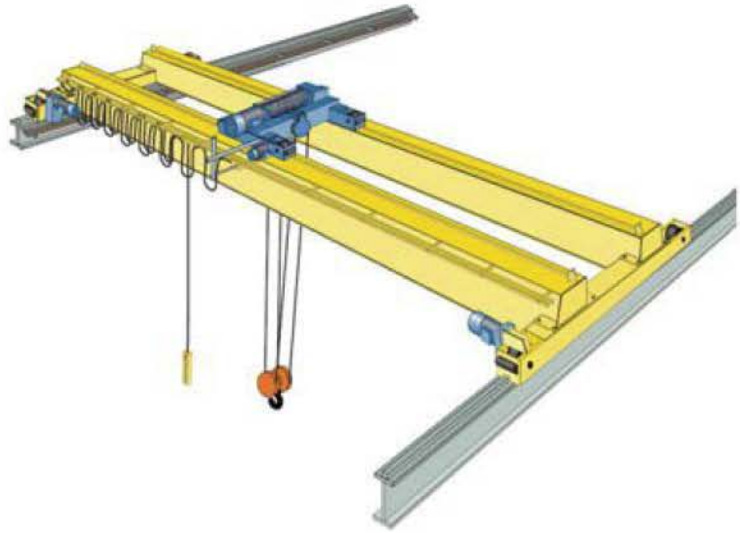

OVERHEAD CRANE OPERATOR
AND
RIGGER TRAINING

Table Of Contents

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Overhead Crane Operator / Rigger Training Course objectives

1. Given any selected overhead crane, the trainee will be able to perform a pre-operational inspection of the crane .
2. Given the basic requirements for a lift, the trainee will be able to plan a lift such that it can be accomplished efficiently, safely, and in complete accordance NASA STD 8719.9, Goddard Space Flight Center (GSFC) GPR 8834.1, (GSFC) GPR 8719.1, OSHA 1910.179, and ANSI B30 Standards.
3. Given any selected overhead crane, the trainee will be able to perform crane operation efficiently, safely, and in complete accordance NASA STD 8719.9, (GSFC) GPR 8834b, (GSFC) GPR 8719.1, OSHA 1910.179, and ANSI B30 Standards.
4. Given a sample load composed of multiple elements of mixed shapes and densities, trainee will be able to correctly determine total weight within +/- 5%.
5. Given a sample load composed of multiple elements of mixed shapes and densities, trainee will be able to correctly determine the center of gravity (CG) of the load within 6”.
6. Given load parameters and lift conditions for typical lifts, the trainee will be able to properly select the rigging for each case based upon weight, dimensions, weight distribution, and type of load, temperature, and chemical influences.
7. Given examples of any of the rigging components commonly used, the trainee will be able to visually inspect those components and detect errors.
8. Given a drawing and specifications for a lifting assembly, the trainee will be able to select the proper components and assemble them accordingly.
9. Given a sample load and correct rigging components, the trainee will be able to rig the load for a lift efficiently, safely, and in complete accordance NASA STD 8719.9, Goddard Space Flight Center (GSFC) GPR 8834, (GSFC) GPR 8719.1, OSHA 1910.184, and ANSI B30 Standards.
10. Given a fully rigged load, the trainee will be able to perform the lift as a crane operator and as a rigger as part of a lift team using proper methods and communication.

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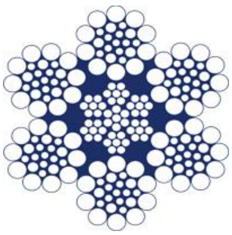
Rigging Terminology

Lets first look at some common components used in rigging and lifting operations.

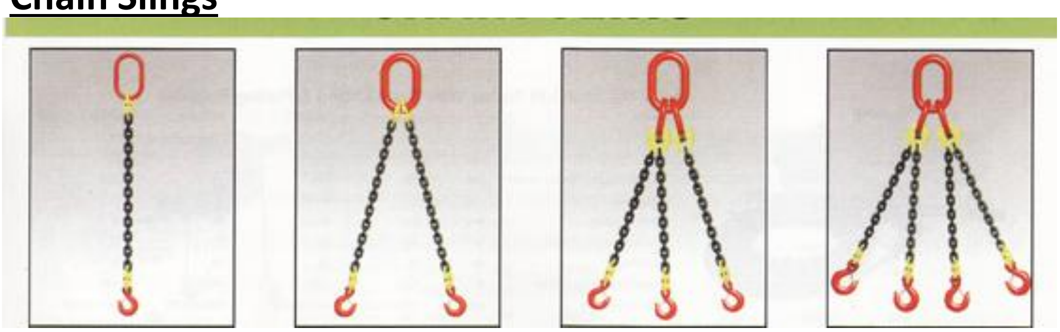
Wire Rope Slings



Wire Rope Thimble

Protects Wire Rope Sling Eye from being damaged or worn.

Chain Slings



Synthetic Rope Sling

Rigging Terminology

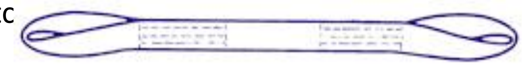
Nylon Slings

Type 1 : Triangle & Choker (TC) - Hardware on each end produces the most effective choker hitch. Can also be used in vertical and basket hitches.

Type 2 : Triangle & Triangle (TT) - Hardware on each end for use in basket or vertical hitch.

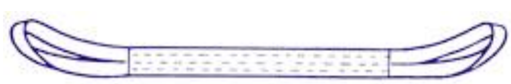
Type 3 : Flat Eye & Eye (EE) - Popular, versatile sling used in vertical, choker & basket hitches. Easy to remove from underneath loads.

Type 4 : Twisted Eye & Eye (EE) - Eyes turned at a right angle to sling body. Forms superior choker hitc & allows better fit on crane hook in basket hitch.



Type 5 : Endless (EN) - Economical & adaptable sling with no fixed wear points. Used in all hitches.

Type 6 : Reversed Eye (RE) - Extremely strong & durable for continuous &/or abusive applications. Wear pads on both sides of body.



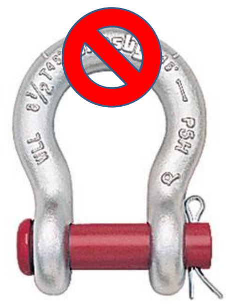
Hoist Rings



Rigging Terminology

Synthetic Round Slings

Shackles



Not to be used for any angular Lifting

Due to the angular lifting properties of most lifts GSFC recommends not using this type for any overhead lifting

Shouldered Eye Bolts

Not to be used for any overhead Lifting

Due to properties of Un-Shouldered Eye Bolts the use of this type of Eye Bolt is forbidden at GSFC for any overhead lifting

Rigging Terminology

Pear Rings

Oval Rings

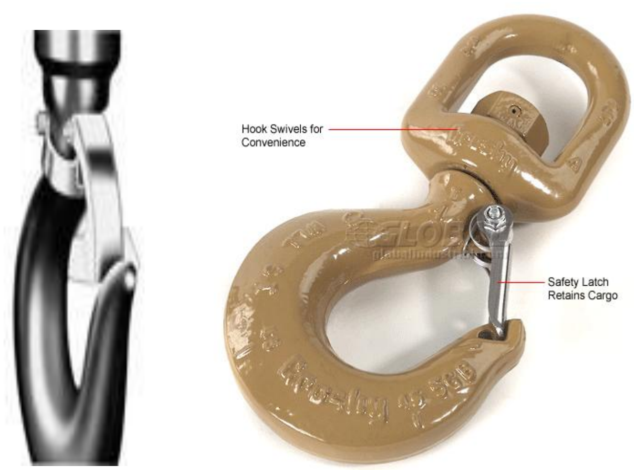
Round Ring

Turnbuckles

Can Only be used in a Straight Line Lift

Spreader Bars

Hooks & Safety Latches



Rigging Terminology

Specialty Slings

Hydra-Sets

Used for Critical Lift of Flight and for Precision Mating

Rigging Terminology

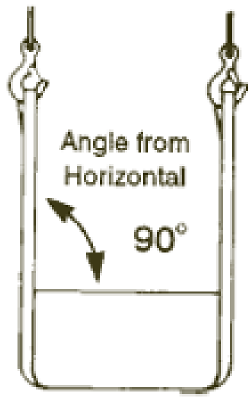
The 4 Basic Hitches used in Rigging Operations

Vertical Hitch

One eye is on the hook, while the other eye is attached directly to the load.

Also referred to as an EYE to EYE Hitch

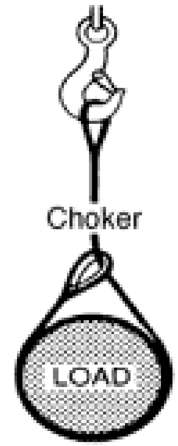
Basket Hitch



The sling cradles the load while both eyes are attached overhead.

Maintaining a 90 degree Load angle will offer approximately twice the capacity of the same sling used in a vertical hitch

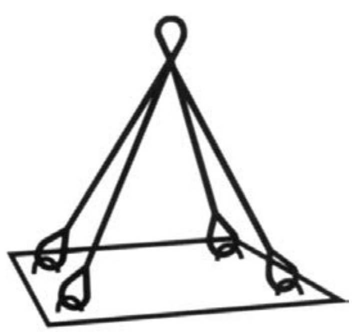
Choker Hitch

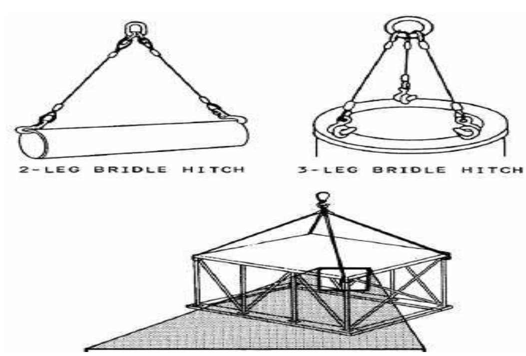


Sling passes through one eye around the load. The other eye is free to be placed on the Load hook of the lifting device.

Using a sling in a choker greatly reduces the capacity of the sling

Bridle Hitch

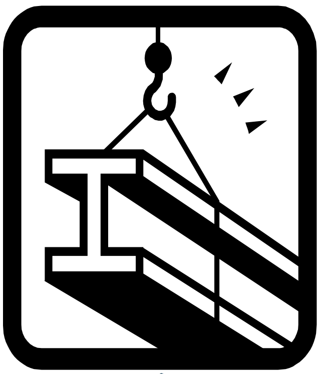


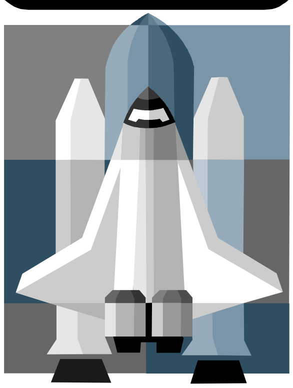


The Bridle Hitch provides excellent load stability when the load is distributed equally amongst the legs, the hook is directly over the center of gravity of the load, and the load is raised level.

The use of a bridle sling requires that the sling angles be carefully determined to ensure that the individual legs are not overloaded

Rigging Terminology





- Rigging skills are utilized in millions of jobs, from Construction to Aerospace. Cranes and rigging are important tools in the manufacturing industry, processing Industry, and many areas too numerous to mention.
- Although used in so many industries that literally support life and limb, many times training for proper use and selection of rigging is taken for granted or ignored completely.
- Only approved methods and practices should be used for rigging. And rigging operations should only be performed by trained and experienced personnel.

Good Rigging Practices

It is a good practice:

• for Riggers to wear proper PPE such as heavy duty work gloves.
• Ensure all components of the rigging are secure and load is balanced
• there are no twist in multi-leg slings and unused slings are securely stored out of the way.
•All rigging is properly installed (i.e. never place running line of choker on the pin of a shackle).
• Always plan your lift and ensure you have a place to land your load safely and securely.

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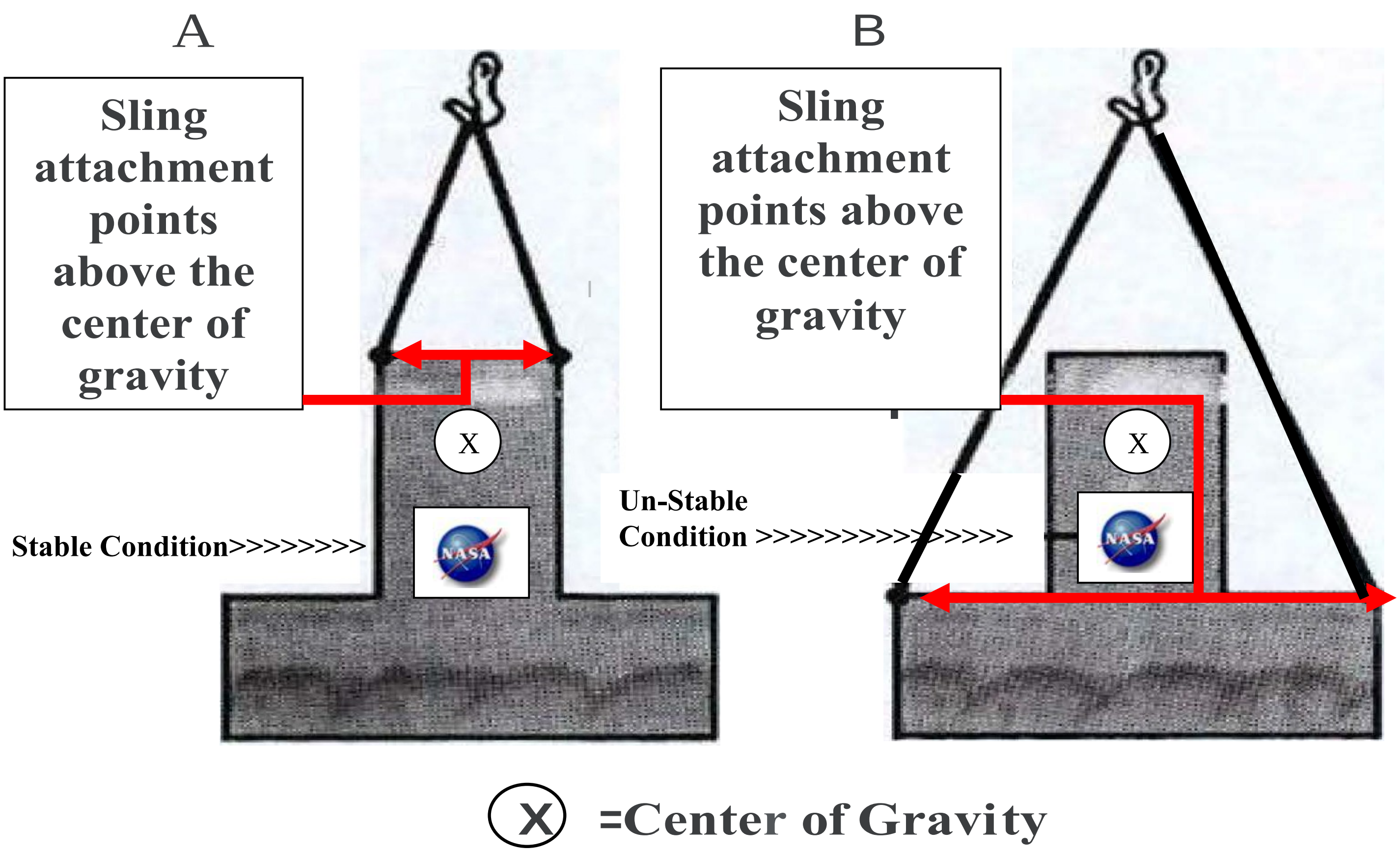
RIGGERS WORKSHEET

Acceptable Configuration



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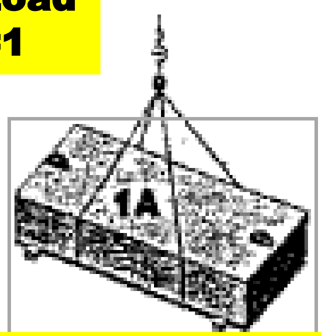
Rigging Configurations

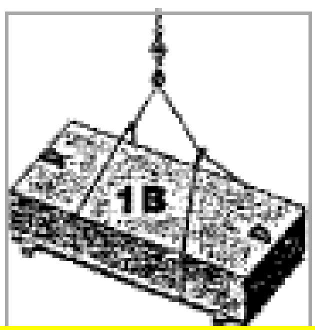
Acceptable or Unacceptable

When we first start out to be riggers we are fascinated and perhaps overwhelmed by the variety of rigging methods and configurations out there. But once a rigger gains some experience they begin to realize that some methods are acceptable and safe while others are unacceptable and Dangerous.
Review the configurations on the left and see if you can distinguish an acceptable rigging configuration/method from a dangerous one.
Place a check in the box to deem the rigging technique as acceptable or Unacceptable.

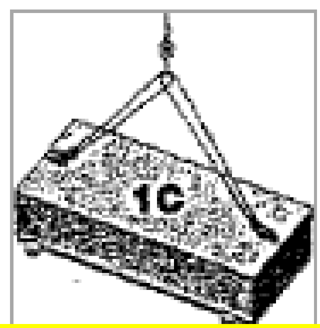
Load #1



2 ea single Wrap Baskets

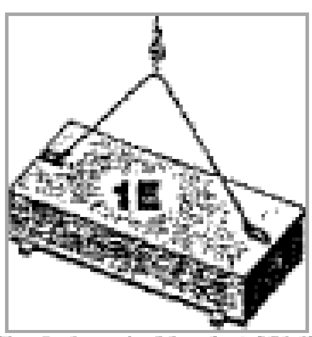


2 ea single Wrap chokers

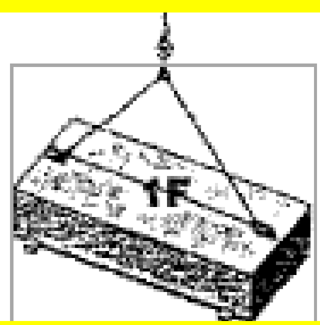


2 ea single Wrap Baskets Inverted

2 Leg Bridle



Single Inverted Basket (Hoist ring through Load Hook and back to 2nd Hoist Ring)

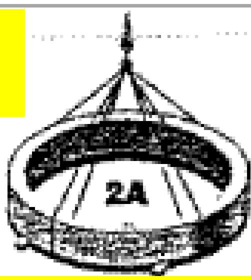


Single Basket through Hoist Rings

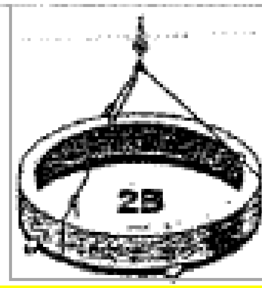
Rigging Configurations

Acceptable or Unacceptable

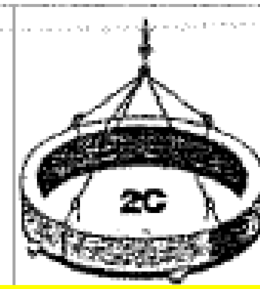
Load #2



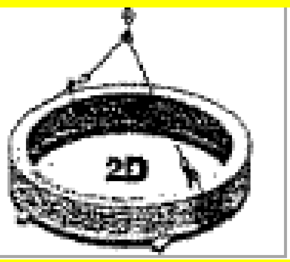
4ea Single Wrap Baskets



3 ea Single Wrap Chokers

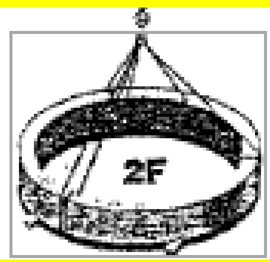


4 ea single Wrap Chokers



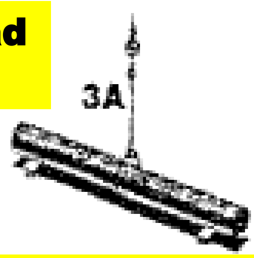
2 –Leg Bridle and 2ea. Single Wrap Baskets

Single Inverted Baskets and 2 ea. Single Wrap Baskets

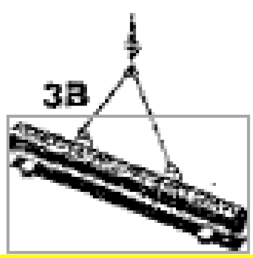


3 ea. Double Wrap Baskets

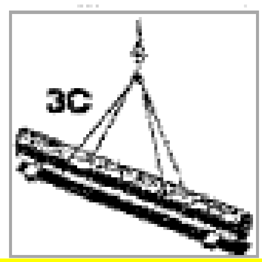
Load #3



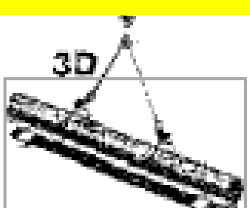
Single Wrap Choker



2 leg Bridle with 2 ea. Single Wrap Chokers

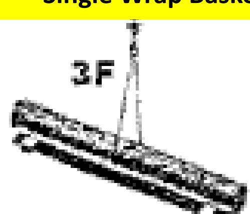


2 Leg Bridle with 2 ea. Single Wrap Baskets



@ Leg Bridle and 2 ea. Single Wrap Baskets

2 ea Single Inverted Baskets and 2 ea. Single Wrap Chokers



1 ea. Single Wrap Basket

Rigging Safety Volume 1

Video & Quiz

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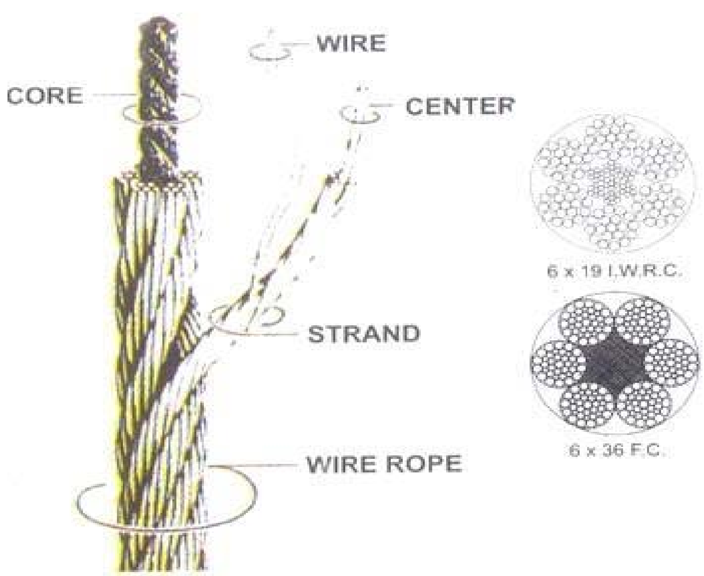
Wire Rope Use, Care and Inspection



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Section 3

Hardware, Wire Rope, Slings

The rigger must be able to rig the load to ensure its stability when lifted. This requires a knowledge of safe sling configurations and the use of related hardware such as shackles, eyebolts, and wire rope clips.

Determining the working load limits of the rigging equipment as well as the weight of the load is a fundamental requirement of safe rigging practice.

Do not use any equipment that is suspected to be unsafe or unsuitable until its suitability has been verified by a competent person.

The working load limits of all hoisting equipment and rigging hardware are based on almost ideal conditions seldom achieved in the field. It is therefore important to recognize the factors such as wear, improper sling angles, point loading, and centre of gravity that can affect the rated working load limits of equipment and hardware.

This section describes the selection and safe use of various types of slings and different kinds of rigging hardware. Subjects include factors that can reduce capacity, inspection for signs of wear, calculating safe sling angles, and requirements for slings and hardware under the *Regulations for Construction Projects.*

Wire Rope

Selection

In selecting equipment, we must consider not only how to get the job done as economically as possible but also how to eliminate hazards to personnel, public, and property for as long as the rope will be used and under all anticipated conditions of exposure and operation.

Although nothing can take the place of experience in making these decisions, it is possible to summarize some of the main points to consider.

Many factors influence the selection of wire rope. Rope strength, although of major importance, is only one factor. Pay attention to the other factors such as size, grade, type, and construction that are specified by equipment or rope manufacturers who base their recommendations on actual working conditions.

Always consider six basic requirements when selecting wire rope:

1. The rope must possess enough strength to take the maximum load that may be applied, with a design factor of at least 5 to 1 – and 10 to 1 when the rope will be used to carry personnel.

> Wire ropes that are supplied as rigging on cranes must possess design factors as follows:
>
> - live or running ropes that wind on drums or pass over sheaves
>   = 3.5 to 1 under operating conditions
>   = 3.0 to 1 when erecting the boom
>
> - pendants or standing ropes
>   = 3.0 to 1 under operating conditions
>   = 2.5 to 1 when erecting the boom

2. The rope must withstand repeated bending without failure of the wires from fatigue.
3. The rope must resist abrasion.
4. The rope must withstand distortion and crushing.
5. The rope must resist rotation.
6. The rope must resist corrosion.

