (see page 170)

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

RIGGING – The act of attaching hoisting equipment to the load.

ROPE LAY – The length of rope required for one strand to be laid completely around the rope core.

RUNNING LINE – A rope that moves over sheaves or drums.

SAFETY FACTOR – See design factor.

SAFE WORKING LOAD (SWL) – See rated capacity.
SALVAGE EDGE – The finished edge of synthetic webbing designed to prevent unraveling.

SEIZE – To bind securely, by wrapping seizing wire or strand at the end of a wire rope.

SEIZING WIRE – A soft anneal-iron wire.

SHACKLE – A U-shaped piece of metal provided with a means of applying a bolt or pin through the ends and used to hold multiple lifting members together. (see page 93)

SHEAVE – A wheel or pulley with a circumferential groove designed for a particular size of wire rope; used to change direction of a running rope.

SIDE PULL – That portion of the hoist pull acting horizontally when the hoist lines are not operated vertically.

SIDE LOADING – A loading applied at an angle to the vertical plane of a boom or the lifting axis of rigging hardware.

SLING LOADING – The total tension load applied to a sling during a lifting application.

SLING – Wire rope, chains or synthetic fabric or fibers made into forms, with or without end fittings, for handling loads.

SLINGS, BRAIDED – A very flexible sling composed of several individual wire ropes or synthetic components braided into a single sling.

SLINGS, ENDLESS – These are slings manufactured in a continuous loop rather than an eye and eye format.
SLINGS, METAL MESH – Slings made from wire mesh attached to steel fittings at each end. (see page 92)

SLINGS, ROUND – Synthetic grommet style slings made with twisted polyester or high performance core fibers inserted in synthetic covers. (see page 58)

SLINGS, WEB – Sling made from flat synthetic webbing with eye or fittings sewn at each end. They are made in single or multiply plies of webbing. (see page 54)

SLINGS, WIRE ROPE – Slings normally made from six strand wire rope with fabricated eyes with or without fittings at each end. (see page 52)

SHARE OF LOAD (SOL) – The portion (%) of the total weight, of a load, that a particular lift point is responsible for during the lift. (see page 25)

SHOCK LOAD – A load that results when the rigging is slack from a rapid change of movement or jerking applied to a load. A shock load is generally significantly greater than a static load.

SNATCH BLOCK – A single sheave block hinged so that it can be opened to insert a rope over a sheave without having to use a free end of the rope.

SOFTENERS – Devices used to protect the load or rigging from damage while making a lift. Softeners are also used to increase the radius of a corner or to prevent loads from slipping. (see page 149)

SOL – Share of Load (see page 25)
SPREADER BEAM – A fixture made of rigid parts such as pipe, channel, I-beam, plate, etc. to assist in rigging the load. Spreader beams are designed for the upper rigging to share the load with the lower rigging. (see page 156)

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

SYNTHETIC FIBER – Man made material used for the cover, load core, webbing and thread of conventional and high performance slings.

TAG LINE – A length of rope used to control a load's spin and guide it into a desired position. (see page 11)

TELL-TAILS™ – Extension of the load core yarns in some round slings as an external inspection device to determine internal damage to load fibers. (see page 60)

THIMBLE – A grooved fitting designed to prevent crushing or over stressing of wire or synthetic rope at the terminal end which is used to protect the eye of a wire or synthetic rope sling.

THREAD – The synthetic yarn that is used to sew web slings and the covers of round slings.

TIP/TURN POINT – The part of a load around which the load pivots when upended. (see page 8)

TURNBUCKLE – A device that can be attached to rigging systems for making limited adjustments in length. A turnbuckle consists of a body and right-hand and left-hand threaded bolts. (see page 123)
TWO-BLOCKING – A condition in which the load block exceeds the upper limit of its travel and comes in contact with the running block or other structural limitations, thereby preventing further upward travel.

ULTIMATE LOAD – The average load at which the item is being tested fails or no longer supports the load.

ULTIMATE STRENGTH – The maximum conventional stress, tensile, compressive or shear that a material can stand without failure.

UV DEGRADATION – Ultra-violet radiation that breaks down the fiber structure of synthetic material used to make synthetic rope, web and roundslings. Damaged is normally recognized by fading and fuzziness of slings components.

