

Section 18

Slings, Rigging Hardware, and Wire Rope

18.1 Scope

This section sets forth equipment requirements for slings, rigging hardware, chains, wire rope and rope end connectors. This section addresses equipment related responsibilities, training, inspection, repair, and removal from service. Please refer to Section 19 for guidance on hoisting and lifting operations, as well as roles and responsibilities involved in hoisting and rigging operations.

18.2 General Requirements

Safe use of slings is governed by the American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME) standards and the Occupational Safety and Health Administration (OSHA) regulations. It is Reclamation policy to adhere to the contents of the standards listed in Table 18-1. Slings and Rigging Standards.

Table 18-1. Slings and Rigging Standards

Standard Number	Title
ANSI/ASME B30.9	<i>Slings</i>
ANSI/ASME B30.10	<i>Hooks</i>
ANSI/ASME B30.20	<i>Below-the-Hook Lifting Devices</i>
ANSI/ASME B30.26	<i>Rigging Hardware</i>
OSHA 29 CFR 1910.179	<i>Overhead and Gantry Cranes</i>
OSHA 29 CFR 1910.184	<i>Slings</i>
OSHA 29 CFR 1926.251	<i>Rigging Equipment for Material Handling</i>
OSHA 29 CFR 1926.753	<i>Hoisting and Rigging</i>
OSHA 29 CFR 1926.1412	<i>Inspection</i>
OSHA 29 CFR 1926.1413	<i>Wire rope-- inspection</i>
OSHA 29 CFR 1926.1434	<i>Equipment Modifications</i>

18.3 Responsibilities

18.3.1 Area Office Safety Professional

- 18.3.1.1** Shall verify annually inspection documentation is complete, clear, and in conformance with this section, FIST 4-1A, and manufacturer's procedures.

18.3.1.2 Shall verify annually that equipment is inspected, tested, and documented as required by this section.

18.3.1.3 Shall ensure equipment is consistently documented or marked.

18.3.2 Facility Manager

18.3.2.1 Shall designated and coordinate/provide training for designated person(s) to complete daily/shift equipment inspections.

18.3.2.2 Shall ensure the designated person doing daily/shift inspections understands the hazards, equipment use, testing, documentation and wear and tear.

18.3.2.3 Shall ensure employees using slings, wire rope, and rigging hardware have the necessary personal protective equipment.

18.3.2.4 Shall ensure equipment inspection documentation is available and includes date, signature of who performed the inspection and identity of equipment inspected.

18.3.2.5 Shall ensure equipment is consistently and clearly labeled or marked.

18.4 Training Requirements

18.4.1 Initial

Inspection of equipment shall be completed by a designated person who has been trained in equipment selection, inspection, potential hazards and cautions to personnel, effects of environment, and rigging practices of the specific components/equipment in use. The designated person shall be trained to meet ASME B30 requirements for rigging inspection and removal from service.

18.4.2 Recordkeeping

All Reclamation training records shall be kept in the Department of the Interior (DOI) official repository.

18.5 Hazard Identification, Assessment, and Safety Measures

18.5.1 Equipment Hazard Identification

Slings, rigging hardware, and related equipment shall be visually inspected before each use. Remove items from service if found to be deformed, damaged or otherwise do not meet inspection criteria and are not safe for use. Manufacturer's instructions shall be referred to for equipment specific signs of damage or excessive wear and tear.

18.5.1.1 Slings. Slings (any material or shape) shall be removed from service if showing any visible damage or defects, such as snags, punctures, tears, cuts, work stitches

or core yarn, elongation, knots, broken/worn fittings, or inability to function as designed. Cut up and discard slings removed from service due to defects or plainly mark them as being unfit for load-bearing service.

18.5.1.2 Hardware. Hardware shall be removed from service if showing visible signs of acid or caustic burns, melting or charring, heat damage from welding and arc strikes, pitting or corrosion, 10% reduction of the original dimension at any point, distortion or inability to function as designed.

18.5.1.3 Temperature and Chemical Limitations. Extreme temperatures and chemically active environments may reduce the performance or degrade the strength and integrity of components. Manufacturer instructions and information must be consulted for temperature limits and use in chemically active environments. If identification is missing or illegible, equipment shall be removed from use until approved by a qualified inspector.

18.5.1.4 Unauthorized Alterations. Unauthorized alterations to equipment shall be cause for removal from service. A qualified registered PE must approve any special equipment used to complete a lift. Modifications or additions which affect the capacity or safe operation of the equipment are unauthorized and prohibited until the requirements of OSHA 1926.1434 are met.