Types of Construction

The number of wires in a rope is an important factor in determining a rope's characteristics. But the arrangement of the wires in the strand is also importan*

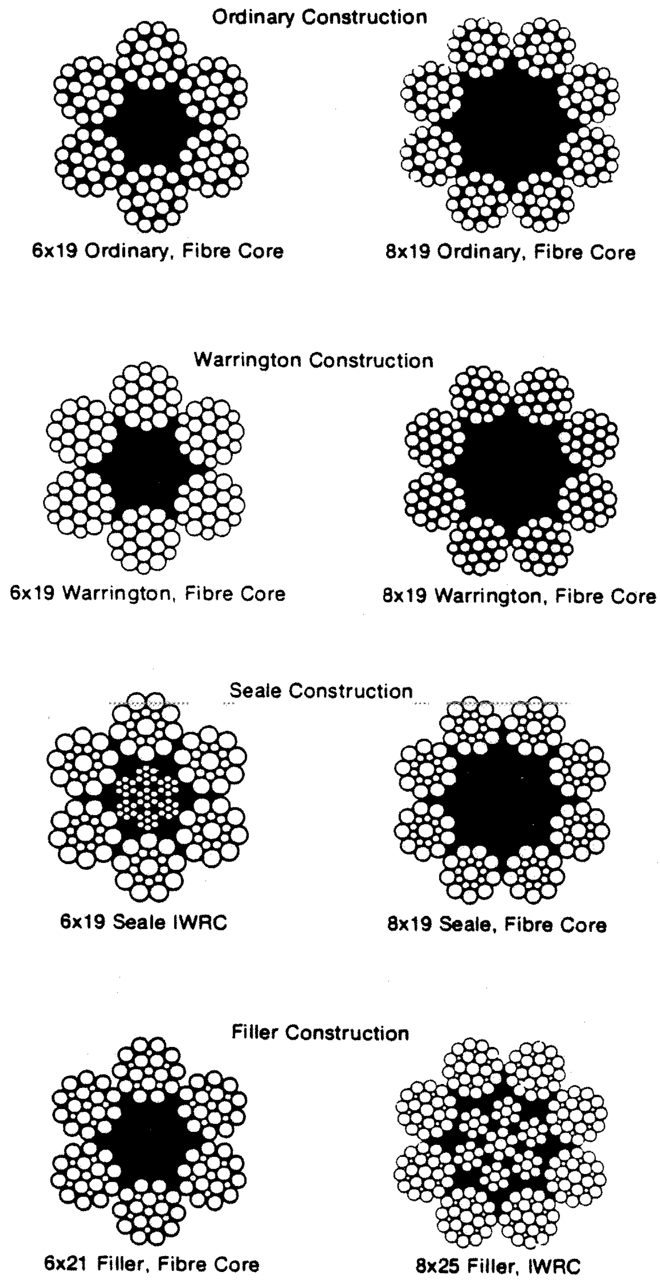
Basic Types

The four basic constructions are illustrated in Figure 1 :

1. **Ordinary** – all wires are the same size.
2. **Warrington** – outer wires are alternately larger and smaller.
3. **Filler** – small wires fill spaces between larger wires.
4. **Seale** – wires of outer layer are larger diameter than wires of inner layer.

On ropes of **Ordinary** construction the strands are built in layers. The basic seven-wire strand consists of six wires laid around a central wire. A nineteen-wire strand is constructed by adding a layer of twelve wires over a seven-wire strand. Adding a third layer of eighteen wires results in a 37-wire strand.

In this type of construction the wires in each layer have different lay lengths. This means that the wires in adjacent layers contact each other at an angle. When the rope is loaded the wires rub against each other with a sawing action. This causes eventual failure of the wires at these points.



BASIC WIRE ROPE CONSTRUCTIONS
Figure 1

Wire Rope Inspection

It is essential to have a well-planned program of regular inspection carried out by an experienced inspector.

All wire rope in continuous service should be checked daily during normal operation and inspected on a weekly basis. A complete and thorough inspection of all ropes in use must be made at least once a month. Rope idle for a month or more should be given a thorough inspection before it is returned to service.

A record of each rope should include date of installation, size, construction, length, extent of service and any defects found.

The inspector will decide whether the rope must be removed from service. His decision will be based on:

1. details of the equipment on which the rope has been used,
2. maintenance history of the equipment,
3. consequences of failure, and
4. experience with similar equipment.

Conditions such as the following should be looked for during inspection.

Broken Wires

Occasional wire breaks are normal for most ropes and are not critical provided they are at well spaced intervals. Note the area and watch carefully for any further wire breaks. Broken wire ends should be removed as soon as possible by bending the broken ends back and forth with a pair of pliers. This way broken ends will be left tucked between the strands.

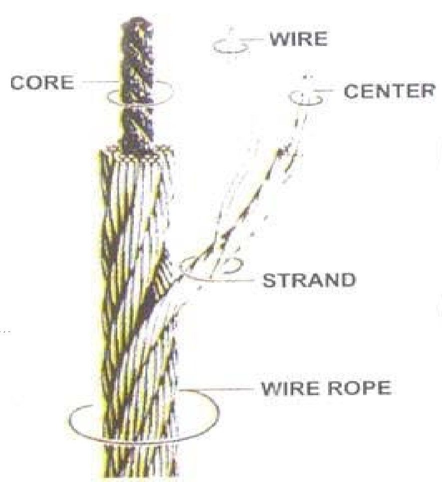
Construction regulations under The *Occupational Health and Safety Act* establish criteria for retiring a rope based on the number of wire breaks.

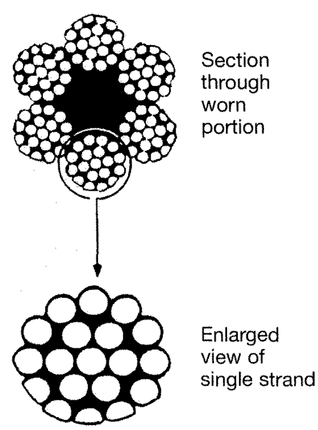
Worn and Abraded Wires

Abrasive wear causes the outer wires to become “D” shaped. These worn areas are often shiny in appearance (Figure 2). The rope must be replaced if wear exceeds 1/3 of the diameter of the wires.

Reduction in Rope Diameter

Reduction in rope diameter can be caused by abrasion of outside wires, crushing of the core, inner wire failure, or a loosening of the rope lay. All new ropes stretch slightly and decrease in diameter after being used.





When the surface wires are worn by 1/3 or more of their diameter, the rope must be replaced.

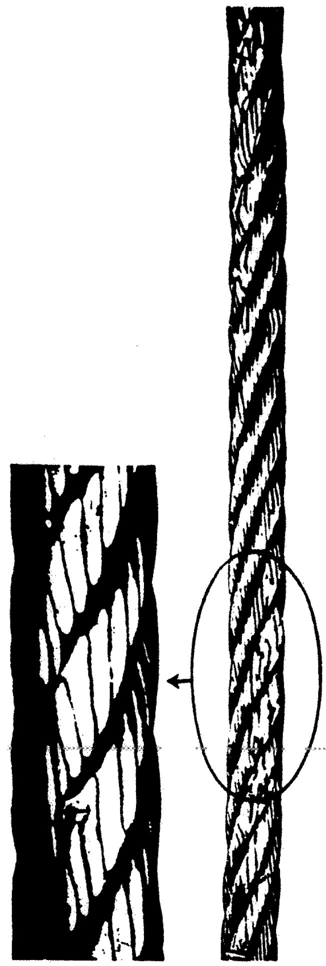
Figure 2

Snagged wires resulting from drum crushing

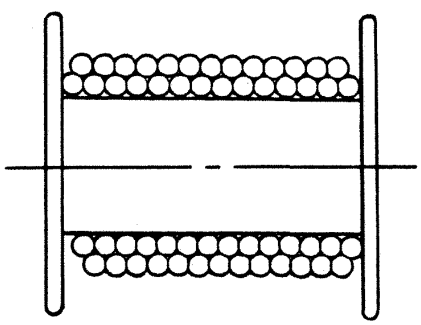
Rope that has been jammed after jumping off sheave

Rope subjected to drum crushing. Note the distortion of the individual wires and displacement from their original postion. This is usually caused by the rope scrubbing on itself.

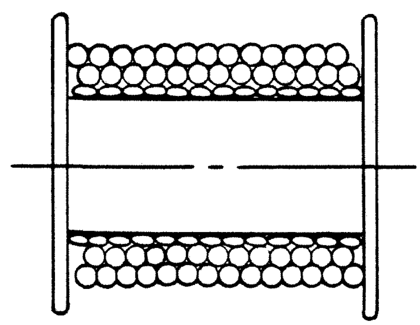
Localized crushing of rope



Drum crushing



With no more than 2 layers on drum, use any kind of rope.



With more than 2 layers on drum, there is danger of crushing. Use larger rope or IWRC rope.

CRUSHED, JAMMED AND FLATTENED STRANDS
Figure 3

Rope Stretch

All steel ropes will stretch during initial periods of use. Called "constructional stretch", this conditior is permanent. It results when wires in the strands and strands in the rope seat themselves unde load. Rope stretch can be recognized by increased lay length. Six-strand ropes will stretch abou six inches per 100 feet of rope while eight-strand ropes stretch approximately 10 inches per 10(feet. Rope stretched by more than this amount must be replaced.

Corrosion

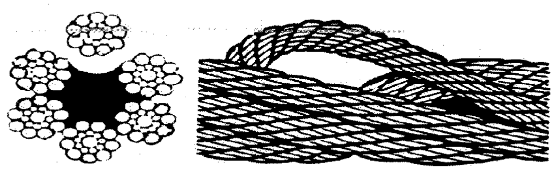
Corrosion is a very dangerous condition because it can develop inside the rope without being seen Internal rusting will accelerate wear due to increased abrasion as wires rub against one another When pitting is observed, consider replacing the rope. Noticeable rusting and broken wires nea attachments are also causes for replacement. Corrosion can be minimized by keeping the rop€ well lubricated.

Crushed, Flattened or Jammed Strands

These dangerous conditions require that the rope be replaced (Figure 3). They are often the resul of crushing on the drum.

High Stranding and Unlaying

These conditions will cause the other strands to become overloaded. Replace the rope or renev the end connection to reset the rope lay (Figure 4).



HIGH STRANDING
Figure 4

Bird Caging

Bird caging is caused by the rope being twisted or by a sudden rel
The rope, or the affected section, must be replaced.

Multi-strand rope "birdcages" because of torsional unbalance.
Typical of buildup seen at anchorage end of multi-fall crane application.

A birdcage caused by sudden release of tension
and resulting rebound of rope from overloaded condition.
These strands and wires will **not** return to their original positions.

A birdcage which has been forced through a tight sheave.

BIRD CAGING
Figure 5

Kinks

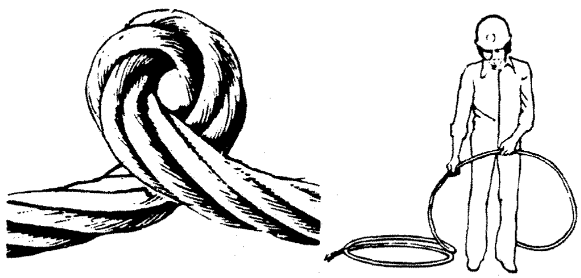
Kinking is caused by loops that have been drawn too tightly as a result of improper handling (Figure 6). Kinks are permanent and will require that the rope, or damaged section, be taken out of service.

Core Protrusion

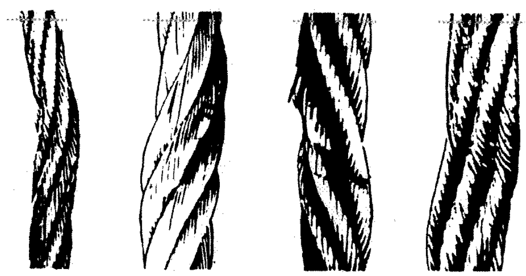
Core protrusion can be caused by shock loads and/or torsional imbalance (Figure 7). This condition requires that the rope be taken out of service.

Electrical Contact

Rope subjected to electrical contact will have wires that are fused, discoloured or annealed and must be removed from service.

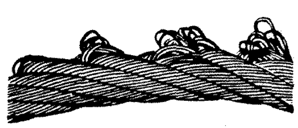


An open kink like this is often caused by improper handling and uncoiling as shown.

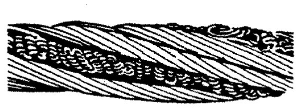


These ropes show the severe damage resulting from the use of kinked ropes.
Local wear, distortion, misplaced wires, and early failure are inevitable.

ROPE KINKS
Figure 6



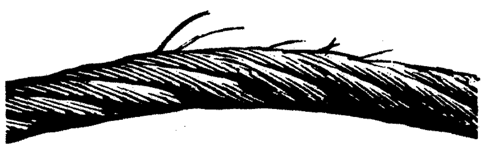
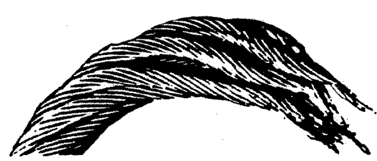
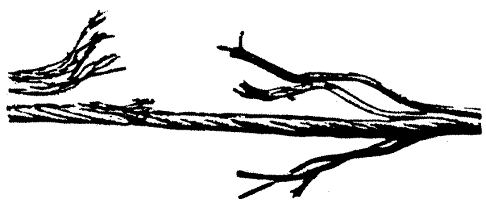
Core protrusion as a result of torsional unbalance created by shock loading



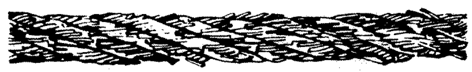
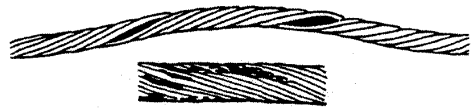
Protrusion of IWRC from shock loading

CORE PROTRUSION
Figure 7

Figure 8 illustrates examples of rope damage, while Table 6 identifies likely causes of typical faults.

 Narrow path of wear resulting in fatigue fractures caused by working in a grossly oversized groove or over small support rollers.	 Breakup of IWRC from high stress. Note nicking of wires in outer strands
 Two parallel paths of broken wires indicate bending through an undersize groove in the sheath.	 Wire fractures at the strand or core interface, as distinct from crown fractures, caused by failure of core support.
 Fatigue failure of wire rope subjected to heavy loads over small sheaves. In addition to the usual crown breaks, there are breaks in the valleys of the strands caused by strand nicking from overloading.	 Wire rope shows severe wear and fatigue from running over small sheaves with heavy loads and constant abrasion.
 Rope failing from fatigue after bending over small sheaves.	 Wire rope that has jumped a sheave. The rope is deformed into a curl as though bent around a round shaft.
 Mechanical damage due to rope movement over sharp edge under load.	 Rope break due to excessive strain.

TYPICAL ROPE DAMAGE
Figure 8

 Rapid appearance of many broken wires.	 A single strand removed from a wire rope subjected to "strand nicking". This condition is the result of adjacent strands rubbing against one another and is usually caused by core failure due to continued operation of a rope under high tensile load. The ultimate result will be individual wire breaks in the valleys of the strands.
 Wear and damage on one side of rope.	

TYPICAL ROPE DAMAGE
Figure 8 (continued)

TABLE 6

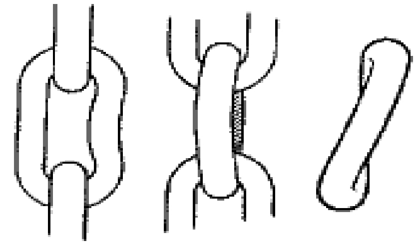
FAULT	POSSIBLE CAUSE
Accelerated Wear	Severe abrasion from being dragged over the ground or obstructions. Rope wires too small for application or wrong construction or grade. Poorly aligned sheaves. Large fleet angle. Worm sheaves with improper groove size or shape. Sheaves, rollers and fairleads having rough wear surfaces. Stiff or seized sheave bearings. High bearing and contact pressures
Rapid Appearance of Broken Wires	Rope is not flexible enough. Sheaves, rollers, drums too small in diameter. Overload and shock load. Excessive rope vibration. Rope speed too high. Kinks that have formed and been straightened out. Crushing and flattening of the rope. Reverse bends. Sheave wobble.
Rope Broken Off Square	Overload, shock load. Kink. Broken or cracked sheave flange.
Strand Break	Overload, shock load. Local wear. Slack in 1 or more strands.
Corrosion	Inadequate lubricant. Improper type of lubricant. Improper storage. Exposure to acids or alkalis.
Kinks, Dog Legs, Distortions	Improper installation. Improper handling.
Excessive Wear in Spots	Kinks or bends in rope due to improper handling in service or during installation. Vibration of rope on drums or sheaves.
Crushing and Flattening	Overload, shock load. Uneven spooling. Cross winding. Too much rope on drum. Loose bearing on drum. Faulty clutches. Rope dragged over obstacle.
Stretch	Overload. Untwist of Lang Lay ropes.

FAULT	POSSIBLE CAUSE
Broken Wires or Undue Wear on One Side of Rope	Improper alignment. Damaged sheaves and drums.
Broken Wires Near Fittings	Rope vibration.
Burns	Sheave groove too small. Sheaves too heavy. Sheave bearings seized. Rope dragged over obstacle.
Rope Core Charred	Excessive heat.
Corrugation and Excessive Wear	Rollers too soft. Sheave and drum material too soft.
Distortion of Lay	Rope improperly cut. Core failure. Sheave grooves too big.
Pinching and Crushing	Sheave grooves too small.
Rope Chatters	Rollers too small.
Rope Unlays	Swivel fittings on Lang Lay ropes. Rope dragging against stationary object.
Crushing and Nicking	Rope struck or hit during handling.
High Stranding	Fittings improperly attached. Broken strand. Kinks, dog legs. Improper seizing.
Reduction in Diameter	Broken core. Overload. Corrosion. Severe wear.
Bird Cage	Sudden release of load.
Strand Nicking	Core failure due to continued operation under high load.
Core Protrusion	Shock loading. Disturbed rope lay. Rope unlays. Load spins.

Procedures and Precautions with Wire Rope

- Ensure that the right size and construction of rope is used for the job.
- t and lubricate rope regularly according to manufacturer's guidelines.
- Never overload the rope. Minimize shock loading. To ensure there is no slack in the rope, start the load carefully, applying power smoothly and steadily.
- Never use frozen ropes.
- Take special precautions and/or use a larger size rope whenever
  - the exact weight of the load is unknown
  - there is a possibility of shock loading
  - conditions are abnormal or severe
  - there are hazards to personnel.
- Use softeners to protect rope from corners and sharp edges.
- Avoid dragging rope out from under loads or over obstacles.
- Do not drop rope from heights.
- Store all unused rope in a clean, dry place.
- Never use wire rope that has been cut, kinked, or crushed.
- Ensure that rope ends are properly seized.
- Use thimbles in eye fittings at all times.
- Prevent loops in slack lines from being pulled tight and kinking. If a loop forms, don't pull it out-unfold it. Once a wire rope is kinked, damage is permanent. A weak spot will remain no matter how well the kink is straightened out.
- Check for abnormal line whip and vibration.
- Avoid reverse bends.
- Ensure that drums and sheaves are the right diameter for the rope being used.
- Ensure that sheaves are aligned and that fleet angle is correct.
- Sheaves with deeply worn or scored grooves, cracked or broken rims, and worn or damaged bearings must be replaced.
- Ensure that rope spools properly on the drum. Never wind more than the correct amount of rope on any drum. Never let the rope cross-wind.

Chain Use Care and Inspection



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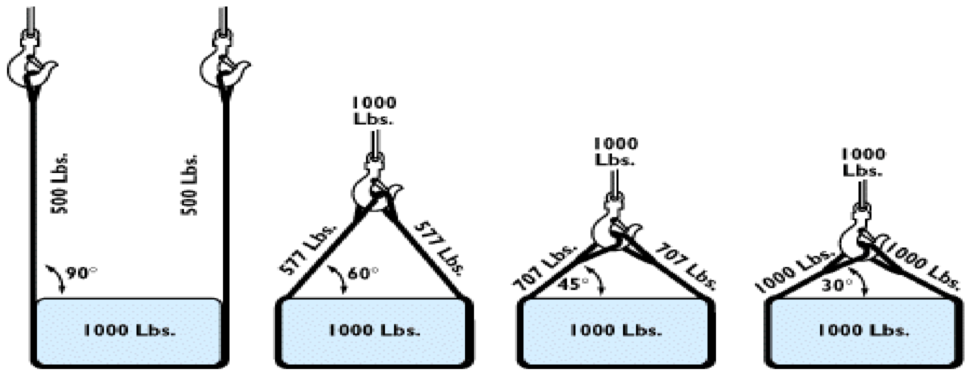
Chain Use, Care and Inspection

USE

To protect both operators and materials, observe these precautions when using chain slings:

- Before use, inspect chain and attachments following the instructions under "inspection" below.
- Do not exceed working load limit at any time. Any of the factors listed here can reduce the load a chain will hold
  - o Acceleration in rate of load application can produce dangerous overloading.
  - o Twisting, knotting or kinking subjects links to unusual loading, decreasing the working load of the sling.
  - o Use for purposes other than those for which slings are intended can reduce the working load of the sling.
  - o Variations in the angle of the load to the sling, as the angle decreases, the working load of the sling will increase.



- Free chain of all twists, knots and kinks.
- Center load in hook(s); hook latches must not support load.
- Avoid sudden jerks when lifting and lowering.
- Balance all loads; avoid tipping of loads.
- Use pads around sharp corners.
- Do not drop load on chains.
- Match the size and working load limit of attachments, such as hooks or rings, to the size and working load limit of the chain.
- For overhead lifting, use only alloy chain and attachments grade 80 and above.

CARE

- Chains require careful storage and regular maintenanc
- Store chains on an A-frame in a clean, dry place.
- To avoid corrosion, oil chains before prolonged storage
- Do not heat chains; this will alter its thermal treatment.
- Do not plate or change surface finish of chain. For harsh environments special chain is available.

The life and strength of a chain sling or assembly depends on proper inspection, maintenance and use. For additional information, refer to ANSI B30.9 and OSHA 1910.184.

Chain Use, Care and Inspection

INSPECTION

It is important both to inspect chain slings regularly, and to keep records of all chain inspections. Follow this guide for such an inspection system.

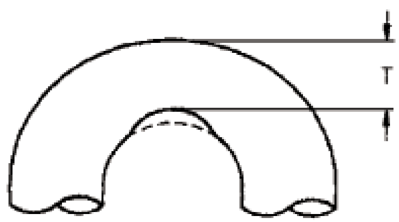
- Before inspecting, clean chains with a non-acid/non-caustic solvent so that marks, nicks, wear and other defects are visible.
- Inspect each link for these conditions:
  - Twists or bends.
  - Nicks or gouges.
  - Excessive wear at bearing points.
  - Stretch.

  Distorted or damaged master links, coupling links or attachments, especially spread in throat opening of hooks.

- Mark plainly each link or attachment showing any of the conditions listed above to indicate rejection; remove from service until properly repaired.

WEAR ALLOWANCES OF CHAINS

Measure cross section at link ends (bearing point) to determine wear. If chain is worn to less than the minimum allowable thickness, remove from service.



Chain size		Minimum allowable thickness (T)	
Inches	mm	Inches	mm
7/32	5.5	0.185	4.7
9/32	7.0	0.239	6.1
3/8	10.0	0.335	8.5
1/2	13.0	0.435	11.1
5/8	16.0	0.536	13.6
3/4	20.0	0.669	17.0
7/8	22.0	0.744	18.9
1	26.0	0.870	22.1
1 1/4	32.0	1.071	27.2

Note: For sizes not listed, the Minimum Allowable Thickness can be calculated as 85% of the original material diameter.

Chain Use, Care and Inspection

USE OF CHAIN UNDER EXTREME TEMPERATURE CONDITIONS

When the chain itself is subjected to temperatures shown here, working load limits should be reduced as indicated.

Temperature of chain (°F)	Working load limit while at temperature[1]	Permanent reduction in working load limit[2]
<-40	not recommended	none
-40 to 400	100%	none
>400 to 600	90%	none
>600 to 750	75%	10%
>750	not recommended	Contact CM rep.

[1] While chain is at temperature shown in first column.
[2] When chain is used at room temperature after having been subjected to temperatures shown in first column.

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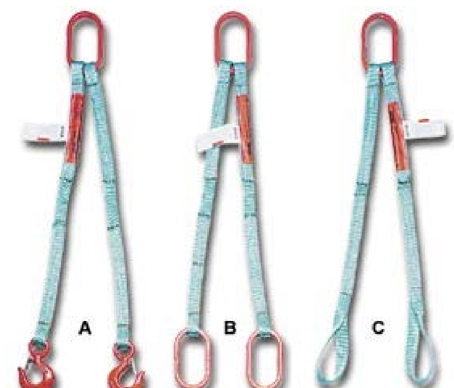
Nylon Sling Use Care and Inspection



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Lifting Products and Services

OPERATORS INSTRUCTIONS FOR NYLON & POLYESTER WEBBING SLINGS

⚠ DANGER	• Avoid being HURT OR KILLED! Inspect sling before use! • If you see red core yarn, sling is in DANGEROUS CONDITION! DO NOT USE! Take sling out of service IMMEDIATELY.
⚠ CAUTION	• This product is to be used by trained Personnel only. • Read and understand these Warnings and Operating Instructions before using product.

Warning and Application Instructions for CERTEX Nylon & Polyester Webbing Slings

TO ORDER ADDITIONAL COPIES OF THESE WARNINGS AND INSTRUCTIONS CALL 1-800-882-9118, CONTACT YOUR LOCAL CERTEX BRANCH OR PRINT A COPY FROM OUR WEBSITE AT WWW.CERTEXUSA.COM

WARNING

Follow these steps to avoid SEVERE INJURY OR DEATH!

BEFORE USE:

• Inspect sling for damage from cuts, heat, chemicals or excessive wear.
• If damage is visible, DO NOT USE! Remove sling from service IMMEDIATELY!
• Be sure sling capacity tag is in place and can be easily read.
• See Sling Angle Load Chart to determine loss of capacity due to lift angle and sling configuration (hitch)
• NEVER expose sling to temperatures above 194 degrees F (90 degrees C)
• Remember: Exposure to sunlight and ultraviolet light degradessling strength.