VERTICAL HITCH – A hitch where the sling is used in an eye and eye or straight pull configuration. (see page 12)

VRC – Vertical Rated Capacity

WEDGE SOCKET – A socket attachment for the end of a wire rope that employs the wedge principle to hold the rope in the socket. (see page 140)

WIRE ROPE – A rope made from steel or metal wires formed into strands which are, in turn, laid into the complete rope. Sometimes referred to as a cable.

WORKING LOAD LIMIT (WLL) – The maximum weight that a piece of rigging equipment should carry.

YARN-ON-YARN ABRASION – The abrading of sling fibers against each other during lifting.
Reference Standards

Common standards relate to crane and rigging activity.

ASME B30 Standards
ASME B30.1 — Jacks
ASME B30.2 — Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.3 — Construction Tower Cranes
ASME B30.4 — Portal, Tower and Pedestal Cranes
ASME B30.5 — Mobile and Locomotive Cranes
ASME B30.6 — Derricks
ASME B30.7 — Base Mounted Drum Hoists
ASME B30.8 — Floating Cranes and Floating Derricks
ASME B30.9 — Slings
ASME B30.10 — Hooks
ASME B30.11 — Monorails and Underhung Cranes
ASME B30.12 — Handling Loads Suspended From Rotorcraft
ASME B30.13 — Storage/Retrieval (S/R) Machines and Associated Equipment
ASME B30.14 — Side Boom Tractors
ASME B30.15 — Mobile Hydraulic Cranes (Withdrawn - included in latest edition of B30.5)
ASME B30.16 — Overhead Hoists (Underhung)
ASME B30.17 — Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
ASME B30.18 — Stacker Cranes (Top or Under Running Bridge, Multiple Girder With Top or Under Running Trolley Hoist)
ASME B30.19 — Cableways
ASME B30.20 — Below-the-Hook Lifting Devices
Reference Standards (Cont...)
ASME B30.21 — Manually Lever Operated Hoists
ASME B30.22 — Articulating Boom Cranes
ASME B30.23 — Personnel Lifting Systems
ASME B30.24 — Container Cranes
ASME B30.25 — Scrap and Material Handlers
ASME B30.26 — Rigging Hardware
ASME B30.27 — Material Placement Systems
ASME B30.28 — Balance Lifting Units

OSHA 29 CFR 1910 General Industry
Subpart N -- Material Handling and Storage
1910.179 — Overhead and gantry cranes.
1910.180 — Crawler locomotive and truck cranes.
1910.181 — Derricks.
1910.183 — Helicopters.
1910.184 — Slings.

OSHA 29 CFR 1926 Safety and Health Regulations for Construction
Subpart N -- Cranes, Derricks, Hoists, Elevators, and Conveyors
1926.551 — Helicopters.
1926.552 — Material hoists, personnel hoists and elevators.
1926.553 — Base-mounted drum hoists.
1926.554 — Overhead hoists

Subpart R -- Steel Erection
1926.753 — Hoisting and Rigging.
Reference Standards (Cont...)

Subpart CC -- Cranes and Derricks in Construction

1926.1402 — Ground conditions.
1926.1403 — Assembly/Disassembly – selection of manufacturer or employer procedures.
1926.1404 — Assembly / Disassembly – general requirements (applies to all assembly and disassembly operations).
1926.1405 — Disassembly – additional requirements for dismantling of booms and jibs (applies to both the use of manufacturer procedures and employer procedures).
1926.1406 — Assembly/Disassembly-employer procedures - general requirements.
1926.1407 — Power line safety (up to 350 kV) – assembly and disassembly.
1926.1408 — Power line safety (up to 350 kV) – equipment operations.
1926.1409 — Power line safety (over 350 kV).
1926.1410 — Power line safety (all voltages) - equipment operations closer than the Table A zone.
1926.1411 — Power line safety - while traveling.
1926.1412 — Inspections.
1926.1413 — Wire rope – inspection.
1926.1414 — Wire rope – selection and installation criteria.
1926.1415 — Safety devices.
1926.1416 — Operational aids.
1926.1417 — Operation.
1926.1418 — Authority to stop operation.
1926.1419 — Signals – general requirements.
1926.1420 — Signals – radio, telephone or other electronic transmission of signals.
1926.1421 — Signals – voice signals – additional requirements.
1926.1422 — Signals – hand signal chart.
1926.1423 — Fall protection.
Reference Standards (Cont...)
1926.1424 — Work area control.
1926.1425 — Keeping clear of the load.
1926.1426 — Free fall and controlled load lowering.
1926.1427 — Operator qualification and certification.
1926.1428 — Signal person qualifications.
1926.1429 — Qualifications of maintenance & repair employees.
1926.1430 — Training.
1926.1431 — Hoisting personnel.
1926.1432 — Multiple-crane/derrick lifts-supplemental requirements.
1926.1433 — Design, construction and testing.
1926.1434 — Equipment modifications.
1926.1435 — Tower cranes.
1926.1436 — Derricks.
1926.1437 — Floating cranes/derricks and land cranes/derricks on barges.
1926.1438 — Overhead & gantry cranes.
1926.1439 — Dedicated pile drivers.
1926.1440 — Sideboom cranes.
1926.1441 — Equipment with a rated hoisting/lifting capacity of 2,000 pounds or less.
1926.1442 — Severability