18.6 Safe Practices

18.6.1 Safe Use

Use of equipment by a designated qualified person for rigging operations shall comply with equipment manufacturers' instructions/recommendations.

18.6.2 Protection and Storage

Protect slings with a material of enough strength, thickness, and construction to prevent damage to strands, fibers, wires, or links from sharp, rough, or square corners. Properly store slings when they are not in use to protect them from mechanical damage, corrosive action, moisture, temperature extremes, ultraviolet light, ozone, or other factors as appropriate. Hardware shall be stored away from extreme heat and chemicals, or other potentially damaging conditions.

18.6.3 General Safe Practices

Whenever any sling is used, observe the following practices:

- identify each sling with a tag or band for use and inspection purposes;
- do not use damaged or defective slings;

- do not shorten slings with knots, bolts, or other makeshift devices, or kink sling legs;
- do not load slings in excess of their rated capacities;
- balance the loads of slings used in a basket hitch to prevent slippage;
- do not rig slings or legs less than 30 degrees;
- securely attach slings to their loads;
- pad or protect slings from the sharp edges of their loads;
- keep suspended loads clear of all obstructions;
- keep all employees clear of loads about to be lifted and of suspended loads;
- do not place hands or fingers between the sling and its load while the sling is being tightened around the load;
- prohibit shock loading;and
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- do not drag slings on the floor or over an abrasive surface.

18.6.4 Inspections

Conduct thorough visual inspections of equipment, observing for apparent deficiencies, proper labeling of equipment, and adherence to manufacturers' recommended use.

Inspections shall be performed in accordance with Reclamation FIST 4-1A, Chapter 6, *Cranes, Hoists, Rigging Equipment, and Elevators*, OSHA 1926.1412, *Inspections*, and OSHA 1926.1413, *Wire rope—inspections*.

- 18.6.4.1 Initial.** An inspection shall be conducted before initial use and after any approved alterations are made. This is performed by the manufacturer or a qualified professional engineer (PE) for any altered/modified equipment.
- 18.6.4.2 Daily/Shift.** Prior to using specific equipment, daily or shift inspections shall be conducted by the operator and qualified rigger.
- 18.6.4.3 Frequent.** Frequent inspections by a qualified rigger shall be performed monthly or more frequently as needed, per FIST 4-1A, chapter 6. Considerations of frequency shall include the use, severity of service conditions, nature of lifts, and experience with equipment in similar circumstances.
- 18.6.4.4 Periodic.** Periodic inspections shall be performed annually or more frequently as needed, by the area office safety professional and a qualified rigger designated by the facility manager.
- 18.6.4.5 Documentation.** Inspection records shall be retained until the next periodic inspection and available for operating personnel and upon request for employees and compliance officials.

18.6.5 Job-fabricated/purpose-built rigging hardware

A qualified PE must design and certify the use of any job-fabricated/purpose-built rigging hardware to be built to a safety factor of 5. Proof test any special custom job-fabricated/purpose-built hardware to 125% of rated load. Inspection criteria for job-fabricated and purpose-built below-the-hook lifting devices, other than slings, shall follow ANSI/ASME B.30.20, specifically sections 20-1.3.1 through 20-1.3.7 and 20-1.3.9.

18.6.6 Use, Repair, and Maintenance

The use, repair, and maintenance of ropes, chains, slings, and rigging accessories must conform to the manufacturer's written instruction, applicable standards listed in Table 18-1, and Reclamation FIST 4-1A, Chapter 6, *Cranes, Hoists, Rigging Equipment, and Elevators*.

18.6.7 Alloy Steel Chain Slings

For additional information, refer to Reclamation FIST 4-1A, 6.11.4, *Alloy Steel Chain Slings*, OSHA 1910.184(e), 1926.251(b), and ANSI/ASME B30.9, Chapter 9-1 *Alloy Steel Chain Slings: Selection, Use, and Maintenance*.

- 18.6.7.1 Identification.** Alloy steel chain slings shall have permanently affixed durable identification stating size, grade, rated capacity, and reach. Only rigging identified chain shall be used for rigging operations.
- 18.6.7.2 Working Load Limit.** Chains shall have a minimum design factor of 5 of the anticipated rated load. Do not exceed the manufacturer's working load limit for any configuration.
- 18.6.7.3 Proof Testing.** Proof test load requirements are listed in ANSI/ASME B30.9. When repaired, a chain sling must be permanently marked to identify the repairing agency. Prior to use, each new, repaired, or reconditioned alloy steel chain sling and all welded parts in the sling assembly shall be proof tested by the manufacturer or a qualified person. Make a copy of the proof test certificate, including the date and weight, and make the records available for examination.
- 18.6.7.4 Grade.** In hoisting operations, use only heat-treated alloy steel chains that meet at least Grade 80. Alloy steel chains shall have permanently affixed identification stating size, grade, rated capacity, and reach.
- 18.6.7.5 Attachments.** The rated capacity of hooks, rings, links, or other attachments used with alloy steel chains must at least equal that of the chains. Do not use job-made hooks, links, or makeshift fasteners made from bolts or rods.
- 18.6.7.6 Shock Loading.** Do not subject chains to shock loading.