DURING USE:

• ALWAYS protect sling from cuts. Avoid sharp edges & corners, pointed objects, and rough surfaces.
• NEVER tie knots in sling webbing.
• NEVER pull objects that are stuck or snagged.
• NEVER use near acids with nylon OR alkalis with polyester.

Inspection, care and use of Synthetic Web Slings

REMOVAL FROM SERVICE CRITERIA:

A Sling shall be removed from service if any of the following are visible:

1. Red Core Yarn is visible on any part of the Sling.
2. If Sling rated capacity tag is missing or not readable.
3. Acid or alkalis burns
4. Melting, charring or weld spatter on any part of the Sling
5. Holes, tears, cuts, snags, or embedded particles
6. Broken or worn stitching in load bearing slices.
7. Excessive abrasive wear
8. Knots in any part of the Sling.
9. Distortion, excessive pitting, corrosionor broken fittings.
10. Any conditions which causes doubt as to the strength of the Sling.

INSPECTION RECORDS

Written inspection records should be established and kept on file for each new Sling. Records should include all the information taken from the Sling's identification tag (type, reach, rated capacity, manufacture, and date purchased), along with its location. These records should be updated after each periodic inspection.

TYPES OF INSPECTION

IMPORTANT: ALL INSPECTIONS MUST BE DONE ONLY BY TRAINED AND QUALIFIED PERSONNEL

A. Initial Inspection: Before any new or repaired Sling is placed in service, it shall be inspected to ensure that the correct Sling is being used, as well as to determine that the Sling meets the requirements of this specification and has not been damaged in shipment.

B. Frequent Inspection: This inspection shall be done each time the Sling is used.

C. Periodic Inspection: Frequency of inspection should be based on: 1. Frequency of Sling use. 2. Severity of service conditions. 3. Experience gained on the service life of Slings used in similar applications. 4. Periodic inspections should be conducted at least monthly.

PROOF TESTING OF SLING EXPOSED TO ULTRA VIOLET LIGHT

Slings used in environments where they are subject to continuous exposure to ultra violet light (sunlight) should be proof tested to two (2) times rated capacity semi-annually, or more frequently, depending on severity of exposure. Testing has confirmed that Nylon Slings lose fifty (50) to sixty (60) percent of their strength after 36 months of continuous exposure to sunlight. Polyester loses about thirty (30) percent over the same period. Contact Certex for further information on the Testing program completed by the Web Sling and Tie Down Association.

OPERATING PRACTICES

1. Determine weight of the load. The weight of the load shall be within the rated capacity of the Sling.
2. Select Sling having suitable characteristics for the type of load, hitch and environment.
3. Slings shall not be loaded in excess of the rated capacity. Consideration shall be given to the Sling to load angle which affects rated capacity. (See Sling Angle Chart)
4. Slings with fittings which are used in a choker hitch shall be of sufficient length to assure that the choking action is on the webbing and never on a fitting or splice.
5. Slings used in a basket hitch shall have the load controlled to prevent slippage.
6. The opening in fittings shall be the proper shape and size to insure that the fitting will seat properly in the hook or other attachments.
7. Slings shall always be protected from being cut by sharp corners, sharp edges, protrusions or abrasive surfaces with protection sufficient for the intended purpose.
8. Slings shall not be dragged on the floor or over abrasive surface.
9. Slings shall not be twisted or tied into knots, or shorten or joined by knotting.
10. Slings shall not be pulled from under loads if the load is resting on the Sling. Loads resting on Web slings could damage the Sling.
11. Do not drop Slings equipped with metal fittings.
12. Slings that appear to be damaged shall not be used unless inspected and accepted.
13. The Sling shall be hitched in a manner providing control of the load.
14. Personnel shall stand clear of the suspended load.
15. Personnel, including portions of the human body, shall be kept from between the Sling and the load, and from between the Sling and the crane hook or hoist hook.
16. Personnel shall not ride the Sling or load being lifted.
17. Shock loading shall be avoided.
18. Twisting and kinking the legs (branches) shall be avoided.
19. Load applied to the hook shall be centered in the base (bowl) of hook to prevent point loading on the hook.
20. During lifting, with or without the load, personnel shall be alert for possible snagging.
21. The Web Slings’ legs (branches) shall contain or support the load from the sides above the center of gravity when using a basket hitch.
22. Slings shall be long enough so that the rated capacity of the Sling is adequate when the angle of the legs(branches) is taken into consideration. (see load chart)
23. Place blocks under load prior to setting down the load, to allow removal of the Web Sling, if applicable.
24. Nylon & Polyester Slings shall not be used in contact with objects or at temperatures above 194 degrees F (90 degrees C).
25. Exposure to sunlight or ultra-violet light degrades the strength of Slings. Store Slings in a cool, dry and dark place when not in use.
26. Slings shall not be used to pull on objects in a snagged or constrained condition.
27. Only Web Slings with legible identification tags shall be used.
28. Tags and labels should be kept away from the load, hook and point of choke.
29. Web Slings shall not be constricted or bunched between the ears of a clevis or shackle.
30. Web Slings shall not be used as bridles on suspended personnel platforms.

SLING HITCHES

Loads vary in physical dimensions, shape, and weight. Where and how to attach Slings is important to the Rigger.

WARNING

Avoid Serious Injury or Death

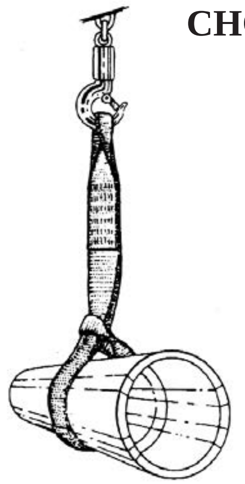
• Any single hitch shall **NEVER** be used to transport a load that is not balanced

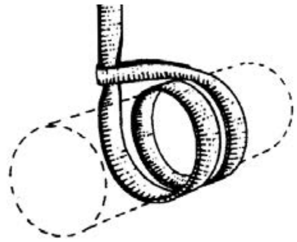
WARNING

Avoid Serious Injury or Death

Rated capacities are affected by the Angle of lift (Sling to load angle) when used in multi-legged Slings or basket hitches. To determine the actual Sling capacity at a given Angle of lift, multiply the original Sling rating by the appropriate loss factor, determined from the Sling Angle Chart.

CHOKER HITCHES

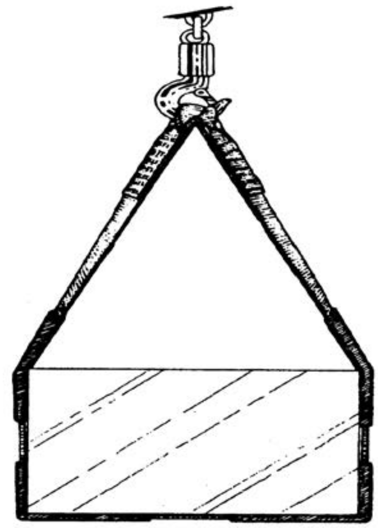




The double wrap hitch or the double wrap choker hitch provides full 360 degree contact with the load.

A contact Sling hitch in which the Sling passes entirely around the load. In its simplest form the Sling has a loop, or eye on each end, and is referred to as a Sling choker or choker. One loop passes through the other, forming a slip noose.

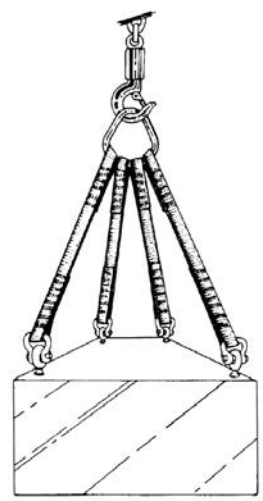
BASKET HITCH



BASIC RULES OF HITCHING

RATED CAPACITY – Be sure the Sling you intend to use is strong enough for the job. Consult CERTEX Catalog or refer to rated capacity tag on actual Sling.
CONTROL AND BALANCE – Use a hitch that will keep the load under control at all times and be sure the lifting device is directly over the Center of Gravity. (see example Figure 1)
PREVENT DAMAGE – Use corner protectors when bending around sharp corners. (see example Figure 2)
LIFTING LOAD – Lift load carefully, accelerating smoothly. Avoid shock loading.
CONDITION OF SLINGS – Inspect Slings and their parts carefully before each lift and at regular intervals.
USE OF LIFTING LUGS/EYE BOLTS – Many loads are equipped with lifting lugs for easy attachment of the Sling. Make sure pull is transmitted to them straight along the axis of the shank. Lifting lugs/eye bolts should be used in accordance with the lug/eye bolt manufacturer's recommendations. (see example Figure 3) However, if "Hoist Rings" are utilized the pull does not have to be along the axis.

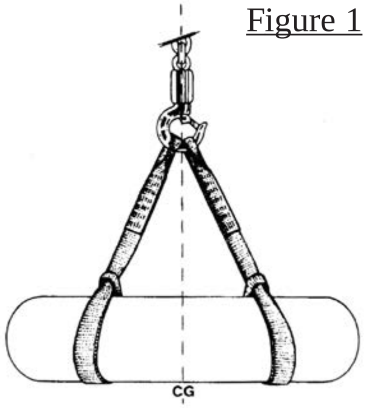
FOUR LEG BRIDLE SLING



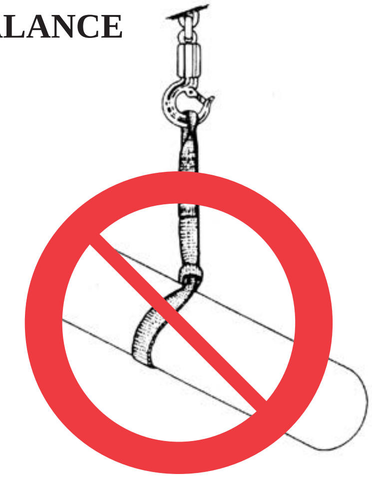
Four Leg Bridle Sling – Each leg length must be the proper length if the object is to hang level. If the hook up is such that two or even three legs are taking the load, the design factor is reduced.

CONTROL & BALANCE

Figure 1



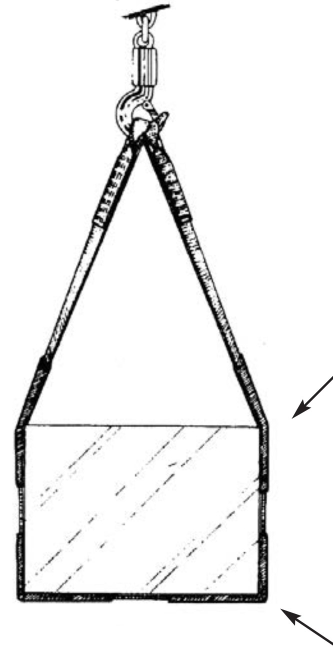
RIGHT WAY



WRONG WAY

PREVENT DAMAGE

Figure 2

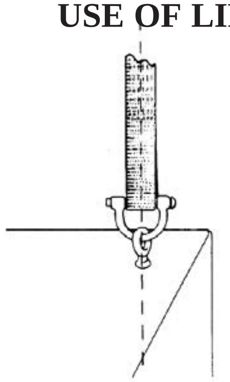


Corner Protector

Corner Protector

USE OF LIFTING LUGS/EYE BOLTS

Figure 3

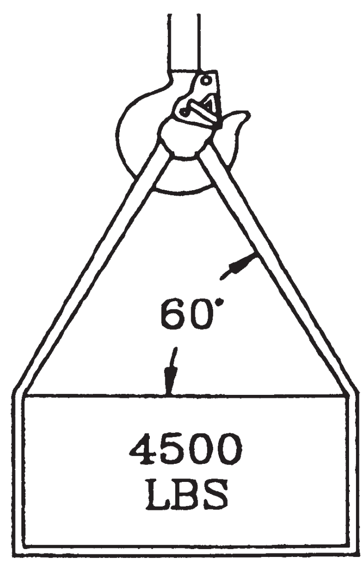


RIGHT WAY

WRONG WAY

Sling Angle Chart (Angle of Lift)

Angle/Degrees Horizontal	Loss Factor	Angle/Degrees Horizontal	Loss Factor
90	1.000	55	0.819
85	0.996	50	0.766
80	0.985	45	0.707
75	0.966	40	0.643
70	0.940	35	0.574
65	0.906	30	0.500
60	0.866	-----	------



Rated capacities are effected by the angle of lift (Sling to load Angle) measured from the horizontal when used with multi-legged Slings or Choker/Basket Hitches. To determine the actual capacity at a given angle of lift, multiply the original Sling rating by the appropriate loss factor determined from the table above.

5200 lbs (Sling Rating) X 0.866 (Loss Factor) = 4500 lbs Rated Capacity

FOR ADDITIONAL INFORMATION, PLEASE REFER TO OSHA 1910.184, ANSI B30.9, OR OTHER REGULATIONS AS APPLICABLE

v1

Inspection, Care & Use . . .

Inspection, care and use of nylon and polyester synthetic web slings

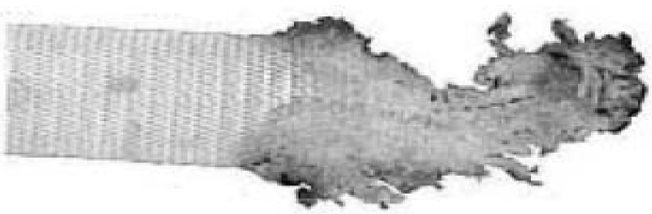
Removal From Service: A sling shall be removed from service if any of the following are visible:

- If sling rated capacity tag is missing or not readable
- Acid or alkalis burns
- Melting, charring or weld spatter on any part of the sling
- Holes, tears, cuts, snags or embedded particles
- Broken or worn stitching in load bearing splices
- Excessive abrasive wear
- Knots in any part of the sling
- Distortion, excessive abrasive wear
- Any conditions which cause doubt as to the strength of the sling

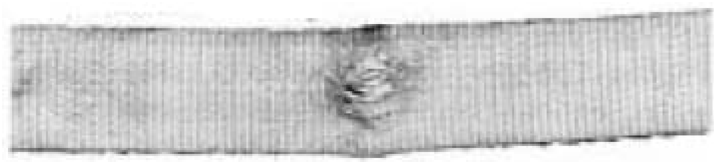
Operating Practices:

- Determine weight of the load. The weight of the load shall be within the rated capacity of the sling.
- Select sling having suitable characteristics for the type of load, hitch and environment.
- Slings shall not be loaded in excess of the rated capacity. Consideration shall be given to the sling to load angle which affects rated capacity. (See load charts.)
- Slings with fittings which are used as a choker hitch shall be of sufficient length to assure that the choking action is on the webbing, and never on a fitting.
- Slings used in a basket hitch shall have the load balanced to prevent slippage.
- The opening in fittings shall be the proper shape and size to insure that the fitting will seat properly in the hook or other attachments.
- Slings shall always be protected from being cut by sharp corners, sharp edges, protrusions or abrasive surfaces.
- Slings shall not be dragged on the floor or over an abrasive surface.
- Slings shall not be twisted or tied into knots, or joined by knotting.
- Slings shall not be pulled from under loads if the load is resting on the sling.
- Do not drop slings equipped with metal fittings.
- Slings that appear to be damaged shall not be used unless inspected and accepted.
- The sling shall be hitched in a manner providing control of the load.
- Personnel, including portions of the human body, shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.
- Personnel shall stand clear of the suspended load.
- Personnel shall not ride the sling.
- Shock loading shall be avoided.
- Twisting and kinking the legs (branches) shall be avoided.
- Load applied to the hook shall be centered in the base (bowl) of hook to prevent point loading on the hook.
- During lifting, with or without the load, personnel shall be alert for possible snagging.
- The slings' legs (branches) shall contain or support the load from the sides above the center of gravity when using basket hitch.
- Slings shall be long enough so that the rated capacity of the sling is adequate when the angle of the legs (branches) is taken into consideration. (See load charts.)

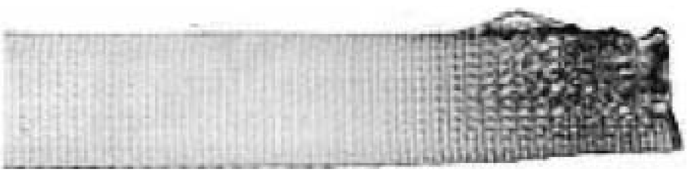
Nylon & Polyester Sling Abuse



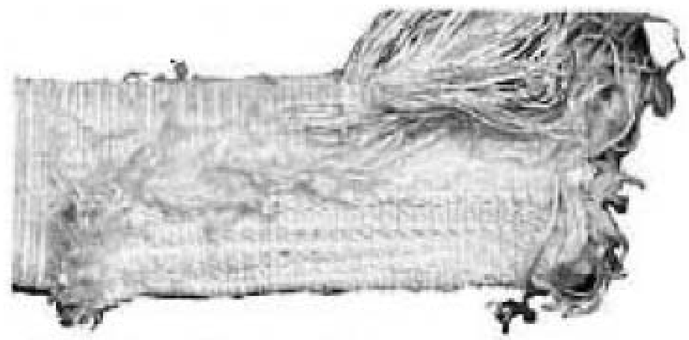
Acid Damage



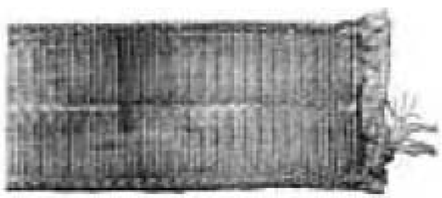
Punctures & Snags



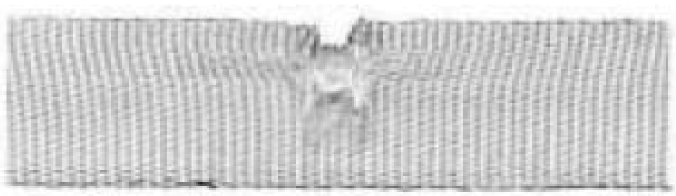
Heat Damage



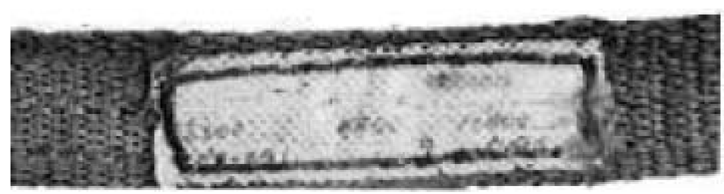
Tensile Break



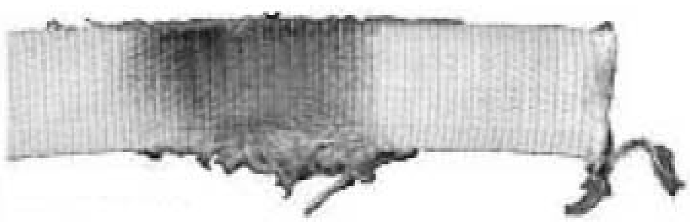
Cuts



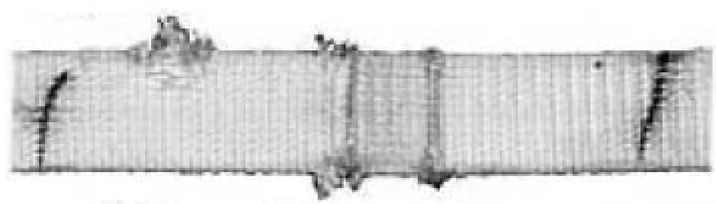
Cut & Tensile Damage



Illegible or Missing Tag

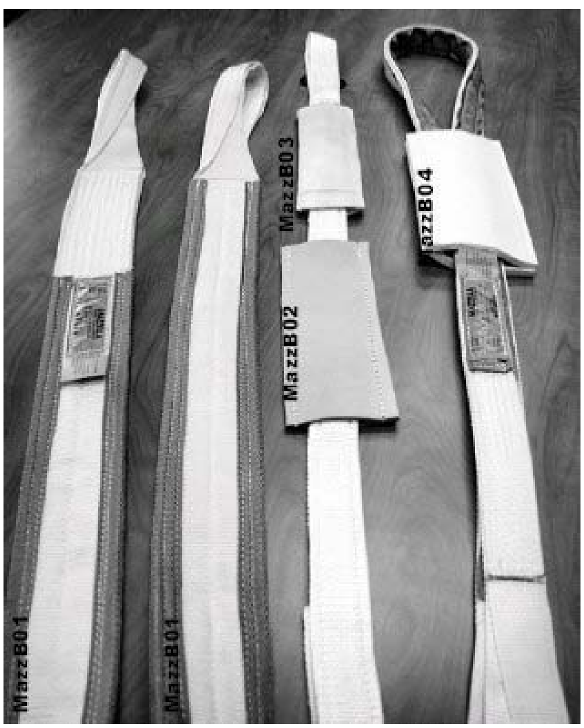


Abrasion Damage



Face Cuts

Sling Wear Pads



MazzB01 = Edgeguard
MazzB02 = Heavy Leather Sewn Sleeve
MazzB03 = Heavy Sewn Nylon
MazzB04 = Felt Quick Sleeve

When slings are cut, property damage and/or personal injury or death can result. Sling wear pads can help to reduce this problem by acting as a buffer between the load and the sling. The number one cause of synthetic sling failure is cutting.

When used with wire rope and chain slings, wear pads help protect both sling and the load from damage along points of contact.

Features and Benefits

Safety

Helps prevent sling cutting that can cause property damage, personal injury and/or death

Saves Money

Protects both sling and load from damage and increases sling life

Inspection Criteria for Sling Wear Pads

If pad is damaged, the sling may also be damaged. Inspect both thoroughly and check slings for:

Wire Rope Slings

Broken wires, Kinking, Crushing, Abrasive wearEct...

Chain Slings

Abrasive wear, Nicks, cracks, gouges, stretch Ect...

Web Slings

Visible red core warning yarns, Cuts on the face or edge of webbing, Holes, tears, snags or crushed web, Signs of abrasive wear, Broken or worn threads in the stitch patterns

<u>Nylon & Polyester Web Slings</u>

Safe Operating Practices
Prior to making a lift, the load be raised slightly, and then lowered so that the wear pads can be inspected for damage. If pads show evidence of cutting, the lift should be tested again using a different type/style of wear pad.

Damage to synthetic slings from abrasion or cutting can be prevented if proper protection is provided on the job site. Common materials used to protect the sling from abrasion damage do not provide adequate protection from cutting. If a sling is exposed to an edge under pressure cutting may occur unless a proven method of protection is provided.

Damaged or misused protection can result in damage or sling failure. Inspect before each use. Inspect for cuts, tears or damage that may prevent protection of the sling. Ensure protection is the correct size and type to protect the sling. *Prevent pads and sling from slipping or sliding across load edge. DEATH* or *INJURY* can occur from improper use, maintenance and/or inspection.

Description

A synthetic web sling is synthetic webbing fabricated into a configuration with or without fittings for raising, lowering, or suspending applications in general industrial and specialized operations.

Basic Sling Types

Type I—Web sling 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, basket or choker hitch.

Type II—Web sling made with a triangle fitting on both ends. It can be used in a vertical or basket hitch only.

Type III—Web sling made with a flat loop eye on each end with loop eye opening on same plane as sling body. This type of sling is sometimes called a flat eye and eye, eye and eye, or double eye sling.

Type IV—Web Sling made with a both loop eyes formed as in Type III, except that the loop eyes are turned to form a loop eye which is at a right angle to the plane of the sling body. This type of sling is commonly referred to as a twisted eye sling.

Nylon & Polyester Web Slings

Type V—Endless web sling, sometimes referred to as a grommet. It is a continuous loop formed by joining the ends of the webbing together with a load-bearing splice.

Type VI—Return eye (reversed eye) web sling is formed by using multiple widths of webbing held edge to edge. A wear pad is attached on one or both sides of the web sling body and on one or both sides of the loop eyes to form a loop eye at each end which is at a right angle to the plane of the web sling body.

Definitions of Terms

Abrasion— The mechanical wearing of a surface resulting from frictional contact with other materials.

Body— That part of a web sling which is between the end fittings or loop eyes.

Breaking Strength— That load in pounds or kilograms at which point any load bearing part of the sling fails.

Coating— A finish applied for a special purpose.

Design Factor— The ratio of the minimum breaking strength to the "rated capacity" for each new web sling.

Elongation— The measurement of stretch, at a given load, expressed as a percentage of the original unloaded length.

Fabrication Efficiency— The ratio of a web sling assembly strength to webbing strength prior to fabrication, expressed as a percentage.

Fitting— A load bearing device which is attached to the web sling.

Hitch/Vertical —A method of rigging a web sling in which the load is attached to one end of the web sling and the other end of the web sling is attached to the lifting device. Hitch/Choker—A method of rigging a web sling in which the web sling is passed around the load, then through itself, then attached to the lifting device.

Hitch/Basket—A method of rigging a web sling in which the web sling is passed around the load, and both ends are attached to the lifting device.

Length (reach)—The distance between the extreme and bearing points of the web sling, including fittings if applicable.

Loop Eye—A length of webbing which has been folded back upon itself, forming an opening, and joined to the web sling body to form a bearing surface.

Nylon & Polyester Web Slings

Minimum Breaking Strength—Minimum load at which a new web sling or component will break when loaded to destruction in direct tension.

Plies—The number of thicknesses of load bearing webbing used in the web sling assembly.

Proof Load Test—A non-destructive load test of the web sling to some multiple of the rated capacity of that web sling, including fittings if applicable. (Usually two (2) times the rated capacity.)

Rated Capacity (Working Load Limit)—The maximum allowable load for each web sling assembly for the type of hitch used.