American Petroleum Institute Codes
API RP 2D — Operation and Maintenance Offshore Cranes
Notes
Notes
To reorder The Complete Rigger's Reference Handbook or other field reference guides contact:

www.riggsafe.com

or email your request to info@riggsafe.com

(888) 315-1325
1.0 OBJECTIVE/PURPOSE

This standard establishes the methods of lifting and handling freight containers (CONEX boxes) including the allowable lifting configurations, procedures, inspection, and rigging requirements outside of maritime use. In order to safely lift any conex box, the type of conex box and proper rigging configuration must be determined prior to performing the lift evolution. Section 3.0 provides conex box measurements for the various types of boxes. Once the type of conex box is determined, the lift configuration can be determined based on the load in the conex box. The type of conex box and the load of the conex box are used to determine the type of rigging configuration required to perform the lift.

2.0 INTRODUCTION/BACKGROUND

The maritime industry handling of the containers conforms to OSHA 29 CFR 1918, Safety and Health Regulations for Longshoring requirements. Questions were raised regarding the proper handling of freight containers for non-maritime applications and whether the maritime standards should be applied. Following a review of the various codes and standards related to container handling, there is primarily one International Standard, ISO 3874, Series 1 Freight Containers – Handling and Securing that shows the proper lifting configurations for the proper handling of the freight containers. These configurations are for lifting containers that comply with the specification and testing for the minimum performance requirements for the manufacture of freight containers identified in ISO-1496-1 1990-08-15, Series 1 Freight Containers–Specifications and Testing. The following lifting configurations and requirements for lifting freight containers will address the most common methods allowed to lift both empty and loaded containers. The lifting requirements follow the guidance of the OSHA 29 CFR 1918, ISO standards and a DOE-Idaho evaluation of container lifting points EDF-6285 (Reference 8). The EDF-6285 documents allowable loads for radioactive contaminated containers that comply with 49 CFR 173. The inspection of the container, inspection of the lift points, and the rigging hardware follow DOE-RL-92-36, the ASME B30 series of standards, this standard, and good industry practice–as applicable.

3.0 CONTAINER REQUIREMENTS

The Series 1 freight containers addressed in this standard should comply with ISO-1496. Other types of containers will be evaluated on a case-by-case basis. Table 1, below, shows the designations of the containers associated with nominal dimensions. The containers should be in good repair, with no significant corrosion or alterations to the container structure. If alterations to the container have been made since it was manufactured and put into service (doors, cut openings, vents), inspection should be completed by a qualified structural person to assure the alterations will not affect the structural integrity/capacity of the container when subjected to lifting loads. The corner fittings of the containers must meet the requirements of ISO 1161 1984-12-15, Series 1 Freight Containers – Corner Fittings – Specifications. The corner fittings should be in good repair with no visible signs of deformation of the holes (edges not straight and square) or excessive peening around the edges (rounded edges with metal deformed beyond the faces of the corner fittings).
The gross weight allowable from ISO 668 1995-12-15, Series 1 Freight Containers – Classification, Dimensions and Ratings for the containers has a factor of safety of about 2 to 2.5. To maintain the factor of 3 to yield requirements of 49CFR173.410 (Ref 5) for radioactive containers, use the load limits given by the calculation performed for the lift connections of freight containers containing radioactive materials at DOE-Idaho, EDF-6285, Evaluation of Cargo Container Lifting Fittings (Ref 8). This calculation reduced the allowable gross weight of the radioactive containers below the allowables of ISO 668 (see Table 2). Specific allowable gross weight of containers may be increased beyond Table 2 if documented by the manufacturer or by faceplate attached to the container. Contaminated containers must still be limited by the Table 2 values per EDF-6285.