18.6.7.7 Excessive Wear. Whenever the wear at any point in any chain link, or the depth of gouge or rounded out portion, exceeds the measurements in Table 18-2, remove it from service. Use a device capable of measuring to one-thousandth of an inch to measure chain wear. Remove any sharp nicks by hand filing.

Table 18-2. Minimum Allowable Thickness on a Link

Original nominal chain stock diameter (inches)	Minimum allowable thickness at any point on a link (inches)
7/32 = 0.219	0.189
9/32 = 0.281	0.239
5/16 = 0.313	0.273
3/8 = 0.375	0.342
1/2 = 0.500	0.443
5/8 = 0.625	0.546
3/4 = 0.750	0.687
7/8 = 0.875	0.750
1 = 1.000	0.887
1-1/4 = 1.250	1.091

18.6.8 Wire Rope Slings

For additional information, refer to FIST 4-1A, 6.11.5, *Wire Rope Slings*, OSHA 1910.184(f), 1926.251(c), and ANSI/ASME B30.9, Chapter 9-2 *Wire Rope Slings: Selection, Use, and Maintenance*.

18.6.8.1 Working Load Limit. Do not exceed the manufacturer's working load limit for any configuration. For angles other than those shown on the manufacturer's tag, use the rated load for the next lower angle, or a qualified person shall calculate the load.

18.6.8.2 Identification. If the wire rope sling identification tag is missing or illegible, remove from service and replace or send it back to the manufacturer for recertification and identification.

18.6.8.3 Proof Test. Proof test load requirements are listed in ANSI/ASME B30.9. Job-made or repaired slings shall be proof tested by the sling manufacturer or a qualified person prior to use. Make a copy of the proof test certificate, including the date and weight, and make the records available for examination.

18.6.8.4 Protruding Ends. Cover or blunt protruding ends of strands in splices on slings and bridles.

18.6.9 Synthetic Web Slings

For additional information, refer to FIST 4-1A, 6.11.8, *Synthetic Webbing Slings* OSHA 1910.184(i), 1926.251(e), and ANSI/ASME B30.9, Chapter 9-5 *Synthetic Webbing Slings: Selection, Use, and Maintenance*.

18.6.9.1 Working Load Limit. Do not use a webbing sling at a load greater than the manufacturer's established working load limit. Follow the manufacturer's recommended working load limit for the specific angle of loading.

18.6.10 Metal Mesh Slings and Synthetic Rope Slings

For additional information, refer to FIST 4-1A, 6.11.6, *Metal Mesh Slings* & 6.11.7, *Natural and Synthetic Fiber Rope Slings*. If either metal mesh slings or synthetic rope slings are selected for special use, consult with the appropriate section of OSHA 1910.184(g) & (h), 1926.251(d), and ANSI B30.9.

18.6.11 Rigging Hardware

For additional information, refer to FIST 4-1A, 6.11.9, *Rigging Hardware*, and OSHA 1926.251(f).

18.6.11.1 Shackles. Each new shackle body and pin shall have forged, cast, or die stamped markings by the manufacturer to show the name or trademark of the manufacturer, working load limit (WLL), size shackle pin and identification/markings.

18.6.11.2 Adjustable Hardware. This hardware used for hoisting must be designed with a minimum safety factor of 5. Load rating will be in accordance with the hardware manufacturer's specifications. If found defective, the rigging hardware will not be repaired; it will be removed from service. All eyebolts shall be forged alloy steel and equipped with shoulders or collars.

18.6.11.3 Hooks. Hooks shall meet or exceed the requirements of ANSI/ASME B30.10 *Hooks*. Hook latches (keepers) are required on lifting hooks. Latch equipped hooks will be used for all hoisting and rigging operations unless the application makes the use of the latch impractical or unsafe. Hooks without latches, or with latches that are removed or disabled, must not be used unless a qualified person has determined that it is safer to hoist and place the load without latches (or with the latches removed/tied back). Alterations and repair of hooks or latches by welding or reshaping are not permitted.