Splice—That part of a web sling which is lapped and secured to become an integral part of the web sling. Types of splices are as follows:

Load Bearing Splice— Any splice that carries a portion of the total load applied.

Assembly Splice— Any splice that joins two or more parts of the sling without bearing any of the applied load.

Stitch Pattern Failure (Lap pulled apart) — Separation of the load bearing splice due to thread.

Synthetic Fiber - Man-made fibers.

Synthetic Web Sling— A lifting assembly made of synthetic webbing which is to be used to connect the load to the lifting device.

Tapered Eye— A loop eye which is formed by folding the webbing to a narrower width at its bearing point to accommodate the lifting device. A tapered eye may be either flat (Type III) or twisted (Type IV).

Thickness— The depth of the sling, as opposed to the width or length.

Thread— The synthetic yarn which is used to sew the web sling together.

Triangle Fitting— An end attachment which is used for connecting the web sling to the lifting device.

Triangle Choker Fitting— Similar to the "triangle fitting" except that it also has a slot through which the "triangle fitting" can be passed through in order to permit a "choker hitch" on the load.

Wear Pad—Leather, webbing or other fixed or sliding material used to protect the web sling from being damaged.
Webbing— A fabric woven of high tenacity synthetic yarns offering suitable characteristics for use in the manufacturing of web slings.

Webbing Strength Rating— The minimum strength of webbing, expressed in pounds per inch (or kilograms per centimeter) of webbing width.

Width— The distance across the web sling body from outer selvedge to outer selvedge.

Working Load Limit—See rated capacity.

Nylon & Polyester Web Slings

Yarn— The synthetic fibers used to make the webbing and thread.

Coatings

Web slings may be coated with suitable materials that will impart desirable characteristics, such as:

- Abrasion resistance
- Sealing to prevent penetration of foreign particles and matter
- Increased coefficient of friction

Design Factor.

The design factor for new synthetic web slings with or without fittings shall be a minimum of five (5).

Web Sling Identification

Each web sling shall have a permanently affixed identification tag marked to show:

- Name or trademark of manufacturer
- Manufacturer's code or stock number
- Rated capacities for the types of hitches used
- Type of synthetic web yarn

Identification of Synthetic Web Sling Manufacturer

Identification Marker— The web sling manufacturer identification marker shall be a permanent mark which includes the name of the manufacturer.

Location of Marker—The web sling manufacturer identification marker shall be located inside a splice.

Recommended Operating Practices for Web Slings Mechanical Considerations

Determine weight of the load. The weight of the load shall be within the rated capacity of the web sling. Select a web sling having suitable characteristics for the type of load, hitch and environment. Web slings shall not be loaded in excess of the rated capacity. Consideration shall be given to the sling to load angle which affects rated capacity. Web slings with fittings which are used in a choker hitch shall be of sufficient length to assure that the choking action is on the webbing, and never on the fitting. Web slings used in a basket hitch shall have the load balanced to prevent slippage.

The opening in fittings shall be the proper shape and size to ensure that the fitting will seat properly in the hook or other attachments. Web slings shall always be protected from being cut by sharp comers, sharp edges, protrusions or abrasive surfaces. Web slings shall not be dragged on the floor or over abrasive surfaces.

Web slings shall not be twisted, shortened, lengthened, tied in knots, or joined by knotting. Web slings shall not be pulled from under loads when the load is resting on the web sling. Do not drop web slings equipped with metal fittings. Web slings that appear to be damaged shall not be used unless inspected and accepted as usable.

Nylon & Polyester Web Slings

The web sling shall be hitched in a manner providing control of the load. Personnel, including portions of the human body, shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook. Personnel shall stand clear of suspended loads.

Personnel shall not ride the web sling or the load being lifted. Shock loading shall be avoided. Twisting and kinking the legs (branches) shall be avoided. Load applied to the hook shall be centered in the base (bowl) of hook to prevent point loading on the hook.

During lifting, with or without the load, personnel shall be alert for possible snagging.

The web slings' legs (branches) shall contain or support the load from the sides above the center of gravity when using a basket hitch. Web slings shall be long enough so that the rated load (rated capacity) is adequate when the sling to load angle is taken into consideration. Only web slings with legible identification tags shall be used. Tags and labels should be kept away from the load, hook and point of choke. Web slings shall not be constricted or bunched between the ears of a clevis, shackle, or in a hook. Place blocks under load prior to setting down the load to allow removal of the web sling, if applicable.

Environmental Considerations

Web slings should be stored in a cool, dry, dark place to prevent loss of strength when not in use through exposure to ultra-violet rays. Web slings shall not be stored in chemically active areas. Chemically active environments can affect the strength of synthetic web slings in varying degrees ranging from little to total degradation. The web sling manufacturer or qualified person should be consulted before slings are used in chemically active environments.

Acids

Nylon is subject to degradation in acids, ranging from little to total degradation.

Polyester is resistant to many acids, but is subject to degradation, ranging from little to moderate in some acids.

Each application shall be evaluated, taking into consider-ation the following:

1. a. Type of Acid
2. b. Exposure Conditions
3. c. Concentration
4. d. Temperature

Alkalis

Polyester is subject to degradation in alkalis, ranging from little to total degradation.
Nylon is resistant to many alkalis, but is subject to Degradation ranging from little to moderate in some alkalis.
Each application shall be evaluated, taking into consideration the following:

(1) Type of Alkalis
(2) Exposure Conditions
(3) Concentration
(4) Temperature

Nylon & Polyester Web Slings

Nylon and polyester web slings shall not be used at temperatures in excess of 194° F (90° C) or temperatures below minus 40° F (minus 40° C). Web slings incorporating aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of alkalis and/or acids are present.

Environments in which synthetic web slings are continuously exposed to ultra-violet light can affect the strength of synthetic web slings in varying degrees ranging from slight to total degradation.

Caution: Degradation can take place without visible indications.

1. **Factors which affect the degree of strength loss are:**
    1. **Length of time of continuous exposure**
    2. **Web sling construction and design**
    3. **Other environmental factors such as weather conditions and geographic location**
2. **Suggested procedures to minimize the effects of ultra-violet light.**
    1. **Store web slings in a cool, dry, dark place when not being used for prolonged periods of time.**
3. **Some visual indications of ultra-violet degradation are:**
    1. **Bleaching out of web sling color**
    2. **Increased stiffness of web sling material**
    3. **Surface abrasion in areas not normally in contact with the load**
    4. **Proof Testing—Slings used in environments where they are subject to continuous exposure to ultraviolet light shall be proof tested to twice the rated capacity semi-annually, or more frequently depending on severity of exposure.**

Inspection

Type of Inspection.

1. Initial Inspection— before any new or repaired web sling is placed in service, it shall be inspected by a designated person to ensure that the correct web sling is being used, as well as to determine that the web sling meets the requirements of this specification.
2. Frequent Inspection— this inspection shall be conducted by a qualified person handling the sling each time the sling is used.

3. Periodic Inspection— this inspection shall be conducted by designated personnel. Frequency of inspection should be based on:
   - A. Frequency of web sling use
   - B. Severity of service conditions
   - C Experience gained on the service life of web slings used in similar applications
   - D. Inspections should be conducted at least annually

Removal from Service

A sling shall be removed from service if any of the following are visible:

A. If sling rated capacity or sling material identification is missing or not legible

B. Acid or alkalis burns

C. Melting, charring, or weld spatter on any part of the web sling

D. Holes, tears, cuts, snags or embedded particles

E. Broken or worn stitching in load bearing splices

F. Excessive abrasive wear

G. Knots in any part of the web sling

H. Distortion and excessive pitting, corrosion or broken fittings

I .Any conditions which cause doubt as to the strength of the sling

Inspection Records

Written inspection records, utilizing the identification for each sling as established by the user, should be kept on file for all web slings. These records should show a description of the new web sling and its condition on each subsequent inspection.

Repair

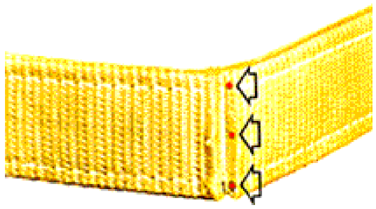
Repair of Web Slings

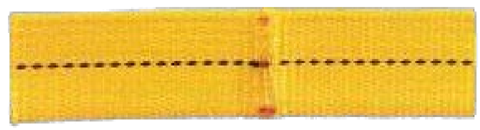
Sling webbing with structural damage shall never be repaired. Type I and Type II web slings, and other web slings utilizing hardware, may be re-webbed utilizing existing fittings. It shall be the responsibility of the manufacturer repairing the web sling to determine if the hardware is re-usable.

All re-webbed Type I and Type II, and other web slings utilizing fittings, shall be proof tested to two (2) times their vertical rated capacity before being placed back into service. A certificate of proof testing shall be provided. Temporary repairs of webbing, fittings, or stitching shall not be permitted.

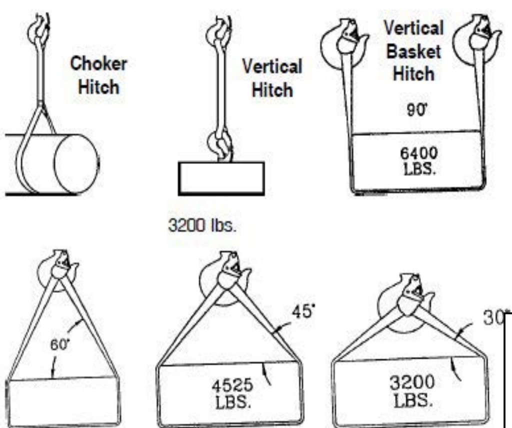
Red Core Yarns Warning System

All standard nylon and polyester web slings have red warning yarns. Red core yarns become exposed when the sling surface is cut or worn through the woven face yarns. This is one criterion, but not the only one for removal from service!





Angles



When using multi-legged slings or chocker/basket hitches with included angle. To determine the actual sling capacity necessary at any given angle of lift, multiply the total weight by the appropriate Load angle factor from the table on the below and divide by the number of legs.

Load Factor Chart	
Leg Angle	**Multiplier**
90°	1.000
85°	1.003
80°	1.015
75°	1.035
70°	1.064
65°	1.103
60°	1.154
55°	1.220
50°	1.305
45°	1.414
40°	1.555
35°	1.743
30°	2.000

Effect of Angle

Rated capacities are affected by angle of lift (sling to load) measured from the horizontal

Tips on synthetic sling load factors.

After identifying the material type, the next consideration must be the rated lifting capacity required. Remember that the rated lifting capacity of the sling must be greater than the weight of the load to be lifted. Because the angle of pull on the leg of a sling varies with the leg angle, forces may be exerted on a sling greater than the user may expect.

Example of how to calculate the load on a particular sling leg:

1. Take the total weight of the load and divide this by the number of supporting the load. For example, assume a 2000 pound load is to be supported by 2 legs of a sling. The above will give a total minimum weight on each leg of the sling of 2000 pounds divided by 2 legs or 1000 pounds.
2. Determine the load factor by observing the load factor chart. Ex.

   Assume that the leg angle will be 60°. The load factor for 60° from load factor chart is 1.154.
3. Multiply the load factor times the minimum weight to be supported by the leg, i.e. 1000 pounds times 1.154=1154 pounds. The rated sling capacity needed is then 2308 (1154x2) pounds in basket capacity to safely lift the 2000 pound load.

CAUTION: These tips are provided as starting points in the selection process are not universally applicable. Please consult an experts for the solution to your specific application problem.

Sling Savers Shackles & Hooks

Synthetic Sling Saver Shackles and Hooks—

Designed with Non-Slip surface that:

- Eliminates “bunching effect caused by traditional shackles.
- Reduces sling tendency to slide.

Shackles available in sizes 3-1/4 to 50 tons.

Hooks available in sizes 1- 1/2, 3 and 5 tons.

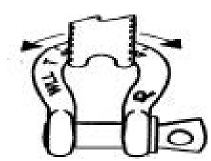
- Shackles available in both a Screw Pin and Bolt,
- Nut and cotter pin configuration.
- Bolt (pin) has a larger diameter that provides better load distribution.
- All Alloy construction.

WEB SLING
WEB SLINGS SHALL NOT BE CONSTRICTED OR BUNCHED BETWEEN THE EARS OF A CLEVIS OR SHACKLE, OR IN A HOOK.

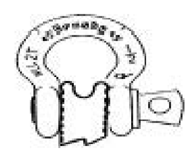
ROUND SLINGS
THE ROUND SLING SHALL NOT BE CONSTRICTED OR BUNCHED BETWEEN THE EARS OF A CLEVIS OR SHACKLE, OR IN A HOOK.

THE OPENING OF FITTINGS SHALL BE PROPER SHAPE AND SIZE TO ENSURE THAT THE FITTINGS WILL SEAT PROPERLY ON THE ROUND SLING.

SYNTHETIC SLINGS RATED LOAD
FOLDING, BUNCHING OR PINCHING OF SYNTHETIC SLINGS, WHICH OCCURS WHEN USED WITH SHACKLES, HOOKS OR OTHER APPLICATIONS WILL REDUCE THE RATED LOAD.

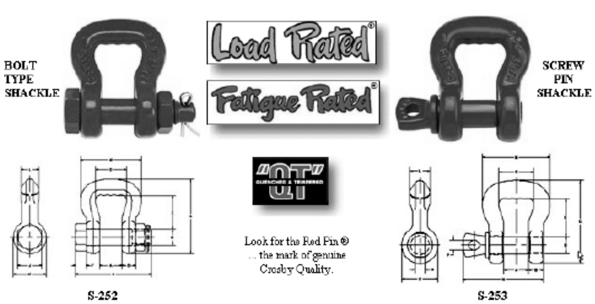


BUNCHING



PINCHING

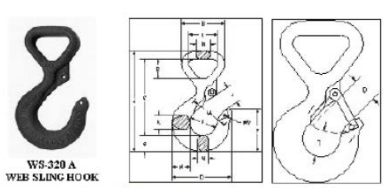
ANSI B30.9-1994



Web Sling Eye Width (in.)	Round Sling size (No.)	Working Load Limit* (tons)	S-252 Bolt Type S-252 Stock No.	S-252 Bolt Type Weight Each (lbs)	S-253 Screw Type S-253 Stock No.	S-253 Screw Type Weight Each (lbs)	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
1	1& 2	3 1/4	1020485	1.4	1020575	1.4	.88	.62	1.38	.75	1.50	.44	3.38	3.68	1.12	1.50	.75	2.69	3.22	.44	1.00
1.5	3& 4	6 1/2	1020496	2.4	1020584	2.2	1.25	.75	1.75	.88	1.88	.50	4.15	4.25	1.31	1.81	1.00	3.38	4.03	.50	1.19
2	5& 6	8 3/4	1020507	4.1	1020593	3.8	1.38	.88	2.25	1.00	2.81	.56	6.50	4.72	1.50	2.09	1.12	4.19	4.50	.50	1.19
3	7& 8	12 1/2	1020518	8.0	1020602	7.3	1.62	1.12	3.25	1.25	3.06	.75	6.34	5.88	1.88	2.62	1.38	5.62	5.59	.62	1.81
4	9& 10	20 1/2	1020529	16.9	1020611	15.2	2.12	1.38	4.50	1.50	5.75	.88	9.75	7.19	2.25	3.12	1.75	7.50	6.88	.75	2.13
5	11& 12	35	1020540	35.0	1020620	30.8	2.50	1.75	5.50	2.00	6.34	1.12	11.50	9.31	3.00	4.19	2.25	9.19	8.66	1.00	2.88
6	13	50	1020551	57.5	1020629	52.0	3.00	2.12	6.50	2.25	7.70	1.25	13.75	10.38	3.38	4.75	2.75	11.00	10.22	1.22	3.19

Dimensions (in)

* Note: Maximum Proof Load is 2-1/2 times the Working Load Limit. Minimum Ultimate Strength is 5 times the Wording Load Limit



WS-320 A
WEB SLING HOOK

Web Sling Normal Size (in)	Round sling Size (Number)	Working Load Limit* (tons)	Hook identification Code	WS-320 S. C.	AWSL-320 A with latch	S-4320 Replacement Latch Kit Stock No
1"	1	1-1/2	FA	1022701	1022706	1096374
2"	2	3	HA	1022712	1022717	1096468
3"	3	5	IA	1022723	1022728	1096515

320 AN-Alloy Steel

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GSFC

Turnbuckle

Revised Policy Feb. 2002

ATTACHMENT A
Revised Policy - Turnbuckles in Lifting Assemblies
GSFC Recertification Program, Code 540
February 4, 2002

(NOTE: This document supersedes Recertification Program (RECERT) Interim Policy dated May 17, 2000, subject: Use of Turnbuckles in Lifting Assemblies.)

The use of any turnbuckles that contains an original equipment manufacturer (OEM) warning label "not recommended for lifting" is not allowed. Since some Cooper turnbuckles (marked "☆ C") contain such warning labels, their use is not allowed. In addition, at the current time, it is unclear whether the Cooper warning label is applicable to other Cooper brands including Brower-Titchener (marked "BTC"), Merrill (marked "MB"), Campbell (marked "CC"), trademarks etc. Until OEM clarification is obtained and proven otherwise, these brands of turnbuckles are not permitted.

Based on continuing investigation and written clarifications provided by lifting equipment manufacturers to date do not generally recomrnend the use of turnbuckles as part of the lifting assemblies. Turnbuckles are designed as a tensioning device. The inclusion of turnbuckles for overhead lifts is addressed by only one OEM with the following four conditions:

1. "Turnbuckles may be used in any attitude or angle as long as the load (tension) is in line and does not exceed the working load limit (WLL)."

2. "The load angle will increase the tension in the turnbuckle and the resultant load must not exceed the WLL."

3. "Turnbuckles are made to be adjusted up to the tension produced by the WLL. They are not designed to repeatedly lift the WLL thru the adjustments of the threads. Torqueing the thread at WLL cause the galvanizing to flake off and bind the threads."

4. "Alternatives:

    1. Un-galvanized turnbuckle with a better class of thread.

    2. Un-galvanized turnbuckle with an acme threads for continuous lifting at WLL.

    3. Ratchet load binders without hooks,(i.e. R-10)."

Due to unknown conditions, use, tension developed, and torque needed, it is impossible to address each use. In light of the above OEM guidance, the use of turnbuckles for overhead lifts is discouraged and alternate methods for lifting adjustment should be considered and developed.

For further clarifications, contact RECERT Support/Code/540.5 at (301) 286-9116, or the RECERT Manager/Code 540, at (301) 286-4209.

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Cortland, NY 13045
Phone: (607) 756-2821
Fax: (607) 753-3722

COOPER Tools

June 23, 2000

Warren Thomas
NASA Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771

Re: CooperTools Turnbuckles

Dear Mr. Thomas

You had questioned the 'UPC' label on one of our Turnbuckle products (6250503). We had stated on this label that it (the Turnbuckle) was not recommended for Overhead Lifting. Overhead Lifting is defined as the process of lifting that would elevate a **freely suspended load** to such a position that dropping the load would present a possibility of bodily injury or property damage. A Turnbuckle is designed for static loading only. The load on a turnbuckle must be applied in a straight line. A freely suspended load could impose angular loading. Turnbuckles are not designed for angular loading.

If you have any other questions or concerns, please do not hesitate to contact me.

Sincerely,

Don Barber

Don Barber
Product Design Engineer

Campbell Operations
45 Cleveland Street
Cortland, NY 13045
Phone (607) 756-2821
Fax (607) 753-3722

COOPER Tools

June 29, 2000

Warren Thomas
NASA Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771

Re: CooperTools Turnbuckles

Dear Mr. Thomas

Our carbon steel turnbuckles in the past have been marketed under the brand name "Brower-Titchener". These turnbuckle were marked "BTC" or " ☆C". Our stainless steel turnbuckles have been marketed under the brand name "Merrill" in the past. These turnbuckles were marked "MB". Turnbuckles today are marketed under the "Campbell" brand name, and are marked "CC"

If you have any other questions or concerns, please do not hesitate to contact me.

Sincerely,

Don Barber
Product Design Engineer

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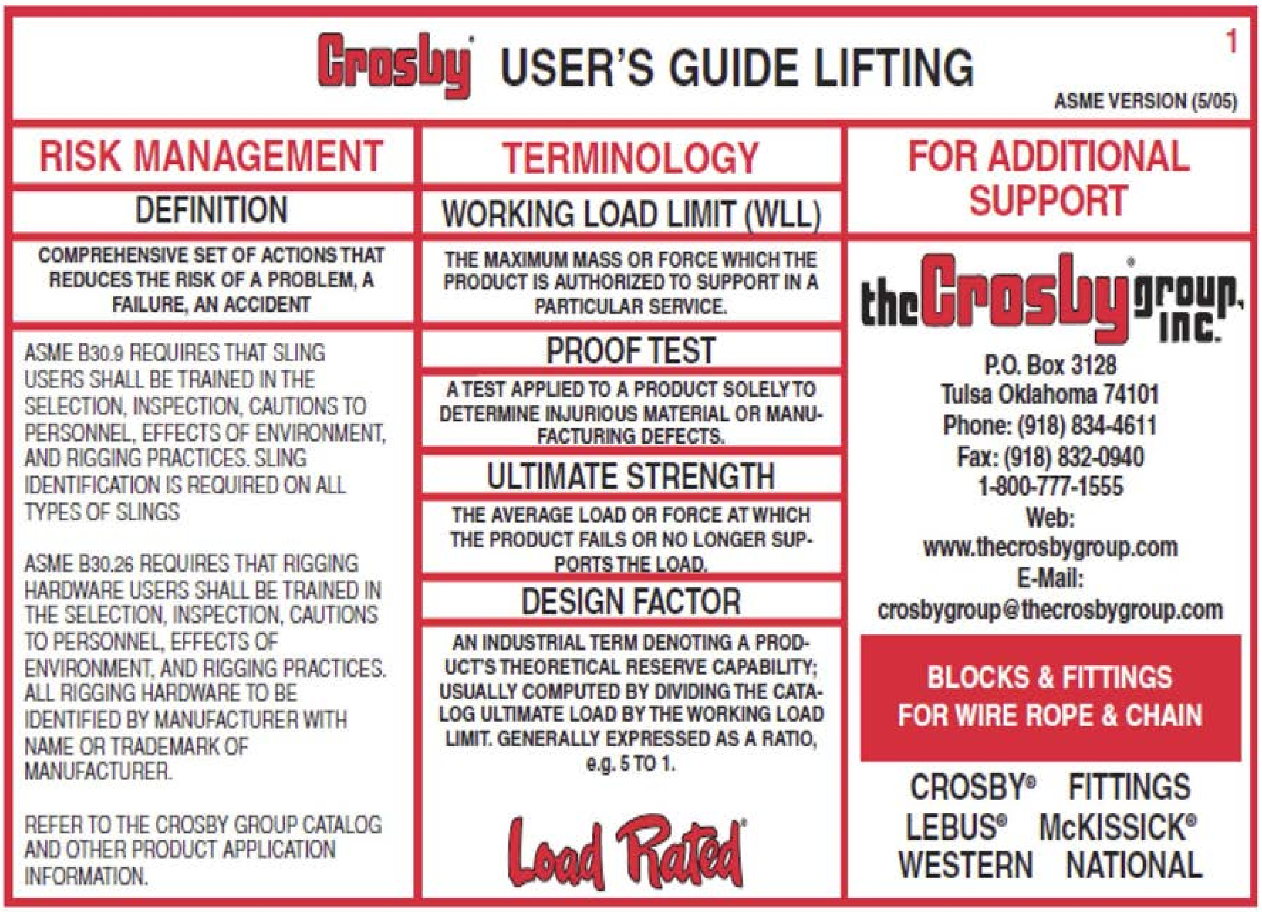
How to Read Sling Manufacturers Charts

Using The CROSBY Users Guide To Lifting

In the front Cover of this book you should find the most recent version of the pocket sized reference card entitled "Crosby Users Guide to Lifting" for your use.


Crosby USER'S GUIDE LIFTING

1

ASME VERSION (5/05)

RISK MANAGEMENT

DEFINITION

COMPREHENSIVE SET OF ACTIONS THAT REDUCES THE RISK OF A PROBLEM, A FAILURE, AN ACCIDENT

ASME B30.9 REQUIRES THAT SLING USERS SHALL BE TRAINED IN THE SELECTION, INSPECTION, CAUTIONS TO PERSONNEL, EFFECTS OF ENVIRONMENT, AND RIGGING PRACTICES. SLING IDENTIFICATION IS REQUIRED ON ALL TYPES OF SLINGS

ASME B30.26 REQUIRES THAT RIGGING HARDWARE USERS SHALL BE TRAINED IN THE SELECTION, INSPECTION, CAUTIONS TO PERSONNEL, EFFECTS OF ENVIRONMENT, AND RIGGING PRACTICES. ALL RIGGING HARDWARE TO BE IDENTIFIED BY MANUFACTURER WITH NAME OR TRADEMARK OF MANUFACTURER.

REFER TO THE CROSBY GROUP CATALOG AND OTHER PRODUCT APPLICATION INFORMATION.

TERMINOLOGY

WORKING LOAD LIMIT (WLL)

THE MAXIMUM MASS OR FORCE WHICH THE PRODUCT IS AUTHORIZED TO SUPPORT IN A PARTICULAR SERVICE.

PROOF TEST

A TEST APPLIED TO A PRODUCT SOLELY TO DETERMINE INJURIOUS MATERIAL OR MANUFACTURING DEFECTS.