### Table 1. Container Size Designations

<table>
<thead>
<tr>
<th>Nominal Length</th>
<th>External Height</th>
<th>AX</th>
<th>A</th>
<th>AA</th>
<th>AAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>m ft</td>
<td>&lt;8 ft 0 in</td>
<td>8 ft 0 in</td>
<td>8 ft 6 in</td>
<td>9 ft 6 in</td>
<td></td>
</tr>
<tr>
<td>12 40</td>
<td>AX</td>
<td>A</td>
<td>AA</td>
<td>AAA</td>
<td></td>
</tr>
<tr>
<td>9 30</td>
<td>BX</td>
<td>B</td>
<td>BB</td>
<td>BBB</td>
<td></td>
</tr>
<tr>
<td>6 20</td>
<td>CX</td>
<td>C</td>
<td>CC</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3 10</td>
<td>DX</td>
<td>D</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Note - All Units have a nominal width of 8 ft 0 in

Note: Containers designated “X” (e.g. DX or AX) are simply short, open-topped containers.

### Table 2. Allowable Gross Weight of Containers

<table>
<thead>
<tr>
<th>Container designation</th>
<th>Per ISO-668 (LBS)</th>
<th>Per EDF-6285 (Ref 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AX, A, AA, AAA</td>
<td>67200</td>
<td>44900</td>
</tr>
<tr>
<td>BX, B, BB, BBB</td>
<td>56000</td>
<td>44900</td>
</tr>
<tr>
<td>CX, C, CC</td>
<td>52900</td>
<td>44900</td>
</tr>
<tr>
<td>DX, D</td>
<td>22400</td>
<td>22400</td>
</tr>
</tbody>
</table>

Note: AX, A, AA and AAA are all the same length but they differ in height (see Table 1). Likewise with B, C, and D series containers.
4.0 APPROVED LIFTING METHODS

There are four basic approved lifting methods for freight containers. They are as follows: the Top Lift Spreader Method, the Top Lift Sling Method, the Bottom Lift Sling Method, and the Fork Lift Method. Any time a sling is used at an angle, it should follow the minimum angle requirements of Table 3 below. See specific lifting methods for more details. Appendix D lists minimum sling lengths to achieve the proper angle in different configurations.

![Table 3. Sling Lifting Angles](image)

<table>
<thead>
<tr>
<th>Container Size Designation</th>
<th>Lifting Angle, $\alpha$, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA; AA; A; AX</td>
<td>$45^\circ$</td>
</tr>
<tr>
<td>BBB; BB; B; BX</td>
<td>$45^\circ$</td>
</tr>
<tr>
<td>CC; C; CX</td>
<td>$45^\circ$</td>
</tr>
<tr>
<td>D; DX</td>
<td>$60^\circ$</td>
</tr>
</tbody>
</table>

5.0 LIFTING EMPTY CONTAINERS

Empty containers can be lifted by all four methods shown in Section 6: Top Lift Spreader, Top Lift Sling, Bottom Lift Sling, and Fork Lift (Figures 1, 2, 3 and 4). Containers can be considered empty if the lifted weight is within 1000 pounds of the listed tare weight of the container. The minimum lifting angles are as shown in Table 3. Empty freight containers can be lifted from the top lift connections using hooks provided that the hooks are placed in an inward to outward direction as shown in Figure 2.