18.6.12 Below-the-Hook Lifting Devices

For additional information, refer to FIST 4-1A, 6.11.13, *Below-the-Hook Lifting Devices* and ASME B30.20, *Below-the-Hook Lifting Devices*. A qualified PE must verify any existing and

new job-fabricated/purpose-built below-the-hook lifting devices meet the required design factor.

18.6.13 Wire Rope

Refer to OSHA 1926.251(c), ASME B30.2-2.2, *Rope Inspection*, and ASME B30.2-4.3, *Rope Replacement and Maintenance* for additional guidance.

- 18.6.13.1 Working Load Limit.** Manufacturer's specification data shall be used in determining working load limit and proper application. Wire rope used for hoisting shall be designed with a minimum safety factor of 5. Calculate the maximum working load limit of wire rope, dividing the manufacturers' supplied breaking strength by the safety factor.
- 18.6.13.2 Inspection and Retirement.** Trained personnel shall inspect wire rope on hoists on a regular basis in accordance with the manufacturer's recommendation. OSHA 1926.1413, *Wire rope inspection*, includes specific deficiencies, critical review items, and inspection frequency. Refer to FIST 4-1A, 6.5 *Inspections*, for guidance regarding wire rope inspection as a part of crane inspection.
- 18.6.13.3 Wire Rope Clip Connectors.** Wire rope clip connectors may use the U-bolt type or the twin base clip ("First" grip, double saddle) type. Use only new clips in making wire rope clip connectors.
- 18.6.13.4 U-bolt Type Clip.** U-Bolt clip saddle will be placed on the live end and shall be constructed from stainless steel or drop forged steel protected by an application of galvanized zinc coating. Consult the manufacturer for correct torque values, exact number of required clips, and spacing dimensions.
- 18.6.13.5 Twin Base Clips.** Twin base clips shall be placed on the live end and must be constructed from stainless steel or drop forged steel protected by an application of galvanized zinc coating. Consult the manufacturer for correct torque values, exact number of required clips, and spacing dimensions.
- 18.6.13.6 Wedge Socket.** Regularly inspect the integrity of the wire rope at the point of exit of the dead-end side. When the wire rope has met one-fifth of service life, remove the portion through the wedge and move the wedge up the rope to a new location.

18.7 Definitions

Angle of loading	The inclination of a leg or branch of a sling measured from the horizontal or vertical plane, provided that an angle of loading of 5 degrees or less from the vertical may be considered a vertical angle of loading.
Basket hitch	A sling configuration in which the sling is passed under the load and has both ends, end attachments, eyes, or handles on the hook or a single master link.
Coating	An elastomer or other suitable material applied to a sling, or to a sling component, to impart desirable properties.
Designated person	A person who is identified by the Facility Manager to complete daily, shift, and periodic equipment inspections and trained per paragraph 18.4.1.
Fabric (metal mesh)	The flexible portion of a metal mesh sling consisting of a series of transverse coils and cross rods.
Hitch	A sling configuration in which the sling is fastened to an object or load, either directly to it or around it.
Link	A single ring of a chain.
Proof load	The load applied when performing a proof test.
Proof test	A nondestructive tension test performed by the sling manufacturer, or an equivalent entity, to verify construction and workmanship of a sling.
Qualified Person	A person who possesses a recognized degree, certificate, or professional standing—or has extensive knowledge, training, and experience—and who can successfully demonstrate the ability to solve problems related to the subject matter, the work, or the project.
Rated capacity	Also, the working load limit, is the maximum working load permitted
Severity of use/service	The relative conditions and factors considered in wear and tear on equipment.
Shock loading	When a load is accelerated or decelerated too quickly. Shock loading puts additional strain on rigging system components and (if too severe) can damage or overload the system.
Sling	An assembly that connects the load to the material handling equipment.
Sling manufacturer	A person or organization that assembles sling components into their final form.

Working load limit See “rated capacity” definition

18.8 References

- Bureau of Reclamation. Facilities Instructions, Standards, and Techniques Volume 4-1A *Maintenance Scheduling for Mechanical Equipment, Revised January 2009*.
https://www.usbr.gov/power/data/fist_pub.html
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- Occupational Safety and Health Administration. Standard Interpretations. *Requirements for load-testing and marking of special custom-design rigging accessories; applicability of ASME standards*. February 9, 2004. <https://www.osha.gov/laws-regs/standardinterpretations/2004-02-09>
- Infrastructure Health & Safety Association (IHSA). Hoisting and Rigging Safety Manual.
<https://www.ihsa.ca/PDFs/Products/ld/M035.pdf>
- US Department of Energy - Hanford Site. Hanford Hoisting and Rigging Manual.
<https://www.hanford.gov/page.cfm/HoistingRiggingManual>