ULTIMATE STRENGTH

THE AVERAGE LOAD OR FORCE AT WHICH THE PRODUCT FAILS OR NO LONGER SUPPORTS THE LOAD.

DESIGN FACTOR

AN INDUSTRIAL TERM DENOTING A PRODUCT'S THEORETICAL RESERVE CAPABILITY; USUALLY COMPUTED BY DIVIDING THE CATALOG ULTIMATE LOAD BY THE WORKING LOAD LIMIT. GENERALLY EXPRESSED AS A RATIO, e.g. 5 TO 1.

Load Rated

FOR ADDITIONAL SUPPORT

the Crosby group, inc.

P.O. Box 3128
Tulsa Oklahoma 74101
Phone: (918) 834-4611
Fax: (918) 832-0940
1-800-777-1555
Web:
www.thecrosbygroup.com
E-Mail:
crosbygroup@thecrosbygroup.com

BLOCKS & FITTINGS FOR WIRE ROPE & CHAIN

CROSBY® FITTINGS
LEBUS® McKISSICK®
WESTERN NATIONAL

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THE CROSBY
USER'S GUIDE

EXERCISE #4
THE CROSBY GROUP USER'S GUIDE / LIFTING

1. *Always use __________ eye bolts if side loading will occur.*
2. *The Working Load Limit of a __________ eye bolt is 3,990 lbs. at a sling angle of 45°.*
3. *The Working Load Limit of a __________ hoist ring is 4,000 lbs. at a sling angle of 45°.*
4. *Apply the u-bolt of a wire rope clip over the __________ of the wire rope.*
5. *The Working Load Limit of a 1/2" eye and hook turnbuckle is __________ a 1/2" eye and jaw turnbuckle.*
6. *Never allow an included angle __________ 90° when connecting a two-legged sling to a hoist hook.*
7. *Rig to the __________.*
8. *The __________ of a load should be selected carefully for load stability.*
9. *The capacity of a four-legged chain sling is __________ a three legged chain sling of the same nominal size and sling angle.*
10. *The __________ of any sling will have a capacity of up to twice that of a single leg.*
11. *A sling connected at a horizontal sling angle of 30° works __________ as that of a vertical sling.*
12. *Removal criteria for web slings include __________.*
13. *Removal criteria for chain slings include __________.*
14. *Removal criteria for wire rope slings includes five broken wires distributed in one __________ of the __________.*
15. *The capacity of a 1/2" wire rope sling is 4,400 lbs. when used as a __________.*
16. *The capacity of a 1/2" wire rope sling is 3,200 lbs. when used as a __________.*
17. *The capacity of a 1/2" wire sling is 7,600 lbs. when used as a __________.*

Choose Answer from the Following List

a. *twice as hard*
b. *single leg*
c. *bridle at 60°*
d. *dead-end*
e. *less than*
f. *greater than*
g. *the same as*
h. *shouldered*
i. *choker*
j. *5/8"*
k. *1"*
l. *lay*
m. *center of gravity*
n. *pick points*
o. *strand*
p. *basket hitch*
q. *stretch and broken stitches*
r. *discoloration from excessive temperature*

the Crosby group, inc.

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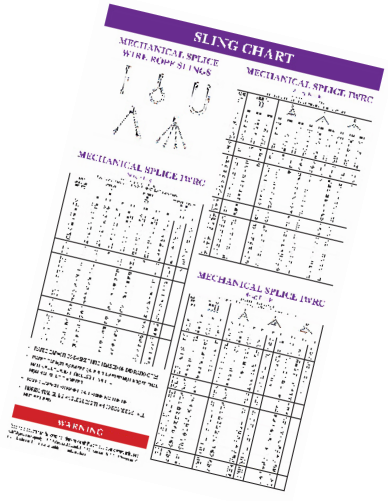
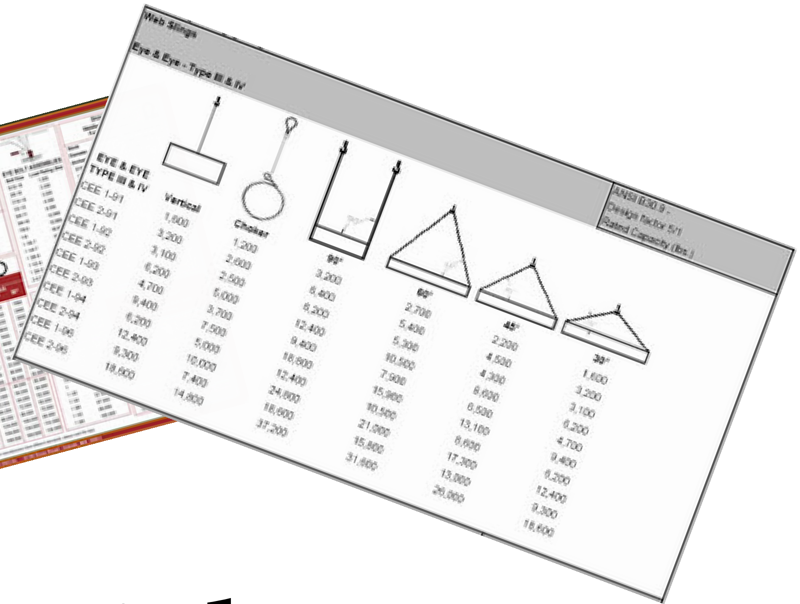
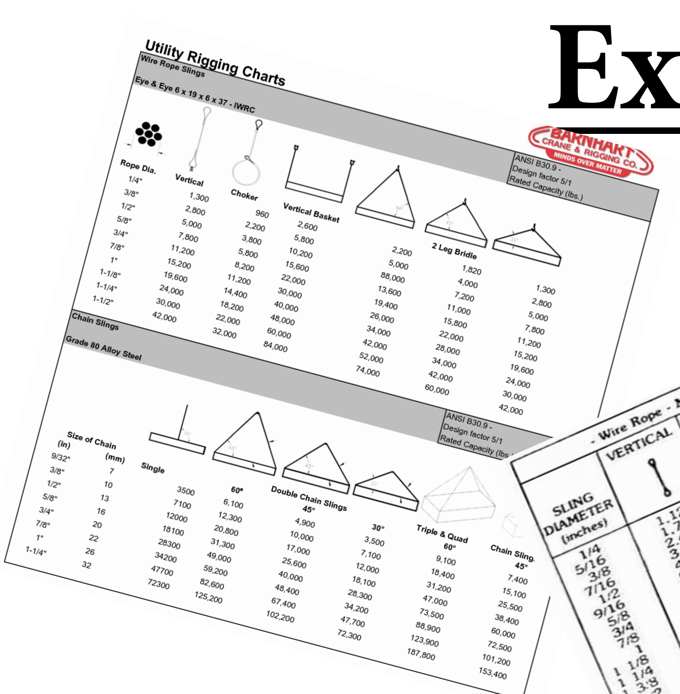
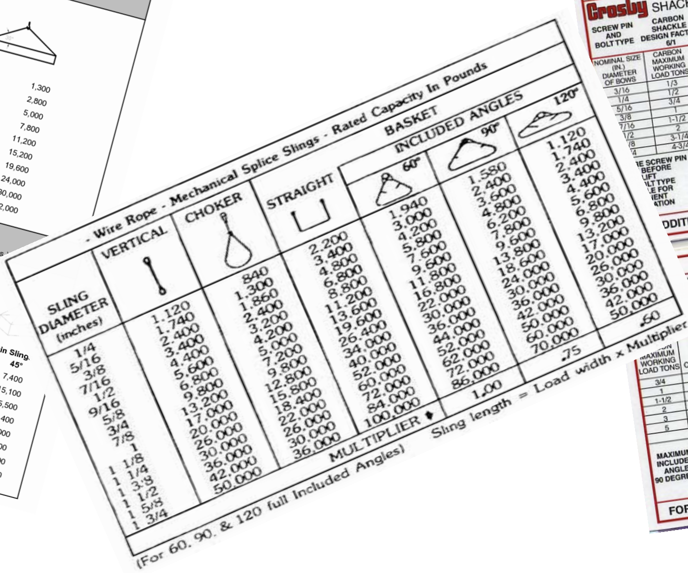
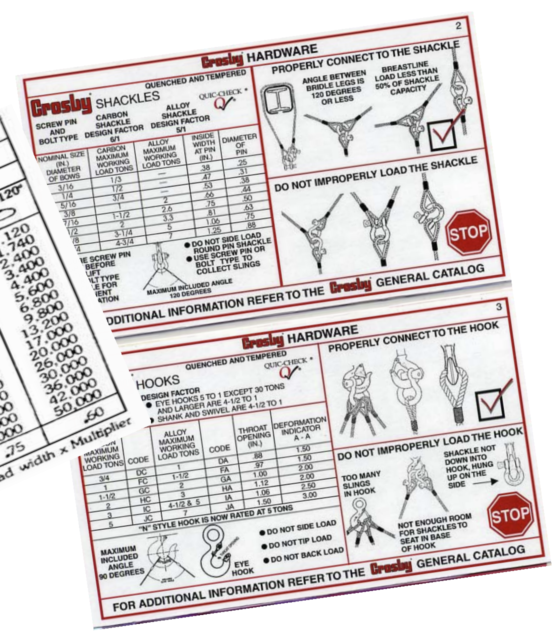




Load Weight Estimation and Selection of Rigging Exercises







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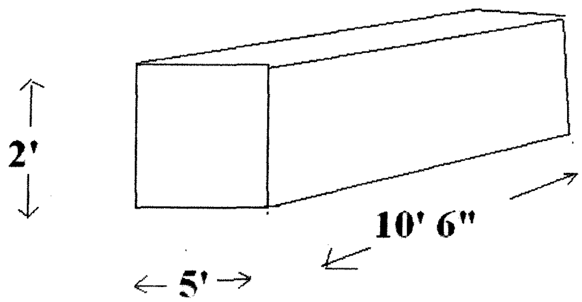
Load Weight Estimation

Utilizing the "Crosby' Users Guide for Lifting" complete the following exercises:

Exercise #1

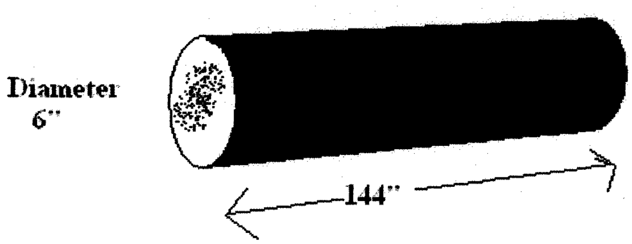
(Concrete Block) **Concrete = (150 Pounds per Cubic Foot)**



Volume________ Weight ________

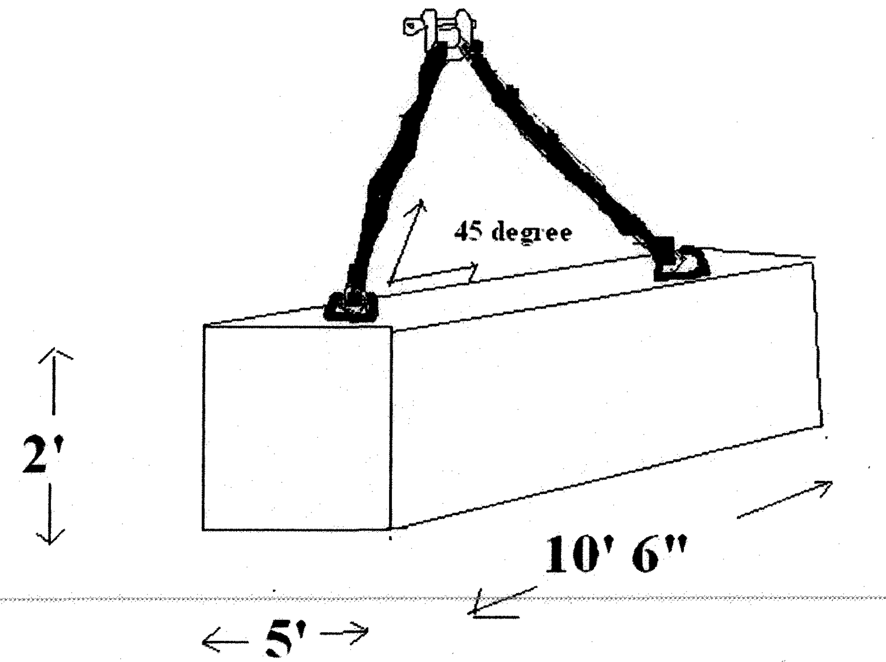
Exercise #2

(Steel Shaft) **(Steel = 490 LBS per Cubic Foot)**



Volume ________ Weight ________

Exercise #3 Rigging Selection



From Exercise #1 you have already determined the Weight is ___________________. Now select the proper rigging:

Alloy Shackle Size = __________________ (Page 12)

Using Chain Slings = ------------------- (Pages 7 & 11)

Using Wire Rope Slings = _____________ (Pages 5 & 11)

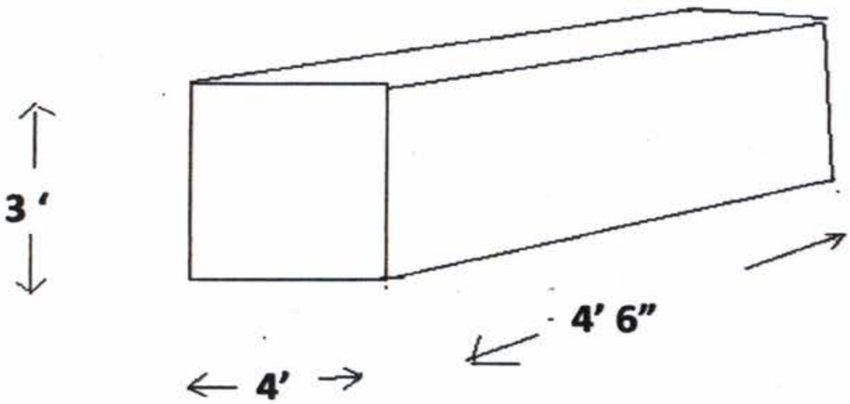
Swivel Hoist Rings = ____________________(Page 14)

Turnbuckle = __________________ (Page 13)

Shouldered Eye Bolt = __________________ (Page 14)

EXERCISE #4

Rigging Selection

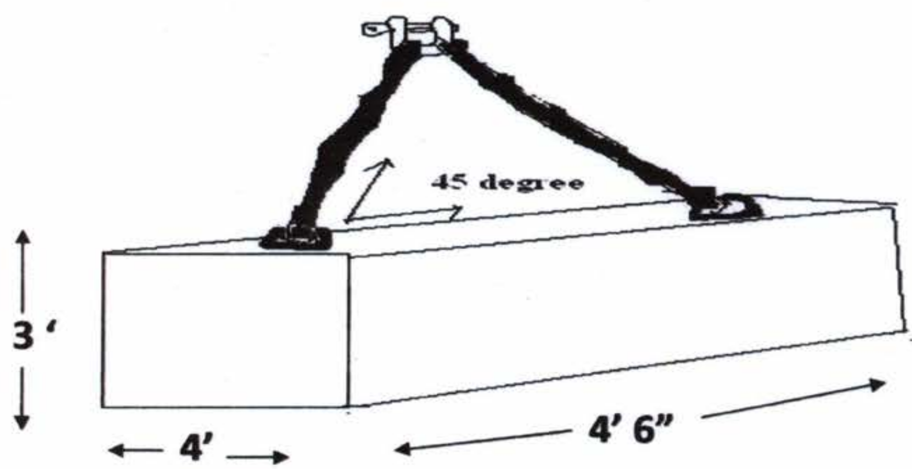


Steel = 490 lbs Cu/Ft

Volume = L x W x H

Volume =____________________

Weight= ____________________



Now select the proper rigging:

Alloy Shackle Size = _____________ (Page 12)

Using Chain Slings = ____________ (Pages 7 & 11)

Using Wire Rope Slings = _________ (Pages 5 & 11)

Swivel Hoist Rings = ______________(Page 14)

Turnbuckle = _____________ (Page 13)

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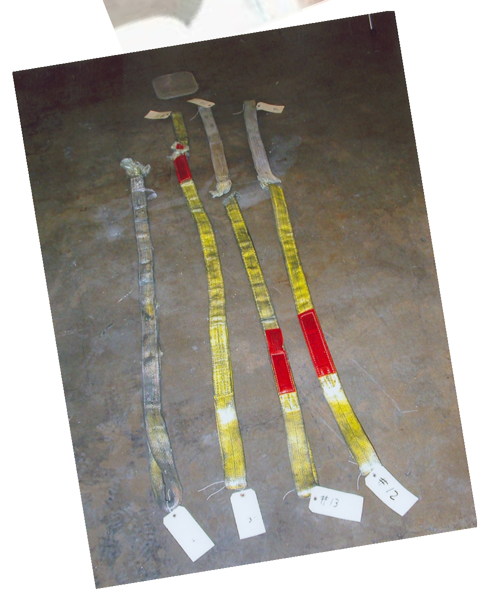
Common Rigging Problems



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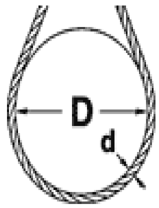
Common Rigging Problems

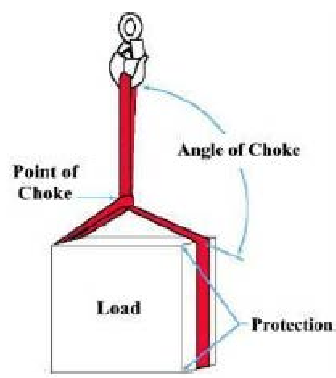
D/d Ratios



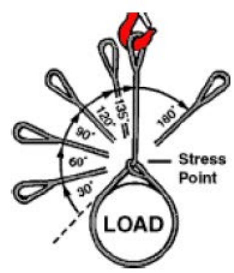
D/d ratio is the ratio of the diameter around which the sling is bent divided by the body diameter of the sling. Tests have shown that whenever a sling body is bent around a diameter, the strength of the sling is decreased.

The capacities in our web site are based on the minimum D/d ratios that are noted on each wire rope sling page. For more severe bending conditions, contact our customer service department for revised capacities.

Beating Down A Choker Hitch



If the angle is less than 120°, you must adjust its Choker Hitch Working Load Limit by the appropriate choke factor from this table.



Choke Angle - When lifting or turning a load rigged with a choker hitch, the angle at which a sling is turned back on itself can reduce its capacity below what is listed for its choker hitch, if the angle is too severe. When a load is allowed to hang free, the natural choke angle is about 135

Choker Hitch Rated Capacity - A choker hitch will have 75% of the capacity of a single leg vertical hitch only if the corners are softened and the horizontal angle is greater than 30°. Use blocks to prevent angles less than 30°.

Not Calculating Sling Angle

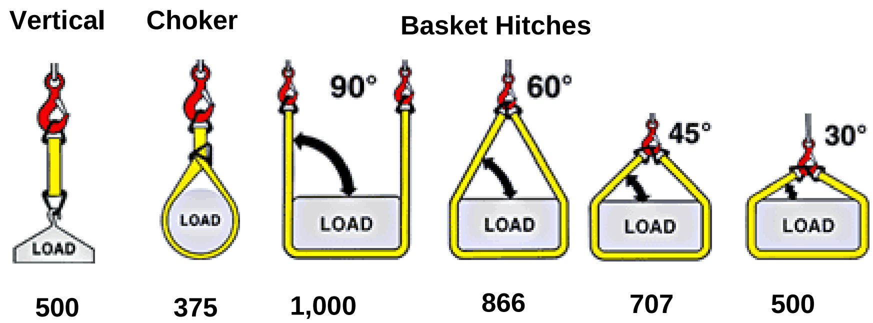
Common Rigging Problems

Basic Sling Hitches and their effect on Working Load Limits

This illustration shows the basic sling hitches.

It also shows capacities for a single sample sling, rigged with each hitch.

The sample sling's Working Load Limit in a vertical hitch is 500 lbs.



Sample Sling WLL (lbs.):

This sling has a Working Load Limit of 500 lbs. in a vertical hitch. Used in a choker hitch, it would have a capacity of 375 lbs. Used in a basket hitch with the legs at a 90° angle to the load, it would have a working load limit of 1,000 lbs. Used in a basket hitch with the legs at a 60° angle to the load, it would have a working load limit of 866 lbs., etc. - Why? The angle at which a sling is used, and the number of legs lifting the load can significantly effect its capacity. The formula for this calculation is shown below.

Vertical - When a sling is used in a vertical hitch, the full lifting capacity of the sling material can be utilized.

Choker - Due to the stress created at the choke point, slings rigged with this hitch achieve only about 75% of their potential capacity.

Always pull a choker hitch tight *before* a lift is made - *never* during the lift. (more, click here)

Basket Hitch (90°) - The cradle configuration of this hitch allows the two extending ends (legs) of the sling to function as if they were two separate slings. The capacity of the sling in this hitch is twice that of the same sling in a vertical hitch, but only if the sling angle of each leg is 90° (see right). Lifting with both legs at 90° would normally require two lifting devices or a spreader bar.

Basket Hitch (less than 90°) - When slings or sling legs are used at an angle during a lift , the sling capacity is reduced. How much it is reduced depends on the sling angle (see above and table, right).

Note that the rated capacity of a 30° Basket is only one half that of a 90° Basket. Sling angles below 30° are strongly discouraged. A sling angle of 60° or more is preferred.

Sling Specification Tables -

Sling tables throughout our site contain the Working Load Limits of slings rigged with these hitches at certain specified angles.

Sling Angle	Sling Angle Factor
90°	1.000
85°	0.996
80°	0.985
75°	0.966
70°	0.940
65°	0.906
60°	0.866
55°	0.819
50°	0.766
45°	0.707
40°	0.643
35°	0.574
30°	0.500

Formula for adjusting the Working Load Limit of a sling or sling

Vertical Hitch Working Load Limit X Number of Legs* X Sling Angle Factor = WLL at specified angle.

Common Rigging Problems

Always pull a choker hitch tight *before* a lift is made - *never* during the lift. **(more, click here)**

Basket Hitch (90°) - The cradle configuration of this hitch allows the two extending ends (legs) of the sling to function as if they were two separate slings. The capacity of the sling in this hitch is twice that of the same sling in a vertical hitch, but only if the sling angle of each leg is 90° (see right). Lifting with both legs at 90° would normally require two lifting devices or a spreader bar.

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Note that the rated capacity of a 30° Basket is only one half that of a 90° Basket. Sling angles below 30° are strongly discouraged. A sling angle of 60° or more is preferred.

Sling Specification Tables - Sling tables throughout our site contain the Working Load Limits of slings rigged with these hitches at certain specified angles.

Sling Angle	Sling Angle Factor
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60°	0.866
55°	0.819
50°	0.766
45°	0.707
40°	0.643
35°	0.574
30°	0.500

Formula for adjusting the Working Load Limit of a sling or sling

Vertical Hitch Working Load Limit X **Number of Legs*** X **Sling Angle Factor** = **WLL at specified angle.**

The Working Load Limit for the sample sling above, in a 60° basket hitch would be calculated as follows:
500 lbs. (Vertical WLL) x **2** (num. of legs) x **.866** (sling angle factor from table) = **866 lbs**

Determining Sling Angle

Use the formula below and the Sling Angle Table to estimate the lift angle

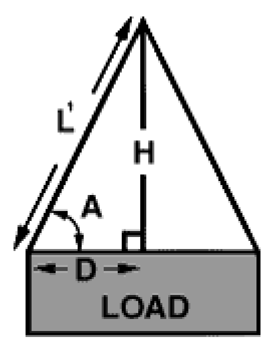
Load Angle Factor = L / H

Sling Angle (A)	Load Angle Factor	Sling Angle (A)	Load Angle Factor
90°	1.000	55°	1.221
85°	1.004	50°	1.305
80°	1.015	45°	1.414
75°	1.035	40°	1.555
70°	1.064	35°	1.742
65°	1.104	30°	2.000
60°	1.155		

To calculate the load on each leg of a sling with equal legs:

Load On Each Leg of a Sling (L^1) =

$$\frac{\text{Load (lbs.) x Load Angle Factor}}{\text{Number of Legs*}}$$



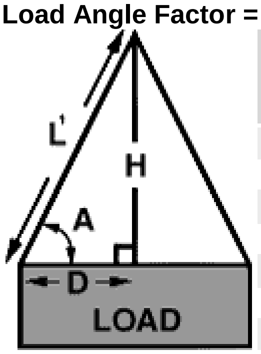
Unequal Legs

To calculate the load on each leg of a sling with unequal legs: Load on Leg L1 = Load (lbs) x D2 x L1 H x (D1 + D2) L oad on Leg 1L2 =

Common Rigging Problems

Determining the Load on Each Leg of a Sling with Equal Legs

Load Angle Factor = L / H



Sling Angle (A)	Load Angle Factor	Sling Angle (A)	Load Angle Factor
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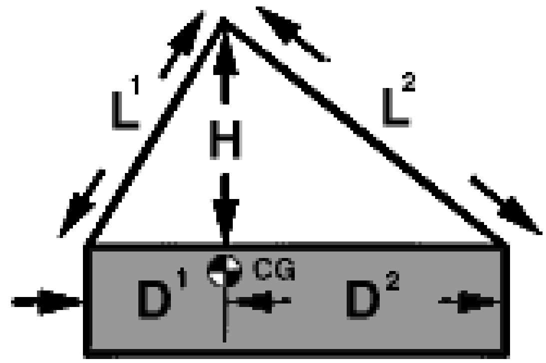
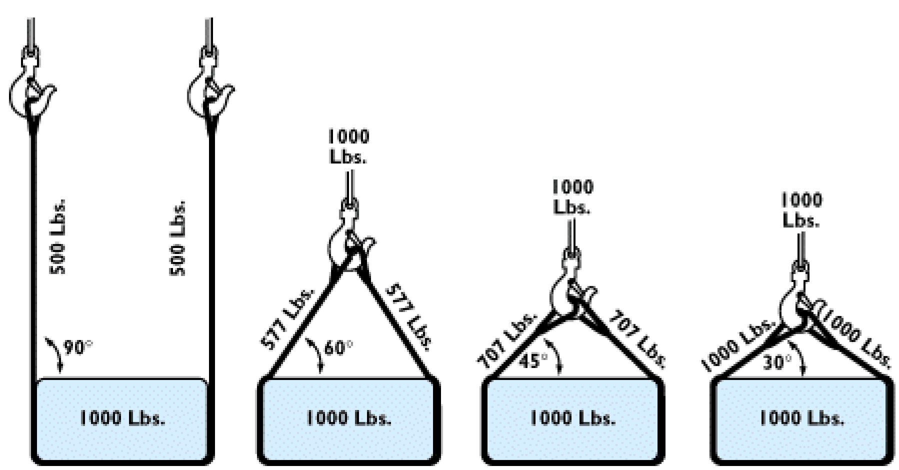
75°	1.035	40°	1.555
70°	1.064	35°	1.742
65°	1.104	30°	2.000
60°	1.155		

Load On Each Leg of a Sling (L^1) =

<u>Load</u> <u>(lbs.)</u> **<u>x Load Angle Factor</u>**
Number of Legs*





Common Rigging Problems

Not Inspecting Rigging Before every use.