6.0 LIFTING LOADED CONTAINERS

All loaded containers can be lifted by the Top Lift Spreader Method or Bottom Lift Sling Method (Figures 1 and 3). Loaded CC, C, CX, D, and DX containers can be lifted with the Fork Lift Method, and loaded D and DX containers can be lifted with the Top Lift Sling Method. The corresponding tables (Tables 4 and 6) show which types of lifting methods can be used for the unloaded and loaded containers. The unacceptable methods are denoted by a shaded box in the tables associated with the lift methods.
6.1 TOP LIFT SPREADER METHOD

The container is lifted by means of a spreader designed to lift containers by the top apertures of the four top corner fittings, the lifting forces being applied vertically. These spreaders have lifting devices specifically designed to connect to the top corner fittings of freight containers. They do not use normal hooks.

a. The lifting devices shall be properly engaged. Gathering devices shall impinge on corner fittings only.

b. The applicability of top lift spreaders is given in Table 4.

![Figure 1. Top Lift Spreader Configuration](image)

Table 4. Top Lift Spreader Acceptable Use Table

<table>
<thead>
<tr>
<th>Container Type</th>
<th>ISO 6346 Def</th>
<th>Loaded Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty Container</td>
<td>General Purpose</td>
<td>GP, VH</td>
</tr>
<tr>
<td></td>
<td>Open Top</td>
<td>UT</td>
</tr>
<tr>
<td></td>
<td>Bulk: non-pressurized</td>
<td>BU</td>
</tr>
<tr>
<td></td>
<td>Thermal</td>
<td>RE, RT, RS</td>
</tr>
<tr>
<td></td>
<td>Platform</td>
<td>PL</td>
</tr>
</tbody>
</table>

Note: Freight containers containing radioactive material have a reduced capacity. See Table 2.
6.2 **TOP LIFT SLING METHOD**

The Top Lift Sling method can only be used for handling empty containers (see Table 5) or loaded D or DX containers (10 ft long).

a. The container is lifted by all four top corner fittings with forces applied other than vertically.

b. Lifting devices shall be properly engaged. Hooks shall always be placed in an inward to outward direction along the length of the container (Figure 2b). These hooks should meet the criteria of ASME B30.10 (Ref 11) and ISO 2308:1972 (Ref 14).

c. The applicability of Top Lift Slings is given in Table 5.

d. For loaded containers, the lifted angle, \( \alpha \), shall not be less than the minimum values shown in Table 3 or exceed the gross container weight of Table 2. See Appendix E for minimum sling lengths to achieve the minimum angle.

![Figure 2. Top Lift Sling Configuration](image)

**Table 5. Top Lift Sling Acceptable Use Table**

<table>
<thead>
<tr>
<th>Empty Container</th>
<th>Container Type</th>
<th>ISO 6346 Def</th>
<th>Loaded Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA AA A AX BBB BB B BX CC C CX D DX</td>
<td>General Purpose</td>
<td>GP, VH</td>
<td>AAA AA A AX BBB BB B BX CC C CX D DX</td>
</tr>
<tr>
<td>1) 1) 1) 1)</td>
<td>Open Top</td>
<td>UT</td>
<td>2) 2)</td>
</tr>
<tr>
<td>n/a</td>
<td>Bulk: non-pressurized</td>
<td>BU</td>
<td>2) 2)</td>
</tr>
<tr>
<td>1) 1) 1) 1)</td>
<td>Thermal</td>
<td>RE, RT, RS</td>
<td>n/a</td>
</tr>
<tr>
<td>n/a</td>
<td>Platform</td>
<td>PL</td>
<td>n/a n/a</td>
</tr>
</tbody>
</table>

1) Center of Gravity may be eccentric
2) For 1D and 1DX containers, lifting forces shall be applied at an angle of no less than 60 degrees to the horizontal

Note: Freight containers containing radioactive material have a reduced capacity. See Table 2.
6.3 BOTTOM LIFT SLING METHOD

The Bottom Lift Sling method of lifting can be used for empty and loaded containers. The container is lifted from the side of the four bottom corner fittings attached by slings to a spreader beam. The bottom sling attachment shall bear on the corner fittings only and should be such to exert lifting forces not more than 1.5 inches away from the outer face of the corner fittings (Figure 3b).

a. The lifting devices shall be properly engaged.

b. The applicability of the Bottom Lift Slings is given in Table 6.

c. For loaded containers, the lifted angle, $\alpha$, shall not be less than the minimum values shown in Table 3 or exceed the gross container weight of Table 2. See Appendix E for minimum sling lengths to achieve the minimum angle.

![Figure 3. Bottom Lift Sling Configuration](image)

### Table 6. Bottom Lift Sling Acceptable Use Table

<table>
<thead>
<tr>
<th>Empty Container</th>
<th>Container Type</th>
<th>ISO 6346 Def</th>
<th>Loaded Container</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Purpose</td>
<td>GP, VH</td>
<td></td>
</tr>
<tr>
<td>AAA</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>AX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAA</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>AA</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>AX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BBB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DX</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Center of Gravity may be eccentric
2) Center of Gravity may be mobile, e.g. liquid, bulk or hanging loads.

- Allowed
- Not allowed (or not applicable)
6.4 FORK LIFT METHOD

The container, if provided with fork-lift pockets as specified in ISO-1496-1 (shown in Figure 4), is lifted by means of forks. This method only applies to the C and D type containers (20 and 10 foot long containers) whether loaded or not (see table 7).

Warning: Containers, with or without fork-lift pockets, shall not be lifted by forks under the base of the container (as opposed to in fork-lift pockets) except as specified in section 7.2.

   a. The forks should ideally extend the whole width of the container, but under no circumstances should they extend less than 6 feet or 72 inches.

   b. When 1CC, 1C, and 1CX containers are fitted with a second (inner) set of fork-lift pockets, these pockets shall be used for empty handling only.

   c. The applicability of fork lifts is given in Table 7.

---

Note: Freight containers containing radioactive material have a reduced capacity. See Table 2.
Note: Freight containers containing radioactive material have a reduced capacity. See Table 2.

7.0 ALTERNATIVE LIFTING METHODS

The following are options for alternative lifting methods:

Note: Freight containers containing radioactive material have a reduced capacity. See Table 2.

7.1 MANUFACTURER’S METHODS

Other lifting methods or applications of the above methods may be used if approved by the freight container’s manufacturer. For instance, some manufacturer’s supply 30 and 40 foot long containers with fork lift pockets. With the manufacturer’s approval, these containers may be lifted using a fork lift. This is typically used on empty containers.

7.2 CONTAINERS UNDERNEATH POWERLINES

Existing containers without fork pockets, residing underneath energized overhead lines and within the prohibited zone (as defined in DOE-0359, Hanford Site Electrical Safety Program), may be moved with a forklift from the prohibited zone within the requirements of one of the following options.

1. Option A
   a. The container is empty;
   b. The container is only moved from the prohibited zone where it can be handled as prescribed in this standard or is moved directly to a transport vehicle outside of the prohibited zone;
   c. The container is inspected by a qualified engineer
      i. Prior to the move to ensure the container is structurally sound and
      ii. After the move for structural damage prior being returned to service;
   d. Management approval is obtained; and
   e. Forks meet the requirements of 6.4 (a).

2. Option B
   a. The container is empty;
   b. The container is inspected for safety and stability by a qualified engineer prior to the move;
   c. The container is permanently removed from service and rendered unusable after the move;
   d. Management approval is obtained; and
   e. Forks meet the requirements of 6.4 (a).
7.3 ENGINEERED METHODS

Engineering may approve alternate lifting methods on a case by case basis. In such cases, engineering shall conduct an evaluation of the box and provide design of the lifting method.

8.0 RIGGING REQUIREMENTS

The lifting device requirements for lifting the containers shall comply with the ASME B30.20 Below the Hook Lifting Devices as applicable and DOE-RL-92-36 for the below the hook lifting equipment. If an accurate reading for documentation or shipping purposes is required, or if the estimated weight of the container is close to the maximum rated capacity of the container, then a dynamometer shall be used to perform the lift. Assure that the maximum loads of the containers are not exceeded (see Table 2).

a. Care shall be taken to ensure that the equipment used is suitable for the load and is safely attached to the container and the container is free to be handled.

b. In the case of a single point lift, special attention should be paid to the risk of the container tilting due to eccentricity of the center of gravity.

9.0 REFERENCES


ASME 30.10-2005, Hooks

ASME B30.20-2006, Below-the-Hook Lifting Devices

ASME B30.26-2004, Rigging Hardware

ASME B30.9-2006, Slings

ASME BTH-1-2005, Design of Below the Hook Lifting Devices


EDF-6285, Evaluation of Cargo Container Lifting Fittings, Idaho Cleanup Project, USDOE by CH2M-WGIIdaho, LLC.