Synthetic Slings

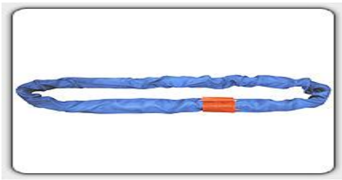

Make a thorough inspection of slings and attachments. Items to look for include:

- Missing or illegible sling identification,
- Acid or caustic burns,
- Melting or charring of any part of the sling,
- Holes, tears, cuts, or snags,
- Broken or worn stitching in load bearing splices,
- Excessive abrasive wear,
- Knots in any part of the sling,
- Discoloration and brittle or stiff areas on any part of the sling,
- Pitted, corroded, cracked, bent, twisted, gouged, or broken fittings, and
- Other conditions that cause doubt as to continued use of a sling.

Where any such damage or deterioration is present, remove the sling or attachment from service immediately.

Common Rigging Problems

Synthetic Round Slings

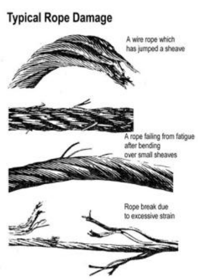



Use and Inspection:

Before each use, all slings, fastenings and attachments should be inspected for defects and damage. Additional inspections should be performed on a regular basis. Damaged or defective slings should be removed and destroyed immediately.
A sling should be removed from service if damage such as the following is visible:

- Acid or caustic burns.
- Melting or charring of any part of the sling.
- Holes, tears, cuts or snags.
- Excessive abrasive wear.
- Knots in any part of the sling.
- Excessive pitting, corrosion, cracking or distortion in end fittings
- Other visible damage that causes doubt as to the strength of the sling.

Wire Rope Slings

REMOVAL CRITERIA
Wire Rope Slings (ASME B30.9) -A wire rope sling shall be removed from service if conditions such as the following are present:

1. Missing or illegible sling identification.
2. *Broken Wires:
   *For strand-laid and single-part slings, ten randomly distributed broken wires in on rope lay, or five broken wires in one strand in one rope lay.
   *For cable-laid slings, 20 broken wires per lay.
   *For six-part braided slings, 20 broken wires per braid
   *For eight-part braided slings, 40 broken wires per braid.
3. Severe localized abrasion or scraping.
4. Kinking, crushing, bird caging, or any 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. For hooks, removal criteria at stated in ASME B30.10.
9. Other conditions, including visible damage, that cause doubt as to the continued use of the sling.

Common Rigging Problems

Wire Mesh Slings

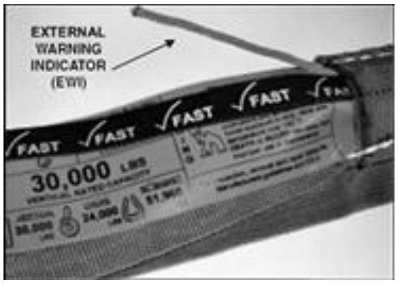
Make a thorough inspection of slings and attachments. Items to look for include:

- Broken wires in any part of the mesh,
- Broken weld or broken brazed joint along the sling edge,
- Reduction in wire diameter of 25 percent or more due to abrasion or 15 percent or more due to corrosion,
- Lack of flexibility due to distortion of the mesh,
- Distortion of the choker fitting so that the depth of the slot is increased by more than 10 percent,
- Distortion of either end fitting so that the width of the eye opening is decreased by more than 10 percent,
- A 15 percent or more reduction of the original cross-sectional area of any point around the hook opening of the end fitting,
- Visible distortion of either end fitting out of its plane,
- Cracked end fitting,
- Sling in which the spirals are locked or without free articulation,
- Fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken,
- Missing or illegible sling identifications, and
- Other conditions that cause doubt as to continued use of the sling.

Where any such defect or deterioration is present, remove the sling or attachment from service immediately.

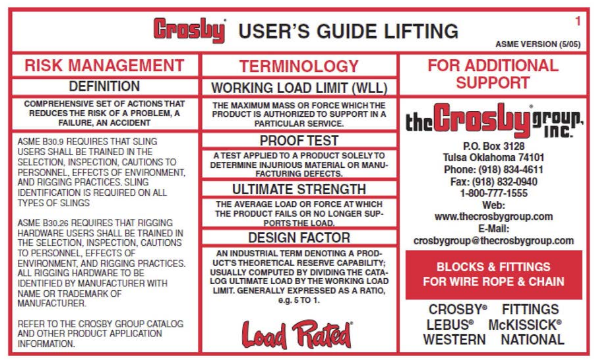
Common Rigging Problems

Missing Or Illegible Tags



Capacity No Known

Not Able to read and understand Rigging Selection Charts


Crosby USER'S GUIDE LIFTING

ASME VERSION (5/05)

RISK MANAGEMENT	TERMINOLOGY	FOR ADDITIONAL SUPPORT
DEFINITION COMPREHENSIVE SET OF ACTIONS THAT REDUCES THE RISK OF A PROBLEM, A FAILURE, AN ACCIDENT ASME B30.9 REQUIRES THAT SLING USERS SHALL BE TRAINED IN THE SELECTION, INSPECTION, CAUTIONS TO PERSONNEL, EFFECTS OF ENVIRONMENT, AND RIGGING PRACTICES. SLING IDENTIFICATION IS REQUIRED ON ALL TYPES OF SLINGS ASME B30.26 REQUIRES THAT RIGGING HARDWARE USERS SHALL BE TRAINED IN THE SELECTION, INSPECTION, CAUTIONS TO PERSONNEL, EFFECTS OF ENVIRONMENT, AND RIGGING PRACTICES. ALL RIGGING HARDWARE TO BE IDENTIFIED BY MANUFACTURER WITH NAME OR TRADEMARK OF MANUFACTURER. REFER TO THE CROSBY GROUP CATALOG AND OTHER PRODUCT APPLICATION INFORMATION.	WORKING LOAD LIMIT (WLL) THE MAXIMUM MASS OR FORCE WHICH THE PRODUCT IS AUTHORIZED TO SUPPORT IN A PARTICULAR SERVICE. PROOF TEST A TEST APPLIED TO A PRODUCT SOLELY TO DETERMINE INJURIOUS MATERIAL OR MANUFACTURING DEFECTS. ULTIMATE STRENGTH THE AVERAGE LOAD OR FORCE AT WHICH THE PRODUCT FAILS OR NO LONGER SUPPORTS THE LOAD. DESIGN FACTOR AN INDUSTRIAL TERM DENOTING A PRODUCT'S THEORETICAL RESERVE CAPABILITY; USUALLY COMPUTED BY DIVIDING THE CATALOG ULTIMATE LOAD BY THE WORKING LOAD LIMIT. GENERALLY EXPRESSED AS A RATIO, e.g. 5 TO 1. Load Rated	the Crosby group, inc. P.O. Box 3128 Tulsa Oklahoma 74101 Phone: (918) 834-4611 Fax: (918) 832-0940 1-800-777-1555 Web: www.thecrosbygroup.com E-Mail: crosbygroup@thecrosbygroup.com BLOCKS & FITTINGS FOR WIRE ROPE & CHAIN CROSBY® FITTINGS LEBUS® McKISSICK® WESTERN NATIONAL

Use of Improperly made below the hook lifting devices

THE RIGGING PLAN

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THE RIGGING PLAN

Are the working load limits adequate?

Are the working load limits known?

What is the weight of the load?

Where is the center of gravity?

Is a tag line needed?

Will the load be under control?

THE RIGGING PLAN

Is the equipment in acceptable condition?

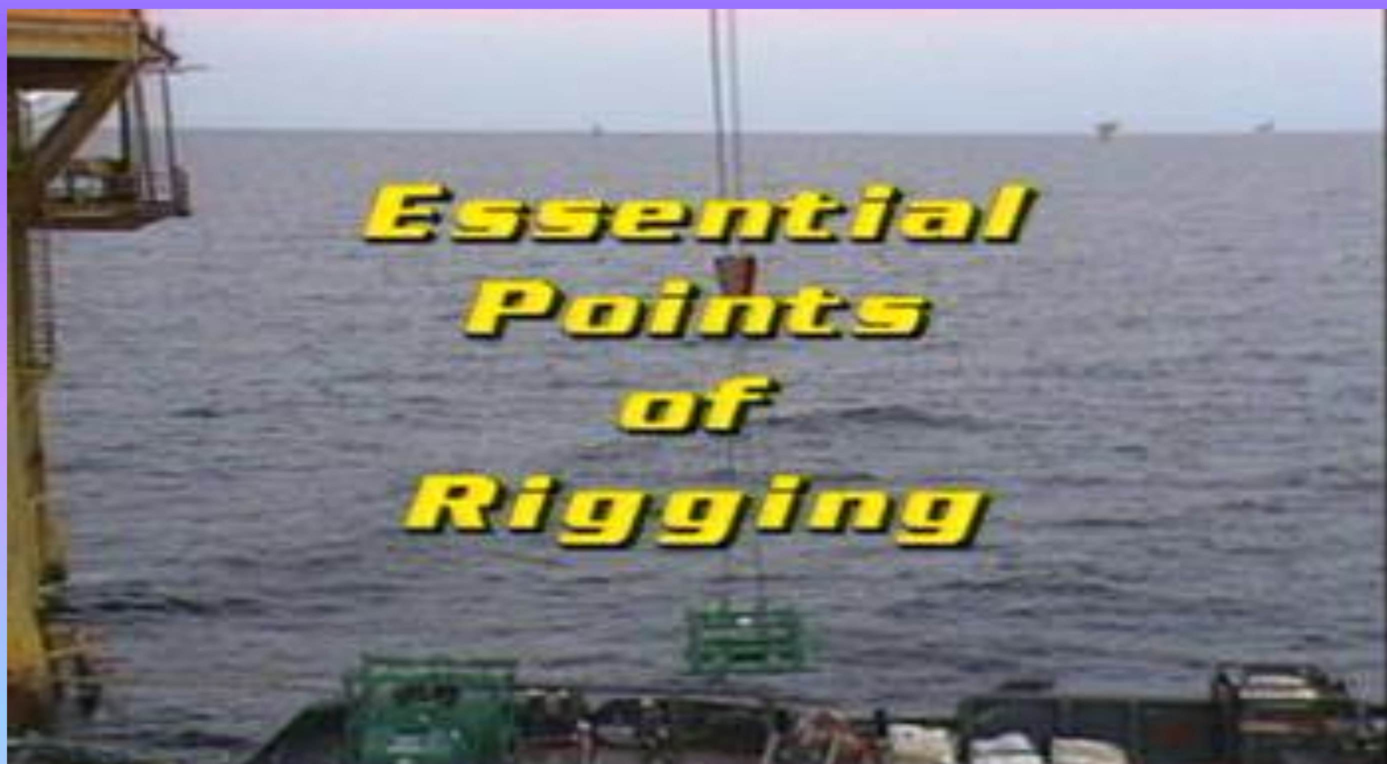
Is the equipment the appropriate type with proper identification?

THE RIGGING PLAN

Is the Load Odd Shaped ?

THE RIGGING PLAN

Do **<u>YOU</u>** have a Plan?



THE RIGGING PLAN

<u>Is there any possibility of the gear or load fouling on an obstruction?</u>

THE RIGGING PLAN

<u>Are personnel clear of the load to be suspended?</u>

THE RIGGING PLAN

- Who is responsible for the rigging and have communications been properly established?

THE RIGGING PLAN

- **<u>What is the sling angle?</u>**
- **<u>Is the load rigged to the center of gravity?</u>**
- **<u>Are the slings padded against sharp edges?</u>**
- **<u>Will there be any side loading?</u>**

The Flip-Right Spreader Sling

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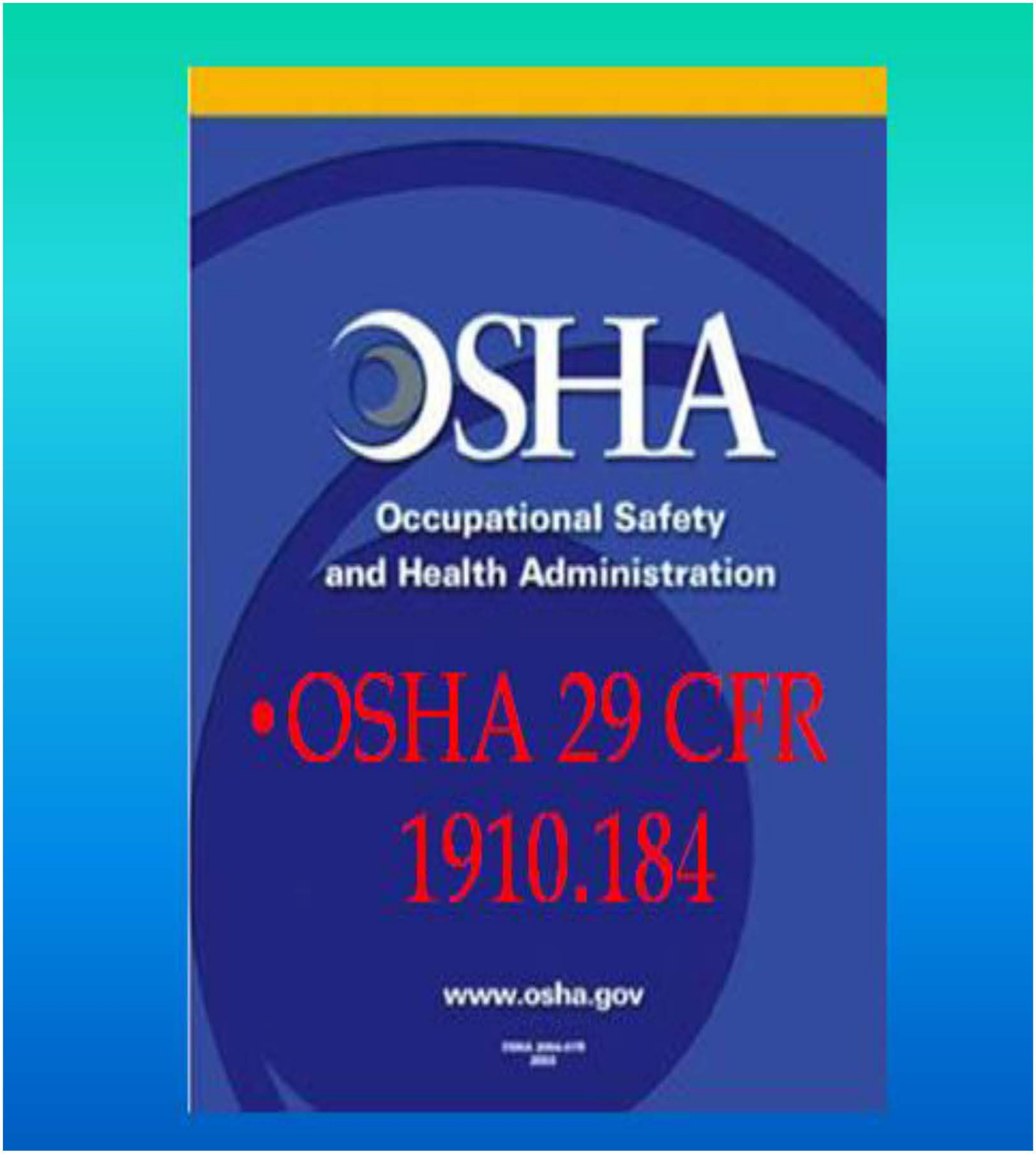
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Regulations (Standards - 29 CFR)

Slings. - 1910.184

Regulations (Standards - 29 CFR) - Table of Contents

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** N
- **Subpart Title:** Materials Handling and Storage
- **Standard Number:** 1910.184
- **Title:** Slings.

1910.184(a)

Scope. This section applies to slings used in conjunction with other material handling equipment for the movement of material by hoisting, in employments covered by this part. The types of slings covered are those made from alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope (conventional three strand construction), and synthetic web (nylon, polyester, and polypropylene).

1910.184(b)

Definitions.

Angle of loading is the inclination of a leg or branch of a sling measured from the horizontal or vertical plane as shown in Fig. N-184-5; provided that an angle of loading of five degrees or less from the vertical may be considered a vertical angle of loading.

Basket hitch is a sling configuration whereby the sling is passed under the load and has both ends, end attachments, eyes or handles on the hook or a single master link.

Braided wire rope is a wire rope formed by plaiting component wire ropes.

Bridle wire rope sling is a sling composed of multiple wire rope legs with the top ends gathered in a fitting that goes over the lifting hook.

Cable laid endless sling-mechanical joint is a wire rope sling made endless by joining the ends of a single length of cable laid rope with one or more metallic fittings.

Cable laid grommet-hand tucked is an endless wire rope sling made from one length of rope wrapped six times around a core formed by hand tucking the ends of the rope inside the six wraps.

Cable laid rope is a wire rope composed of six wire ropes wrapped around a fiber or wire rope core.

Cable laid rope sling-mechanical joint is a wire rope sling made from a cable laid rope with eyes fabricated by pressing or swaging one or more metal sleeves over the rope junction.

Choker hitch is a sling configuration with one end of the sling passing under the load and through an end attachment, handle or eye on the other end of the sling.

Coating is an elastomer or other suitable material applied to a sling or to a sling component to impart desirable properties.

Cross rod is a wire used to join spirals of metal mesh to form a complete fabric. (See Fig. N-184-2.)

Designated means selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

Equivalent entity is a person or organization (including an employer) which, by possession of equipment, technical knowledge and skills, can perform with equal competence the same repairs and tests as the person or organization with which it is equated.

Fabric (metal mesh) is the flexible portion of a metal mesh sling consisting of a series of transverse coils and cross rods.

Female handle (choker) is a handle with a handle eye and a slot of such dimension as to permit passage of a male handle thereby allowing the use of a metal mesh sling in a choker hitch. (See Fig. N-184-1.)

Handle is a terminal fitting to which metal mesh fabric is attached. (See Fig. N-184-1.)

Handle eye is an opening in a handle of a metal mesh sling shaped to accept a hook, shackle or other lifting device. (See Fig. N-184-1.)

Hitch is a sling configuration whereby the sling is fastened to an object or load, either directly to it or around it.

Link is a single ring of a chain.

Male handle (triangle) is a handle with a handle eye.

Master coupling link is an alloy steel welded coupling link used as an intermediate link to join alloy steel chain to master links. (See Fig. N-184-3.)

Master link or ***gathering ring*** is a forged or welded steel link used to support all members (legs) of an alloy steel chain sling or wire rope sling. (See Fig. N-184-3.)

Mechanical coupling link is a nonwelded, mechanically closed steel link used to attach master links, hooks, etc., to alloy steel chain.

FIGURE N-184-1 METAL MESH SLING (TYPICAL) (For Figure N-184-1, Click Here)

FIGURE N-184-2 METAL MESH CONSTRUCTION (For Figure N-184-2, Click Here)

FIGURE N-184-3 MAJOR COMPONENTS OF A QUADRUPLE SLING (For Figure N-184-3, Click Here)

Proof load is the load applied in performance of a proof test.

Proof test is a nondestructive tension test performed by the sling manufacturer or an equivalent entity to verify construction and workmanship of a sling.

Rated capacity or ***working load limit*** is the maximum working load permitted by the provisions of this section.

Reach is the effective length of an alloy steel chain sling measured from the top bearing surface of the upper terminal component to the bottom bearing surface of the lower terminal component.

Selvage edge is the finished edge of synthetic webbing designed to prevent unraveling.

Sling is an assembly which connects the load to the material handling equipment.

Sling manufacturer is a person or organization that assembles sling components into their final form for sale to users.

Spiral is a single transverse coil that is the basic element from which metal mesh is fabricated. (See Fig. N-184-2.)

Strand laid endless sling-mechanical joint is a wire rope sling made endless from one length of rope with the ends joined by one or more metallic fittings.

Strand laid grommet-hand tucked is an endless wire rope sling made from one length of strand wrapped six times around a core formed by hand tucking the ends of the strand inside the six wraps.

Strand laid rope is a wire rope made with strands (usually six or eight) wrapped around a fiber core, wire strand core, or independent wire rope core (IWRC).

Vertical hitch is a method of supporting a load by a single, vertical part or leg of the sling. (See Fig. N-184-4.)

1910.184(c)

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

1910.184(c)(1)

Slings that are damaged or defective shall not be used.

1910.184(c)(2)

Slings shall not be shortened with knots or bolts or other makeshift devices.

1910.184(c)(3)

Sling legs shall not be kinked.

1910.184(c)(4)

Slings shall not be loaded in excess of their rated capacities.

..1910.184(c)(5)

1910.184(c)(5)

Slings used in a basket hitch shall have the loads balanced to prevent slippage.

1910.184(c)(6)

Slings shall be securely attached to their loads.

1910.184(c)(7)

Slings shall be padded or protected from the sharp edges of their loads.

1910.184(c)(8)

Suspended loads shall be kept clear of all obstructions.

1910.184(c)(9)

All employees shall be kept clear of loads about to be lifted and of suspended loads.

1910.184(c)(10)

Hands or fingers shall not be placed between the sling and its load while the sling is being tightened around the load.

1910.184(c)(11)

Shock loading is prohibited.

1910.184(c)(12)

A sling shall not be pulled from under a load when the load is resting on the sling.

..1910.184(d)

1910.184(d)

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

1910.184(e)

Alloy steel chain slings.

1910.184(e)(1)

Sling identification. Alloy steel chain slings shall have permanently affixed durable identification stating size, grade, rated capacity, and reach.

1910.184(e)(2)

Attachments.

1910.184(e)(2)(i)

Hooks, rings, oblong links, pear shaped links, welded or mechanical coupling links or other attachments shall have a rated capacity at least equal to that of the alloy steel chain with which they are used or the sling shall not be used in excess of the rated capacity of the weakest component.

1910.184(e)(2)(ii)

Makeshift links or fasteners formed from bolts or rods, or other such attachments, shall not be used.

1910.184(e)(3)

Inspections.

1910.184(e)(3)(i)

In addition to the inspection required by paragraph (d) of this section, a thorough periodic inspection of alloy steel chain slings in use shall be made on a regular basis, to be determined on the basis of (A) frequency of sling use; (B) severity of service conditions; (C) nature of lifts being made; and (D) experience gained on the service life of slings used in similar circumstances. Such inspections shall in no event be at intervals greater than once every 12 months.

..1910.184(e)(3)(ii)

1910.184(e)(3)(ii)

The employer shall make and maintain a record of the most recent month in which each alloy steel chain sling was thoroughly inspected, and shall make such record available for examination.

1910.184(e)(3)(iii)

The thorough inspection of alloy steel chain slings shall be performed by a competent person designated by the employer, and shall include a thorough inspection for wear, defective welds, deformation and increase in length. Where such defects or deterioration are present, the sling shall be immediately removed from service.

1910.184(e)(4)

Proof testing. The employer shall ensure that before use, each new, repaired, or reconditioned alloy steel chain sling, including all welded components in the sling assembly, shall be proof tested by the sling manufacturer or equivalent entity, in accordance with paragraph 5.2 of the American Society of Testing and Materials Specification A391-65, which is incorporated by reference as specified in Sec. 1910.6 (ANSI G61.1-1968). The employer shall retain a certificate of the proof test and shall make it available for examination.

1910.184(e)(5)

Sling use. Alloy steel chain slings shall not be used with loads in excess of the rated capacities prescribed in Table N-184-1. Slings not included in this table shall be used only in accordance with the manufacturer's recommendations.

..1910.184(e)(6)

1910.184(e)(6)

Safe operating temperatures. Alloy steel chain slings shall be permanently removed from service if they are heated above 1000 deg. F. When exposed to service temperatures in excess of 600 deg. F, maximum working load limits permitted in Table N-184-1 shall be reduced in accordance with the chain or sling manufacturer's recommendations.

1910.184(e)(7)

Repairing and reconditioning alloy steel chain slings.

1910.184(e)(7)(i)

Worn or damaged alloy steel chain slings or attachments shall not be used until repaired. When welding or heat testing is performed, slings shall not be used unless repaired, reconditioned and proof tested by the sling manufacturer or an equivalent entity.

1910.184(e)(7)(ii)

Mechanical coupling links or low carbon steel repair links shall not be used to repair broken lengths of chain.

1910.184(e)(8)

Effects of wear. If the chain size at any point of any link is less than that stated in Table N-184-2, the sling shall be removed from service.

1910.184(e)(9)

Deformed attachments.

1910.184(e)(9)(i)

Alloy steel chain slings with cracked or deformed master links, coupling links or other components shall be removed from service.

TABLE N-184-1 -- RATED CAPACITY (WORKING LOAD LIMIT), FOR ALLOY STEEL CHAIN SLINGS
Rated Capacity (Working Load Limit), Pounds

[Horizontal angles shown in parentheses]

Chain size, inches	Single branch sling -- 90º loading	Double sling vertical angle (1)			Triple and quadruple sling (3) vertical angle (1)		
		30º (60º)	45º (45º)	60º (30º)	30º (60º)	45º (45º)	60º (30º)
1/4	3,250	5,650	4,550	3,250	8,400	6,800	4,900
3/8	6,600	11,400	9,300	6,600	17,000	14,000	9,900
1/2	11,250	19,500	15,900	11,250	29,000	24,000	17,000
5/8	16,500	28,500	23,300	16,500	43,000	35,000	24,500
3/4	23,000	39,800	32,500	23,000	59,500	48,500	34,500
7/8	28,750	49,800	40,600	28,750	74,500	61,000	43,000
1	38,750	67,100	5,800	38,750	101,000	82,000	58,000
1 1/8	44,500	77,000	63,000	44,500	115,500	94,500	66,500
1 1/4	57,500	99,500	61,000	57,500	149,000	121,500	86,000
1 3/8	67,000	116,000	94,000	67,000	174,000	141,000	100,500
1 1/2	80,000	138,000	112,900	80,000	207,000	169,000	119,500
1 3/4	100,000	172,000	140,000	100,000	258,000	210,000	150,000

(1) Rating of multileg slings adjusted for angle of loading measured as the included angle between the inclined leg and the vertical as shown in Figure N-184-5.
(2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load, as shown in Figure N-184-5.
(3) Quadruple sling rating is same as triple sling because normal lifting practice may not distribute load uniformly to all 4 legs.

TABLE N-184-2. - MINIMUM ALLOWABLE CHAIN SIZE AT ANY POINT OF LINK

Chain size, inches	Minimum allowable chain size, inches
1/4	13/64
3/8	19/64
1/2	25/64
5/8	31/64
3/4	19/32
7/8	45/64
1	13/16
1 1/8	29/32
1 1/4	1
1 3/8	1 3/32
1 1/2	1 3/16
1 3/4	1 13/32

1910.184(e)(9)(ii)

Slings shall be removed from service if hooks are cracked, have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

..1910.184(f)

1910.184(f)

Wire rope slings.

1910.184(f)(1)

Sling use. Wire rope slings shall not be used with loads in excess of the rated capacities shown in Tables N-184-3 through N-184-14. Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

1910.184(f)(2)

Minimum sling lengths.

1910.184(f)(2)(i)

Cable laid and 6x19 and 6x37 slings shall have a minimum clear length of wire rope 10 times the component rope diameter between splices, sleeves or end fittings.

1910.184(f)(2)(ii)

Braided slings shall have a minimum clear length of wire rope 40 times the component rope diameter between the loops or end fittings.

1910.184(f)(2)(iii)

Cable laid grommets, strand laid grommets and endless slings shall have a minimum circumferential length of 96 times their body diameter.

1910.184(f)(3)

Safe operating temperatures. Fiber core wire rope slings of all grades shall be permanently removed from service if they are exposed to temperatures in excess of 200 deg. F. When nonfiber core wire rope slings of any grade are used at temperatures above 400 deg. F or below minus 60 deg. F, recommendations of the sling manufacturer regarding use at that temperature shall be followed.

1910.184(f)(4)

End attachments.

1910.184(f)(4)(i)

Welding of end attachments, except covers to thimbles, shall be performed prior to the assembly of the sling.

..1910.184(f)(4)(ii)

1910.184(f)(4)(ii)

All welded end attachments shall not be used unless proof tested by the manufacturer or equivalent entity at twice their rated capacity prior to initial use. The employer shall retain a certificate of the proof test, and make it available for examination.

TABLE N-184-3. - RATED CAPACITIES FOR SINGLE LEG SLINGS

6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC)

Rope		Rated capacities, tons (2,000 lb)					
		Vertical			Choker		
Dia (inches)	Constr	HT	MS	S	HT	MS	S

1/4	6x19	0.49	0.51	0.55	0.37	0.38	0.41
5/16	6x19	0.76	0.79	0.85	0.57	0.59	0.64
3/8	6x19	1.1	1.1	1.2	0.80	0.85	0.91
7/16	6x19	1.4	1.5	1.6	1.1	1.1	1.2
1/2	6x19	1.8	2.0	2.1	1.4	1.5	12.6
9/16	6x19	2.3	2.5	2.7	1.7	1.9	2.0
5/8	6x19	2.8	3.1	3.3	2.1	2.3	2.5
3/4	6x19	3.9	4.4	4.8	2.9	3.3	3.6
7/8	6x19	5.1	5.9	6.4	3.9	4.5	4.8
1	6x19	6.7	7.7	8.4	5.0	5.8	6.3
1 1/8	6x19	8.4	9.5	10.0	6.3	7.1	7.9
1 1/4	6x37	9.8	11.0	12.0	7.4	8.3	9.2
1 3/8	6x37	12.0	13.0	15.0	8.9	10.0	11.0
1 1/2	6x37	14.0	16.0	15.0	10.0	12.0	13.0
1 5/8	6x37	16.0	18.0	21.0	12.0	14.0	15.0
1 3/4	6x37	19.0	21.0	24.0	14.0	16.0	18.0
2	6x37	25.0	28.0	31.0	18.0	21.0	23.0

TABLE N-184-3. - RATED CAPACITIES FOR SINGLE LEG SLINGS

(CONTINUED)

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Fiber Core (FC)

Rope		Rated capacities, tons (2,000 lb)		
		Vertical Basket(1)		
Dia (inches)	Constr	HT	MS	S
1/4	6x19	0.99	1.0	1.1
5/16	6x19	1.5	1.6	1.7
3/8	6x19	2.1	2.2	2.4
7/16	6x19	2.9	3.0	3.3
1/2	6x19	3.7	3.9	4.3
9/16	6x19	4.6	5.0	5.4
5/8	6x19	5.6	6.2	6.7
3/4	6x19	7.8	8.8	9.5
7/8	6x19	10.0	12.0	13.0
1	6x19	13.0	15.0	17.0
1 1/8	6x19	17.0	19.0	21.0
1 1/4	6x37	20.0	22.0	25.0
1 3/8	6x37	24.0	27.0	30.0
1 1/2	6x37	28.0	32.0	35.0
1 5/8	6x37	33.0	27.0	41.0
1 3/4	6x37	38.0	43.0	48.0
2	6x37	49.0	55.0	62.0

HT = Hand Tucked Splice and Hidden Tuck Splice.
For hidden tuck splice (IWRC) use values in HT columns.
MS = Mechanical Splice.
S = Swaged or Zinc Poured Socket.

Footnote(1) These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S slings is 20 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of rope.

TABLE N-184-4. - RATED CAPACITIES FOR SINGLE LEG SLINGS

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Independent Wire Rope Core (IWRC)

Rope		Rated capacities, tons (2,000 lb)					
		Vertical			Choker		
Dia (inches)	Constr	HT	MS	S	HT	MS	S
1/4	6x19	0.53	0.56	0.59	0.40	0.42	0.44
5/16	6x19	0.81	0.87	0.92	0.61	0.65	0.69
3/8	6x19	1.1	1.2	1.3	0.86	0.93	0.98
7/16	6x19	1.5	1.7	1.8	1.2	1.3	1.3
1/2	6x19	2.0	2.2	2.3	1.5	1.6	1.7
9/16	6x19	2.5	2.7	2.9	1.8	2.1	2.2
5/8	6x19	3.0	3.4	3.6	2.2	2.5	2.7
3/4	6x19	4.2	4.9	5.1	3.1	3.6	3.8
7/8	6x19	5.5	6.6	6.9	4.1	4.9	5.2
1	6x19	7.2	8.5	9.0	5.4	6.4	6.7
1 1/8	6x19	9.0	10.0	11.0	6.8	7.8	8.5
1 1/4	6x37	10.0	12.0	13.0	7.9	9.2	9.9
1 3/8	6x37	13.0	15.0	16.0	9.6	11.0	12.0
1 1/2	6x37	15.0	17.0	19.0	11.0	13.0	14.0
1 5/8	6x37	18.0	20.0	22.0	13.0	15.0	17.0
1 3/4	6x37	20.0	24.0	26.0	15.0	18.0	19.0
2	6x37	26.0	30.0	33.0	20.0	23.0	25.0

TABLE N-184-4. - RATED CAPACITIES FOR SINGLE LEG SLINGS

(CONTINUED)

6x19 and 6x37 Classification Improved Plow Steel Grade Rope
With Independent Wire Rope Core (IWRC)

Rope		Rated capacities, tons (2,000 lb)		
		Vertical Basket(1)		
Dia (inches)	Constr	HT	MS	S
1/4	6x19	1.0	1.1	1.2
5/16	6x19	1.6	1.7	1.8
3/8	6x19	2.3	2.5	2.6
7/16	6x19	3.1	3.4	3.5
1/2	6x19	3.9	4.4	4.6
9/16	6x19	4.9	5.5	5.8
5/8	6x19	6.0	6.8	7.2
3/4	6x19	8.4	9.7	10.0
7/8	6x19	11.0	13.0	14.0
1	6x19	14.0	17.0	18.0
1 1/8	6x19	18.0	21.0	23.0
1 1/4	6x37	21.0	24.0	26.0
1 3/8	6x37	25.0	29.0	32.0
1 1/2	6x37	30.0	35.0	38.0
1 5/8	6x37	35.0	41.0	44.0
1 3/4	6x37	41.0	47.0	51.0
2	6x37	53.0	61.0	66.0

HT = Hand Tucked Splice. For hidden tuck splice

(IWRC) use Table 1 values in HT column.
MS = Mechanical Splice.
S = Swaged or Zinc Poured Socket.

Footnote(1) These values only apply when the D/d ratio for HT slings is 10 or greater, and for MS and S slings is 20 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of rope.

TABLE N-184-5. -- RATED CAPACITIES FOR SINGLE LEG SLINGS

Cable Laid Rope -- Mechanical Splice Only

7x7x7 & 7X19 Constructions Galvanized Aircraft Grade Rope
7x6x19 IWRC Construction Improved Plow Steel Grade Rope

Rope		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
1/4	7x7x7	0.50	0.38	1.0
3/8	7x7x7	1.1	0.81	2.0
1/2	7x7x7	1.8	1.4	3.7
5/8	7x7x7	2.8	2.1	5.5
3/4	7x7x7	3.8	2.9	7.6
5/8	7x7x19	2.9	2.2	5.8
3/4	7x7x19	4.1	3.0	8.1
7/8	7x7x19	5.4	4.0	11.0
1	7x7x19	6.9	5.1	14.0
1 1/8	7x7x19	8.2	6.2	16.0
1 1/4	7x7x19	9.9	7.4	20.0
3/4	7x6x19 IWRC	3.8	2.8	7.6
7/8	7x6x19 IWRC	5.0	3.8	10.0
1	7x6x19 IWRC	6.4	4.8	13.0
1 1/8	7x6x19 IWRC	7.7	5.8	15.0
1 1/4	7x6x19 IWRC	9.2	6.9	18.0
1 5/16	7x6x19 IWRC	10.0	7.5	20.0
1 3/8	7x6x19 IWRC	11.0	8.2	22.0
1 1/2	7x6x19 IWRC	13.0	9.6	26.0

Footnote(1) These values only apply when the D/d ratio is 10 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of rope.

TABLE N-184-6. -- RATED CAPACITIES FOR SINGLE LEG SLINGS

8-Part and 6-Part Braided Rope

6x7 and 6x19 Construction Improved Plow Steel Grade Rope

7x7 Construction Galvanized Aircraft Grade Rope

Component ropes		Rated capacities, tons (2,000 lb)					
Diameter (inches)	Constr	Vertical		Choker		Basket vertical to 30 deg.(1)	

		8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32.....	6x7	0.42	0.32	0.32	0.24	0.74	0.55
1/8......	6x7	0.75	0.57	0.57	0.42	1.3	0.98
3/16.....	6x7	1.7	1.3	1.3	0.94	2.9	2.2
3/32.....	7x7	0.51	0.39	0.38	0.29	0.89	0.67
1/8......	7x7	0.95	0.7	0.71	0.53	1.6	1.2
3/16.....	7x7	2.1	1.5	1.5	1.2	3.6	2.7
3/16.....	6x19	1.7	1.3	1.3	0.98	3.0	2.2
1/4......	6x19	3.1	2.3	2.3	1.7	5.3	4.0
5/16.....	6x19	4.8	3.6	3.6	2.7	8.3	6.2
3/8......	6x19	6.8	5.1	5.1	3.8	12.0	8.9
7/16.....	6x19	9.3	6.9	6.9	5.2	16.0	12.0
1/2......	6x19	12.0	9.0	9.0	6.7	21.0	15.0
9/16.....	6x19	15.0	11.0	11.0	8.5	26.0	20.0
5/8......	6x19	19.0	14.0	14.0	10.0	32.0	24.0
3/4......	6x19	27.0	20.0	20.0	15.0	46.0	35.0
7/8......	6x19	36.0	27.0	27.0	20.0	62.0	47.0
1........	6x19	47.0	35.0	35.0	26.0	81.0	61.0

Footnote(1) These values only apply when the D/d ratio is 20 or greater where: D=Diameter of curvature around which the body of the sling is bent; d=Diameter of component rope.

TABLE N-184-7.-- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC)
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		2-Leg bridle slings					
Dia [in.]	Constr	30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	0.85	0.83	0.70	0.72	0.49	0.51
5/16	6x19	1.3	1.4	1.1	1.1	0.76	0.79
3/8	6x19	1.8	1.9	1.5	1.6	1.1	1.1
7/16	6x19	2.5	2.6	2.0	2.2	1.4	1.5
1/2	6x19	3.2	3.4	2.6	2.8	1.8	2.0
9/16	6x19	4.0	4.3	3.2	3.5	2.3	2.5
5/8	6x19	4.8	5.3	4.0	4.4	2.8	3.1
3/4	6x19	5.8	7.6	5.5	6.2	3.9	4.4
7/8	6x19	8.9	10.0	7.3	8.4	5.1	5.9
1	6x19	11.0	13.0	9.4	11.0	6.7	7.7
1 1/8	6x19	14.0	16.0	12.0	13.0	8.4	9.3
1 1/4	6x37	17.0	19.0	14.0	16.0	9.8	11.0
1 3/8	6x37	20.0	23.0	17.0	19.0	12.0	13.0
1 1/2	6x37	24.0	27.0	20.0	22.0	14.0	16.0
1 5/8	6x37	28.0	32.0	23.0	26.0	16.0	18.0
1 3/4	6x37	33.0	37.0	27.0	30.0	19.0	21.0
2	6x37	43.0	48.0	35.0	39.0	25.0	28.0

TABLE N-184-7.-- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

[Continued]

6x19 and 6x37 Classification Improved Plow Steel
Grade Rope With Fiber Core (FC)
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		3-Leg bridle slings					
Dia [in.]	Constr	30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	1.3	1.3	1.0	1.1	0.74	0.76
5/16	6x19	2.0	2.0	1.6	1.7	1.1	1.2
3/8	6x19	2.8	2.9	2.3	2.4	1.6	1.7
7/16	6x19	3.7	4.0	3.0	3.2	2.1	2.3
1/2	6x19	4.8	5.1	3.9	4.2	2.8	3.0
9/16	6x19	6.0	6.5	4.9	5.3	3.4	3.7
5/8	6x19	7.3	8.0	5.9	6.5	4.2	4.6
3/4	6x19	10.0	11.0	8.3	9.3	5.8	6.6
7/8	6x19	13.0	15.0	11.0	13.0	7.7	8.9
1	6x19	17.0	20.0	14.0	16.0	10.0	11.0
1 1/8	6x19	22.0	24.0	18.0	20.0	13.0	14.0
1 1/4	6x37	25.0	29.0	21.0	23.0	15.0	17.0
1 3/8	6x37	31.0	35.0	25.0	28.0	18.0	20.0
1 1/2	6x37	36.0	41.0	30.0	33.0	21.0	24.0
1 5/8	6x37	43.0	48.0	35.0	39.0	25.0	28.0
1 3/4	6x37	49.0	56.0	40.0	45.0	28.0	32.0
2	6x37	64.0	72.0	52.0	59.0	37.0	41.0

HT = Hand Tucked Splice.
MS = Mechanical Splice.

TABLE N-184-8.-- RATED CAPACITIES FOR 2-LEG
AND 3-LEG BRIDLE SLINGS

6x19 and 6x37 Classification Improved Plow Steel
Grade Rope With Independent Wire Rope Core (IWRC)
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		2-Leg bridle slings					
Dia [in.]	Constr	30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	0.92	0.97	0.75	0.79	0.53	0.56
5/16	6x19	1.4	1.5	1.1	1.2	0.81	0.87
3/8	6x19	2.0	2.1	1.6	1.8	1.1	1.2
7/16	6x19	2.7	2.9	2.2	2.4	1.5	1.7
1/2	6x19	3.4	3.8	2.8	3.1	2.0	2.2

9/16	6x19	4.3	4.8	3.5	3.9	2.5	2.7
5/8	6x19	5.2	5.9	4.2	4.8	3.0	3.4
3/4	6x19	7.3	8.4	5.9	6.9	4.2	4.9
7/8	6x19	9.6	11.0	7.8	9.3	5.5	6.6
1	6x19	12.0	15.0	10.0	12.0	7.2	8.5
1 1/8	6x19	16.0	18.0	13.0	15.0	9.0	10.0
1 1/4	6x37	18.0	21.0	15.0	17.0	10.0	12.0
1 3/8	6x37	22.0	25.0	18.0	21.0	13.0	15.0
1 1/2	6x37	26.0	30.0	21.0	25.0	15.0	17.0
1 5/8	6x37	31.0	35.0	25.0	29.0	18.0	20.0
1 3/4	6x37	35.0	41.0	29.0	33.0	20.0	24.0
2	6x37	46.0	53.0	37.0	43.0	26.0	30.0

TABLE N-184-8.-- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

[Continued]

6x19 and 6x37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC)
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		3-Leg bridle slings					
Dia [in.]	Constr	30 deg. (60 deg.)		45 deg. angle		60 deg. (30 deg.)	
		HT	MS	HT	MS	HT	MS
1/4	6x19	1.4	1.4	1.1	1.2	0.79	0.84
5/16	6x19	2.1	2.3	1.7	1.8	1.2	1.3
3/8	6x19	3.0	3.2	2.4	2.6	1.7	1.9
7/16	6x19	4.0	4.4	3.3	3.6	2.3	2.5
1/2	6x19	5.1	5.7	4.2	4.6	3.0	3.3
9/16	6x19	6.4	7.1	5.2	5.8	3.7	4.1
5/8	6x19	7.8	8.8	6.4	7.2	4.5	5.1
3/4	6x19	11.0	13.0	8.9	10.0	6.3	7.3
7/8	6x19	14.0	17.0	12.0	14.0	8.3	9.9
1	6x19	19.0	22.0	15.0	18.0	11.0	13.0
1 1/8	6x19	23.0	27.0	19.0	22.0	13.0	16.0
1 1/4	6x37	27.0	32.0	22.0	26.0	16.0	18.0
1 3/8	6x37	33.0	38.0	27.0	31.0	19.0	22.0
1 1/2	6x37	39.0	45.0	32.0	37.0	23.0	26.0
1 5/8	6x37	46.0	53.0	38.0	43.0	27.0	31.0
1 3/4	6x37	53.0	61.0	43.0	50.0	31.0	35.0
2	6x37	68.0	79.0	56.0	65.0	40.0	46.0

HT = Hand Tucked Splice.
MS = Mechanical Splice.

TABLE N-184-9. -- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

Cable Laid Rope - Mechanical Splice Only
7x7x7 and 7x7x19 Construction Galvanized Aircraft Grade Rope
7x6x19 IWRC Construction Improved Plow Steel Grade Rope
[Horizontal angles shown in parenthesis]

Rope Dia [in.]	Rope Constr	2-Leg bridle slings 30 deg. (60 deg.)	45 deg. angle	60 deg. (30 deg.)
1/4......	7x7x7.......	0.87	0.71	0.50
3/8......	7x7x7.......	1.9	1.5	1.1
1/2......	7x7x7.......	3.2	2.6	1.8
5/8......	7x7x7.......	4.8	3.9	2.8
3/4......	7x7x7.......	6.6	5.4	3.8
5/8......	7x7x19......	5.0	4.1	2.9
3/4......	7x7x19......	7.0	5.7	4.1
7/8......	7x7x19......	9.3	7.6	5.4
1........	7x7x19......	12.0	9.7	6.9
1 1/8....	7x7x19......	14.0	12.0	8.2
1 1/4....	7x7x19......	17.0	14.0	9.9
3/4......	7x6x19 IWRC.	6.6	5.4	3.8
7/8......	7x6x19 IWRC.	8.7	7.1	5.0
1........	7x6x19 IWRC.	11.0	9.0	6.4
1 1/8....	7x6x19 IWRC.	13.0	11.0	7.7
1 1/4....	7x6x19 IWRC.	16.0	13.0	9.2
1 5/16...	7x6x19 IWRC.	17.0	14.0	10.0
1 3/8....	7x6x19 IWRC.	19.0	15.0	11.0
1 1/2....	7x6x19 IWRC.	22.0	18.0	13.0

(Rated capacities, tons (2,000 lb))

TABLE N-184-9. -- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

[Continued]

Cable Laid Rope - Mechanical Splice Only
7x7x7 and 7x7x19 Construction Galvanized Aircraft Grade Rope
7x6x19 IWRC Construction Improved Plow Steel Grade Rope
[Horizontal angles shown in parenthesis]

Rope Dia [in.]	Rope Constr	Rated capacities, tons (2,000 lb) — 3-Leg bridle slings 30 deg. (60 deg.)	45 deg. angle	60 deg. (30 deg.)
1/4......	7x7x7	1.3	1.1	0.75
3/8......	7x7x7.......	2.8	2.3	1.6
1/2......	7x7x7.......	4.8	3.9	2.8
5/8......	7x7x7.......	7.2	5.9	4.2
3/4......	7x7x7.......	9.9	8.1	3.7
5/8......	7x7x19......	7.5	6.1	4.3
3/4......	7x7x19......	10.0	8.6	6.1
7/8......	7x7x19......	14.0	11.0	8.1
1........	7x7x19......	18.0	14.0	10.0
1 1/8....	7x7x19......	21.0	17.0	12.0
1 1/4....	7x7x19......	26.0	21.0	15.0
3/4......	7x6x19 IWRC.	9.9	8.0	5.7
7/8......	7x6x19 IWRC.	13.0	11.0	7.5
1........	7x6x19 IWRC.	17.0	13.0	9.6
1 1/8....	7x6x19 IWRC.	20.0	16.0	11.0
1 1/4....	7x6x19 IWRC.	24.0	20.0	14.0
1 5/16...	7x6x19 IWRC.	26.0	21.0	15.0

1 3/8....	7x6x19 IWRC.	28.0	23.0	16.0
1 1/2....	7x6x19 IWRC.	33.0	27.0	19.0

TABLE N-184-10. -- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

8-Part and 6-Part Braided Rope
6x7 and 6x19 Construction Improved Plow Steel Grade Rope
7x7 Construction Galvanized Aircraft Grade Rope
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		2-Leg bridle sling					
Dia (in.)	Constr	30 deg (60 deg)		45 deg angle		60 deg (30 deg)	
		8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6x7	0.74	0.55	0.60	0.45	0.42	0.32
1/8	6x7	1.3	0.98	1.1	0.80	0.76	0.57
3/16	6x7	2.9	2.2	2.4	1.8	1.7	1.3
3/32	7x7	0.89	0.67	0.72	0.55	0.51	0.39
1/8	7x7	1.6	1.2	1.3	1.0	0.95	0.71
3/16	7x7	3.6	2.7	2.9	2.2	2.1	1.5
3/16	6x19	3.0	2.2	2.4	1.8	1.7	1.3
1/4	6x19	5.3	4.0	4.3	3.2	3.1	2.3
5/16	6x19	8.3	6.2	6.7	5.0	4.8	3.6
3/8	6x19	12.0	8.9	9.7	7.2	6.8	5.1
7/16	6x19	16.0	12.0	13.0	9.8	9.3	6.9
1/2	6x19	21.0	15.0	17.0	13.0	12.0	9.0
9/16	6x19	26.0	20.0	21.0	16.0	15.0	11.0
5/8	6x19	32.0	24.0	26.0	20.0	10.0	14.0
3/4	6x19	46.0	35.0	38.0	28.0	27.0	20.0
7/8	6x19	62.0	47.0	51.0	38.0	36.0	27.0
1	6x19	81.0	61.0	66.0	50.0	47.0	35.0

TABLE N-184-10. -- RATED CAPACITIES FOR 2-LEG AND 3-LEG BRIDLE SLINGS

[Continued]

8-Part and 6-Part Braided Rope
6x7 and 6x19 Construction Improved Plow Steel Grade Rope
7x7 Construction Galvanized Aircraft Grade Rope
[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)		
		3-Leg bridle sling		
Dia (in.)	Constr	30 deg (60 deg)	45 deg angle	60 deg (30 deg)

		8-Part	6-Part	8-Part	6-Part	8-Part	6-Part
3/32	6x7	1.1	0.83	0.90	0.68	0.64	0.48
1/8	6x7	2.0	1.5	1.6	1.2	1.1	0.85
3/16	6x7	4.4	3.3	3.6	2.7	2.5	1.9
3/32	7x7	1.3	1.0	1.1	0.82	0.77	0.58
1/8	7x7	2.5	1.8	2.0	1.5	1.4	1.1
3/16	7x7	5.4	4.0	4.4	3.3	3.1	2.3
3/16	6x19	4.5	3.4	3.7	2.8	2.6	1.9
1/4	6x19	8.0	6.0	6.5	4.9	4.6	3.4
5/16	6x19	12.0	9.3	10.0	7.6	7.1	5.4
3/8	6x19	18.0	13.0	14.0	11.0	10.0	7.7
7/16	6x19	24.0	18.0	20.0	15.0	14.0	10.0
1/2	6x19	31.0	23.0	25.0	19.0	18.0	13.0
9/16	6x19	39.0	29.0	32.0	24.0	23.0	17.0
5/8	6x19	48.0	36.0	40.0	30.0	28.0	21.0
3/4	6x19	69.0	52.0	56.0	42.0	40.0	30.0
7/8	6x19	94.0	70.0	76.0	57.0	54.0	40.0
1	6x19	122.0	91.0	99.0	74.0	70.0	53.0

TABLE N-184-11. -- RATED CAPACITIES FOR STRAND LAID GROMMET
-- HAND TUCKED

Improved Plow Steel Grade Rope

Rope body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
1/4	7x19	0.85	0.64	1.7
5/16	7x19	1.3	1.0	2.6
3/8	7x19	1.9	1.4	3.8
7/16	7x19	2.6	1.9	5.2
1/2	7x19	3.3	2.5	6.7
9/16	7x19	4.2	3.1	8.4
5/8	7x19	5.2	3.9	10.0
3/4	7x19	7.4	5.6	15.0
7/8	7x19	10.0	7.5	20.0
1	7x19	13.0	9.7	26.0
1 1/8	7x19	16.0	12.0	32.0
1 1/4	7x37	18.0	14.0	37.0
1 3/8	7x37	22.0	16.0	44.0
1 1/2	7x37	26.0	19.0	52.0

Footnote(1) These values only apply when the D/d ratio is 5 or greater where: D=Diameter of curvature around which rope is bent. d=Diameter of rope body.