ISO 1496-1 1990-08-15, Series 1 Freight Containers – Specification and Testing

ISO 2308:1972, Hooks for lifting freight containers of up to 30 t capacity — Basic requirements.
ISO 3874, Series 1 Freight Containers – Handling and Securing

ISO 668 1995-12-15, Series 1 Freight Containers – Classification, Dimensions and ratings.

OSHA 29 CFR 1918, Safety and Health Regulations for Longshoring
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APPENDIX A

LIFT DESIGNATIONS
APPENDIX A-LIFT DESIGNATIONS

Lift Designations

In order to plan for lifting freight containers (Conex boxes), the type of lift to be performed must first be determined. The lift will be designated as a “Normal,” “Special,” or “Critical” lift. Existing WRPS procedures and the DOE-RL-92-36 already address the requirements for planning and executing all lifts including Special and Critical lifts. For all types of lifts; however, the type of container to be lifted must be determined. The type of container and the container capacity are usually posted on a metal placard inside the door of the container. If the placard information is not available, then the tables in this standard and the associated dimensions for each type of container can be used to determine the container type. The type determination and inspection of each container uses a graded approach.

Lift Planning

For Normal lifts, the planning process for lifting freight containers will normally involve at least the following:

1) Field Work Supervisor
2) Designated Leader (DL) performing the lift.

Special lifts may also require additional approval according to company procedures.

The Hanford Site Hoisting and Rigging Manual DOE-RL-92-36 requires critical lift signature approvals. Additional approvals may be required according to company procedures.
APPENDIX B

LIFT POINT INSPECTIONS
APPENDIX B-LIFT POINT INSPECTIONS

For Normal lifts, the inspection and evaluation of the container and lift points are performed by the Qualified Riggers performing the lift.

For Special and Critical lifts, the lift points and the containers will need to be evaluated by a Qualified Rigging Engineer.

All manufacturer-installed lift points shall be inspected and evaluated by a qualified person before use for cracks, deformation, and excessive wear or damage. When questions arise regarding the use of manufacturer-installed lift points, the Qualified Rigging Engineer shall be consulted.
APPENDIX C

CLOSELY STACKED CONTAINERS
APPENDIX C-CLOSELY STACKED CONTAINERS

In some cases, Conex boxes may be closely stacked side by side. This may prevent lifters (corkies) from being installed on the sides of the bottom of the box. Thus, the Bottom Lift Sling method cannot be used. In this case, the box may be lifted from the top lift points in order to relocate the box. If the box is loaded, the Top Lift Spreader method should be used.

Conex box spreaders; however, are expensive, heavy, and cannot be used if there are fans or other protrusions on the top of the container. Because of this, conex box spreaders are often unavailable or impractical. In these cases where conex box spreaders are unavailable or impractical and the box is loaded, the following approach should be followed:

- Install lifters (e.g. corkies) on the ends of the corner fittings on the bottom of one side of the box, and ensure that the lifters are properly engaged. The ends of the top corner fittings may not be used because they have a different sized and shaped hole.

- Connect slings to the lifting lugs and make sure they meet the requirements for minimum sling lifting angles given in Table 3 of this standard. Note: since corkies rely on the slings being angled to work properly, a spreader beam should not be used for this part of the operation; both slings should connect to one hook or shackle as shown in Figure 5. Lift the end of the box to a minimal height (ideally no more than a few inches off the ground) and shift it to the side. Use care not to side load the crane. The mobile crane operator should use the boom up method or the boom extension method when shifting one end of the container box.

- Set the box end down and repeat for the other side. This should create enough space between the conex boxes to install lifters on the sides of the box.

- Install lifters on the sides and use the bottom lift sling method to move the box.

![Figure 5. Example of one end of a box being lifted in order to slide sideways.](image-url)
APPENDIX D

MODIFIED CONTAINERS
APPENDIX D-MODIFIED CONTAINERS

All Conex boxes will need to be inspected to determine if modifications have been made. If modifications have been made to the Conex box, then it will need to be evaluated by a Qualified Rigging Engineer prior to performing the lift.

In all cases, an inspection of the Conex box is necessary to: 1) determine the type of Conex box, and 2) to determine if there are any detrimental modifications that have been made to the box, and 3) to evaluate the integrity of the lift points. If there are any questions regarding the integrity of the Conex box, contact the Civil/Structural Discipline Lead Engineer.

Some examples of modifications, as illustrated below, include adding roll up doors to the ends or to the sides of the box.

Doors added to the side of a Conex box. These may negatively impact the structural integrity of the box.
Doors added to the ends of two Conex boxes. These may also have a negative effect on the strength of the boxes.
APPENDIX E

MINIMUM SLING LENGTHS
APPENDIX E-MINIMUM SLING LENGTHS

Table 8. Minimum Sling Lengths

<table>
<thead>
<tr>
<th>CONTAINER TYPE</th>
<th>DIMENSIONS (W X L)</th>
<th>4 WAY BRIDLE LENGTH</th>
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</thead>
<tbody>
<tr>
<td>AX, A, AA, AAA</td>
<td>8 X 40</td>
<td>30’</td>
</tr>
<tr>
<td>BX, B, BB, BBBB</td>
<td>8 X 30</td>
<td>24’</td>
</tr>
<tr>
<td>CX, C, CC</td>
<td>8 X 20</td>
<td>16’</td>
</tr>
<tr>
<td>DX, D</td>
<td>8 X 10</td>
<td>14’</td>
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</table>

<table>
<thead>
<tr>
<th>CONTAINER TYPE</th>
<th>DIMENSIONS (W X L)</th>
<th>2 WAY BRIDLE LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>AX, A, AA, AAA</td>
<td>8 X 40</td>
<td>30’</td>
</tr>
<tr>
<td>BX, B, BB, BBB</td>
<td>8 X 30</td>
<td>24’</td>
</tr>
<tr>
<td>CX, C, CC</td>
<td>8 X 20</td>
<td>16’</td>
</tr>
<tr>
<td>DX, D</td>
<td>8 X 10</td>
<td>12’</td>
</tr>
</tbody>
</table>

Note 1: This table was made assuming the center of gravity is centered. Eccentric loads will require varying sling lengths or the addition of shackles.

Note 2: This table only gives sling lengths. Sling size (thickness) will be determined based on load and load placement characteristics and will vary case by case.

Note 3: Lifting lugs shall be properly engaged. Depending on the lugs used, this may require sling angle adjustment, but the angle shall not be below 45 degrees.
ATTACHMENT 2

Lifting Requirements for Concrete Blocks
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Lifting Requirements for Concrete Blocks

Concrete Blocks (i.e., Ecology, Landscaping Blocks) stacked more than two high shall be evaluated for structural stability. Lifting blocks that are not stacked, with a forklift (load on tines) are acceptable. Concrete Block lift bails shall be inspected and found free of cracks, deformation, excessive wear exceeding 10% of nominal size, damage, or broken wires or stands, as applicable, before being lifted using bails under one of the following approved conditions and methods

1. Lifting with “Engineered and Marked” Concrete Blocks

   Concrete blocks that meet the following requirements or equivalent as determined and approved by a qualified engineer, may be lifted using the lifting bale.

   - Concrete Blocks shall be designed by a licensed professional engineer.
   - Concrete shall be per American Concrete Institute (ACI) 318 and 301.
   - Lifting bail embedment shall comply with ACI 318 and lifting bail material shall be designed to the applicable codes to withstand the anticipated lifting loads.
   - Concrete Block manufacturers shall implement a documented system for quality control of the block fabrication. The system shall include random testing of a minimum 10% of the lifting bails to a 125% load test for each contractor purchase order.
   - Each concrete block shall be permanently marked (etched or stenciled) on both sides of the block with the Contract Number and the month and year of fabrication.

2. Lifting with an approved below-the-hook lifting device

   Concrete blocks that do not meet the requirements of an Engineered and Marked block, shall be lifted with an approved below-the-hook lifting device meeting the requirements of DOE-RL-92-36 Hanford Hoisting & Rigging Manual, Chapter 11, Below-the-Hook Lifting Devices.

3. Lifting with Special lift plan

   Existing concrete blocks that do not meet the requirements of an Engineered and Marked block and are configured in a position that prohibits the use of an approved lifting device, shall be lifted by implementing Special/Engineered lift criteria addressing hazards associated with a possible lift point failure.
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