TABLE N-184-12. -- RATED CAPACITIES FOR CABLE LAID GROMMET
-- HAND TUCKED

7x6x7 and 7x6x19 Constructions Improved Plow Steel Grade Rope
7x7x7 Construction Galvanized Aircraft Grade Rope

Cable body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)

3/8	7x6x7	1.3	0.95	2.5
9/16	7x6x7	2.8	2.1	5.6
5/8	7x6x7	3.8	2.8	7.6
3/8	7x7x7	1.6	1.2	3.2
9/16	7x7x7	3.5	2.6	6.9
5/8	7x7x7	4.5	3.4	9.0
5/8	7x6x19	3.9	3.0	7.9
3/4	7x6x19	5.1	3.8	10.0
15/16	7x6x19	7.9	5.9	16.0
1 1/8	7x6x19	11.0	8.4	22.0
1 5/16	7x6x19	15.0	11.0	30.0
1 1/2	7x6x19	19.0	14.0	39.0
1 11/16	7x6x19	24.0	18.0	49.0
1 7/8	7x6x19	30.0	22.0	60.0
2 1/4	7x6x19	42.0	31.0	84.0
2 5/8	7x6x19	56.0	42.0	112.0

Footnote(1) These values only apply when the D/d ratio is 5 or greater where: D=Diameter of curvature around which cable body is bent., d=Diameter of cable body.

TABLE N-184-13. -- RATED CAPACITIES FOR STRAND LAID ENDLESS SLINGS -- MECHANICAL JOINT

Improved Plow Steel Grade Rope

Rope body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
1/4	(2)6x19	0.92	0.69	1.8
3/8	(2)6x19	2.0	1.5	4.1
1/2	(2)6x19	3.6	2.7	7.2
5/8	(2)6x19	5.6	4.2	11.0
3/4	(2)6x19	8.0	6.0	16.0
7/8	(2)6x19	11.0	8.1	21.0
1	(2)6x19	14.0	10.0	28.0
1 1/8	(2)6x19	18.0	13.0	35.0
1 1/4	(2)6x37	21.0	15.0	41.0
1 3/8	(2)6x37	25.0	19.0	50.0
1 1/2	(2)6x37	29.0	22.0	59.0

Footnote(1) These values only apply when the D/d ratio is 5 or greater where: D=Diameter of curvature around which rope is bent. d=Diameter of rope body.
Footnote(2) IWRC.

TABLE N-184-14. -- RATED CAPACITIES FOR CABLE LAID ENDLESS SLINGS -- MECHANICAL JOINT

7x7x7 and 7x7x19 Constructions Galvanized Aircraft Grade Rope
7x6x19 Construction Improved Plow Steel Grade Rope

Cable body		Rated capacities, tons (2,000 lb)		
Dia (inches)	Constr	Vertical	Choker	Vertical basket(1)
1/4	7x7x7	0.83	0.62	1.6

3/8	7x7x7	1.8	1.3	3.5
1/2	7x7x7	3.0	2.3	6.1
5/8	7x7x7	4.5	3.4	9.1
3/4	7x7x7	6.3	4.7	12.0
5/8	7x7x19	4.7	3.5	9.5
3/4	7x7x19	6.7	5.0	13.0
7/8	7x7x19	8.9	6.6	18.0
1	7x7x19	11.0	8.5	22.0
1 1/8	7x7x19	14.0	10.0	28.0
1 1/4	7x7x19	17.0	12.0	33.0
3/4	(2)7x6x19	6.2	4.7	12.0
7/8	(2)7x6x19	8.3	6.2	16.0
1	(2)7x6x19	10.0	7.9	21.0
1 1/8	(2)7x6x19	13.0	9.7	26.0
1 1/4	(2)7x6x19	16.0	12.0	31.0
1 3/8	(2)7x6x19	18.0	14.0	37.0
1 1/2	(2)7x6x19	22.0	16.0	43.0

Footnote(1) These values only apply when the D/d value is 5 or greater where: D=Diameter of curvature around which cable body is bent. d=Diameter of cable body.
Footnote(2) IWRC.

1910.184(f)(5)

Removal from service. Wire rope slings shall be immediately removed from service if any of the following conditions are present:

1910.184(f)(5)(i)

Ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay.

1910.184(f)(5)(ii)

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

1910.184(f)(5)(iii)

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

1910.184(f)(5)(iv)

Evidence of heat damage.

1910.184(f)(5)(v)

End attachments that are cracked, deformed or worn.

1910.184(f)(5)(vi)

Hooks that have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

1910.184(f)(5)(vii)

Corrosion of the rope or end attachments.

..1910.184(g)

1910.184(g)

Metal mesh slings --

1910.184(g)(1)

Sling marking. Each metal mesh sling shall have permanently affixed to it a durable marking that states the rated capacity for vertical basket hitch and choker hitch loadings.

1910.184(g)(2)

Handles. Handles shall have a rated capacity at least equal to the metal fabric and exhibit no deformation after proof testing.

1910.184(g)(3)

Attachments of handles to fabric. The fabric and handles shall be joined so that:

1910.184(g)(3)(i)

The rated capacity of the sling is not reduced.

1910.184(g)(3)(ii)

The load is evenly distributed across the width of the fabric.

1910.184(g)(3)(iii)

Sharp edges will not damage the fabric.

1910.184(g)(4)

Sling coatings. Coatings which diminish the rated capacity of a sling shall not be applied.

1910.184(g)(5)

Sling testing. All new and repaired metal mesh slings, including handles, shall not be used unless proof tested by the manufacturer or equivalent entity at a minimum of 1 1/2 times their rated capacity. Elastomer impregnated slings shall be proof tested before coating.

..1910.184(g)(6)

1910.184(g)(6)

Proper use of metal mesh slings. Metal mesh slings shall not be used to lift loads in excess of their rated capacities as prescribed in Table N-184-15. Slings not included in this table shall be used only in accordance with the manufacturer's recommendations.

1910.184(g)(7)

Safe operating temperatures. Metal mesh slings which are not impregnated with elastomers may be used in a temperature range from minus 20 deg. F to plus 550 deg. F without decreasing the working load limit. Metal mesh slings impregnated with polyvinyl chloride or neoprene may be used only in a temperature range from zero degrees to plus 200 deg. F. For operations outside these temperature ranges or for metal mesh slings impregnated with other materials, the sling manufacturer's recommendations shall be followed.

1910.184(g)(8)

Repairs.

1910.184(g)(8)(i)

Metal mesh slings which are repaired shall not be used unless repaired by a metal mesh sling manufacturer or an equivalent entity.

1910.184(g)(8)(ii)

Once repaired, each sling shall be permanently marked or tagged, or a written record maintained, to indicate the date and nature of the repairs and the person or organization that performed the repairs. Records of repairs shall be made available for examination.

1910.184(g)(9)

Removal from service. Metal mesh slings shall be immediately removed from service if any of the following conditions are present:

..1910.184(g)(9)(i)

1910.184(g)(9)(i)

A broken weld or broken brazed joint along the sling edge.

1910.184(g)(9)(ii)

Reduction in wire diameter of 25 per cent due to abrasion or 15 per cent due to corrosion.

1910.184(g)(9)(iii)

Lack of flexibility due to distortion of the fabric.

TABLE N-184-15 - RATED CAPACITIES
Carbon Steel and Stainless Steel Metal Mesh slings
[Horizontal angles shown in parentheses]

Sling width in inches	Vertical or choker	Vertical basket	Effect of angle on rated capacities in basket hitch		
			30 deg. (60 deg.)	45 deg. (45 deg.)	60 deg. (30 deg.)
Heavy Duty - 10 Ga 35 Spirals/Ft of sling width					
2	1,500	3,000	2,600	2,100	1,500
3	2,700	5,400	4,700	3,800	2,700
4	4,000	8,000	6,900	5,600	4,000
6	6,000	12,000	10,400	8,400	6,000
8	8,000	16,000	13,800	11,300	8,000
10	10,000	20,000	17,000	14,100	10,000
12	12,000	24,000	20,700	16,900	12,000
14	14,000	28,000	24,200	19,700	14,000
16	16,000	32,000	27,700	22,600	16,000
18	18,000	36,000	31,100	25,400	18,000
20	20,000	40,000	34,600	28,200	20,000
Medium Duty - 12 Ga 43 Spirals/Ft of sling width					
2	1,350	2,700	2,300	1,900	1,400
3	2,000	4,000	3,500	2,800	2,000
4	2,700	5,400	4,700	3,800	2,700
6	4,500	9,000	7,800	6,400	4,500
8	6,000	12,000	10,400	8,500	6,000
10	7,500	15,000	13,000	10,600	7,500
12	9,000	18,000	15,600	12,700	9,000
14	10,500	21,000	18,200	14,800	10,500
16	12,000	24,000	20,800	17,000	12,000
18	13,500	27,000	23,400	19,100	13,500
20	15,000	30,000	26,000	21,200	15,000

Light Duty - 14 Ga 59 Spirals/Ft of sling width

2	900	1,800	1,600	1,300	900
3	1,400	2,800	2,400	2,000	1,400
4	2,000	4,000	3,500	2,800	2,000
6	3,000	6,000	5,200	4,200	3,000
8	4,000	8,000	6,900	5,700	4,000
10	5,000	10,000	8,600	7,100	5,000
12	6,000	12,000	10,400	8,500	6,000
14	7,000	14,000	12,100	9,900	7,000
16	8,000	16,000	13,900	11,300	8,000
18	9,000	18,000	15,600	12,700	9,000
20	10,000	20,000	17,300	14,100	10,000

1910.184(g)(9)(iv)

Distortion of the female handle so that the depth of the slot is increased more than 10 per cent.

1910.184(g)(9)(v)

Distortion of either handle so that the width of the eye is decreased more than 10 per cent.

1910.184(g)(9)(vi)

A 15 percent reduction of the original cross sectional area of metal at any point around the handle eye.

1910.184(g)(9)(vii)

Distortion of either handle out of its plane.

1910.184(h)

Natural and synthetic fiber rope slings --

1910.184(h)(1)

Sling use.

1910.184(h)(1)(i)

Fiber rope slings made from conventional three strand construction fiber rope shall not be used with loads in excess of the rated capacities prescribed in Tables N-184-16 through N-184-19.

..1910.184(h)(1)(ii)

1910.184(h)(1)(ii)

Fiber rope slings shall have a diameter of curvature meeting at least the minimums specified in Figs. N-184-4 and N-184-5.

1910.184(h)(1)(iii)

Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

FIGURE N-184-4 Basic Sling Configurations with Vertical Legs
(For Figure N-184-4, Click Here)

FIGURE N-184-5 Basic Sling Configurations with Angled Legs

(For Figure N-184-5, Click Here)

TABLE N-184-16. -- MANILA ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	7.5	480	240	960	830	680	480
9/16	10.4	620	310	1,240	1,070	875	620
5/8	13.3	790	395	1,580	1,370	1,120	790
3/4	16.7	970	485	1,940	1,680	1,370	970
13/16	19.5	1,170	585	2,340	2,030	1,650	1,170
7/8	22.5	1,390	695	2,780	2,410	1,970	1,390
1	27.0	1,620	810	3,240	2,810	2,290	1,620
1 1/16	31.3	1,890	945	3,780	3,270	2,670	1,890
1 1/8	36.0	2,160	1,080	4,320	3,740	3,050	2,160
1 1/4	41.7	2,430	1,220	4,860	4,210	3,440	2,430
1 5/16	47.9	2,700	1,350	5,400	4,680	3,820	2,700
1 1/2	59.9	3,330	1,670	6,660	5,770	4,710	3,330
1 5/8	74.6	4,050	2,030	8,100	7,010	5,730	4,050
1 3/4	89.3	4,770	2,390	9,540	8,260	6,740	4,770
2	107.5	5,580	2,790	11,200	9,660	7,890	5,580
2 1/8	125.0	6,480	3,240	13,000	11,200	9,160	6,480
2 1/4	146.0	7,380	3,690	14,800	12,800	10,400	7,380
2 1/2	166.7	8,370	4,190	16,700	14,500	11,800	8,370
2 5/8	190.8	9,360	4,680	18,700	16,200	13,200	9,360

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-16. -- MANILA ROPE SLINGS

[Continued]

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	7.5	865	430	1,730	1,500	1,220	865
9/16	10.4	1,120	560	2,230	1,930	1,580	1,120
5/8	13.3	1,420	710	2,840	2,460	2,010	1,420
3/4	16.7	1,750	875	3,490	3,020	2,470	1,750
13/16	19.5	2,110	1,050	4,210	3,650	2,980	2,110
7/8	22.5	2,500	1,250	5,000	4,330	3,540	2,500
1	27.0	2,920	1,460	5,830	5,050	4,120	2,920
1 1/16	31.3	3,400	1,700	6,800	5,890	4,810	3,400
1 1/8	36.0	3,890	1,940	7,780	6,730	5,500	3,890

1 1/4	41.7	4,370	2,190	8,750	7,580	6,190	4,370
1 5/16	47.9	4,860	2,430	9,720	8,420	6,870	4,860
1 1/2	59.9	5,990	3,000	12,000	10,400	8,480	5,990
1 5/8	74.6	7,290	3,650	14,600	12,600	10,300	7,290
1 3/4	89.3	8,590	4,290	17,200	14,900	12,100	8,590
2	107.5	10,000	5,020	20,100	17,400	14,200	10,000
2 1/8	125.0	11,700	5,830	23,300	20,200	16,500	11,700
2 1/4	146.0	13,300	6,640	26,600	23,000	18,800	13,300
2 1/2	166.7	15,100	7,530	30,100	26,100	21,300	15,100
2 5/8	190.8	16,800	8,420	33,700	29,200	23,800	16,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-17. -- NYLON ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	6.5	635	320	1,270	1,100	900	635
9/16	8.3	790	395	1,580	1,370	1,120	790
5/8	10.5	1,030	515	2,060	1,780	1,460	1,030
3/4	14.5	1,410	705	2,820	2,440	1,990	1,410
13/16	17.0	1,680	840	3,360	2,910	2,380	1,680
7/8	20.0	1,980	990	3,960	3,430	2,800	1,980
1	26.0	2,480	1,240	4,960	4,300	3,510	2,480
1 1/16	29.0	2,850	1,430	5,700	4,940	4,030	2,850
1 1/8	34.0	3,270	1,640	6,540	5,660	4,620	3,270
1 1/4	40.0	3,710	1,860	7,420	6,430	5,250	3,710
1 5/16	45.0	4,260	2,130	8,520	7,380	6,020	4,260
1 1/2	55.0	5,250	2,630	10,500	9,090	7,420	5,250
1 5/8	68.0	6,440	3,220	12,900	11,200	9,110	6,440
1 3/4	83.0	7,720	3,860	15,400	13,400	10,900	7,720
2	95.0	9,110	4,560	18,200	15,800	12,900	9,110
2 1/8	109.0	10,500	5,250	21,000	18,200	14,800	10,500
2 1/4	129.0	12,400	6,200	24,800	21,500	17,500	12,400
2 1/2	149.0	13,900	6,950	27,800	24,100	19,700	13,900
2 5/8	168.0	16,000	8,000	32,000	27,700	22,600	16,000

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-17. -- NYLON ROPE SLINGS

[Continued]

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg	60 deg	45 deg	30 deg

				(0 deg)	(30 deg)	(45 deg)	(60 deg)
1/2	6.5	1,140	570	2,290	1,980	1,620	1,140
9/16	8.3	1,420	710	2,840	2,460	2,010	1.420
5/8	10.5	1,850	925	3,710	3,210	2,620	1,850
3/4	14.5	2,540	1,270	5,080	4,400	3,590	2,540
13/16	17.0	3,020	1,510	6,050	5,240	4,280	3,020
7/8	20.0	3,560	1,780	7,130	6,170	5,040	3,560
1	26.0	4,460	2,230	8,930	7,730	6,310	4,460
1 1/16	29.0	5,130	2,570	10,300	8,890	7,260	5,130
1 1/8	34.0	5,890	2,940	11,800	10,200	8,330	5,890
1 1/4	40.0	6,680	3,340	13,400	11,600	9,450	6,680
1 5/16	45.0	7,670	3,830	15,300	13,300	10,800	7,670
1 1/2	55.0	9,450	4,730	18,900	16,400	13,400	9,450
1 5/8	68.0	11,600	5,800	23,200	20,100	16,400	11,600
1 3/4	83.0	13,900	6,950	27,800	24,100	19,700	13,900
2	95.0	16,400	8,200	32,800	28,400	23,200	16,400
2 1/8	109.0	18,900	9,450	37,800	32,700	26,700	18,900
2 1/4	129.0	22,300	11,200	44,600	38,700	31,600	22,300
2 1/2	149.0	25,000	12,500	50,000	43,300	35,400	25,000
2 5/8	168.0	28,800	14,400	57,600	49,900	40,700	28,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-18. -- POLYESTER ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling					
		Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal			
				90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	8.0	635	320	1,270	1,100	900	635
9/16	10.2	790	395	1,580	1,370	1,120	790
5/8	13.0	990	495	1,980	1,710	1,400	990
3/4	17.5	1,240	620	2,480	2,150	1,750	1,240
13/16	21.0	1,540	770	3,080	2,670	2,180	1,540
7/8	25.0	1,780	890	3,560	3,080	2,520	1,780
1	30.5	2,180	1,090	4,360	3,780	3,080	2,180
1 1/16	34.5	2,530	1,270	5,060	4,380	3,580	2,530
1 1/8	40.0	2,920	1,460	5,840	5,060	4,130	2,920
1 1/4	46.3	3,290	1,650	6,580	5,700	4,650	3,290
1 5/16	52.5	3,710	1,860	7,420	6,430	5,250	3,710
1 1/2	66.8	4,630	2,320	9,260	8,020	6,550	4,630
1 5/8	82.0	5,640	2,820	11,300	9,770	7,980	5,640
1 3/4	98.0	6,710	3,360	13,400	11,600	9,490	6,710
2	118.0	7,920	3,960	15,800	13,700	11,200	7,920
2 1/8	135.0	9,110	4,460	18,200	15,800	12,900	9,110
2 1/4	157.0	10,600	5,300	21,200	18,400	15,000	10,600
2 1/2	181.0	12,100	6,050	24,200	21,000	17,100	12,100
2 5/8	205.0	13,600	6,800	27,200	23,600	19,200	13,600

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-18. -- POLYESTER ROPE SLINGS

[Continued]

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling: Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal: 90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	8.0	1,140	570	2,290	1,980	1,620	1,140
9/16	10.2	1,420	710	2,840	2,460	2,010	1,420
5/8	13.0	1,780	890	3,570	3,090	2,520	1,780
3/4	17.5	2,230	1,120	4,470	3,870	3,160	2,230
13/16	21.0	2,770	1,390	5,540	4,800	3,920	2,770
7/8	25.0	3,200	1,600	6,410	5,550	4,530	3,200
1	30.5	3,920	2,960	7,850	6,800	5,550	3,920
1 1/16	34.5	4,550	2,280	9,110	7,990	6,440	4,550
1 1/8	40.0	5,260	2,630	10,500	9,100	7,440	5,260
1 1/4	46.3	5,920	2,960	11,800	10,300	8,380	5,920
1 5/16	52.5	6,680	3,340	13,400	11,600	9,450	6,680
1 1/2	66.8	8,330	4,170	16,700	14,400	11,800	8,330
1 5/8	82.0	10,200	5,080	20,300	17,600	14,400	10,200
1 3/4	98.0	12,100	6,040	24,200	20,900	17,100	12,100
2	118.0	14,300	7,130	28,500	24,700	20,200	14,300
2 1/8	135.0	16,400	8,200	32,800	28,400	23,200	16,400
2 1/4	157.0	19,100	9,540	38,200	33,100	27,000	19,100
2 1/2	181.0	21,800	10,900	43,600	37,700	30,800	21,800
2 5/8	205.0	24,500	12,200	49,000	42,400	34,600	24,500

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-19. -- POLYPROPYLENE ROPE SLINGS

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Eye and eye sling: Vertical hitch	Choker hitch	Basket hitch; Angel of rope to horizontal: 90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	4.7	645	325	1,290	1,120	910	645
9/16	6.1	780	390	1,560	1,350	1,100	780
5/8	7.5	950	475	1,900	1,650	1,340	950
3/4	10.7	1,300	650	2,600	2,250	1,840	1,300
13/16	12.7	1,520	760	3,040	2,630	2,150	1,520
7/8	15.0	1,760	880	3,520	3,050	2,490	1,760
1	18.0	2,140	1,070	4,280	3,700	3,030	2,140
1 1/16	20.4	2,450	1,230	4,900	4,240	3,460	2,450
1 1/8	23.7	2,800	1,400	5,600	4,850	3,960	2,800
1 1/4	27.0	3,210	1,610	6,420	5,560	4,540	3,210
1 5/16	30.5	3,600	1,800	7,200	6,240	5,090	3,600
1 1/2	38.5	4,540	2,270	9,080	7,860	6,420	4,540
1 5/8	47.5	5,510	2,760	11,000	9,540	7,790	5,510
1 3/4	57.0	6,580	3,290	13,200	11,400	9,300	6,580
2	69.0	7,960	3,980	15,900	13,800	11,300	7,960
2 1/8	80.0	9,330	4,670	18,700	16,200	13,200	9,330

2 1/4	92.0	10,600	5,300	21,200	18,400	15,000	10,600
2 1/2	107.0	12,200	6,100	24,400	21,100	17,300	12,200
2 5/8	120.0	13,800	6,900	27,600	23,900	19,600	13,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

TABLE N-184-19. -- POLYPROPYLENE ROPE SLINGS

[Continued]

[Angle of rope to vertical shown in parentheses]

Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	Endless sling: Vertical hitch	Endless sling: Choker hitch	Basket hitch; Angel of rope to horizontal: 90 deg (0 deg)	60 deg (30 deg)	45 deg (45 deg)	30 deg (60 deg)
1/2	4.7	1,160	580	2,320	2,010	1,640	1,160
9/16	6.1	1,400	700	2,810	2,430	1,990	1,400
5/8	7.5	1,710	855	3,420	2,960	2,420	1,710
3/4	10.7	2,340	1,170	4,680	4,050	3,310	2,340
13/16	12.7	2,740	1,370	5,470	4,740	3,870	2,740
7/8	15.0	3,170	1,580	6,340	5,490	4,480	3,170
1	18.0	3,850	1,930	7,700	6,670	5,450	3,860
1 1/16	20.4	4,410	2,210	8,820	7,640	6,240	4,410
1 1/8	23.7	5,040	2,520	10,100	8,730	7,130	5,040
1 1/4	27.0	5,780	2,890	11,600	10,000	8,170	5,780
1 5/16	30.5	6,480	3,240	13,000	11,200	9,170	6,480
1 1/2	38.5	8,170	4,090	16,300	14,200	11,600	8,170
1 5/8	47.5	9,920	4,960	19,800	17,200	14,000	9,920
1 3/4	57.0	11,800	5,920	23,700	20,500	16,800	11,800
2	69.0	14,300	7,160	28,700	24,800	20,300	14,300
2 1/8	80.0	16,800	8,400	33,600	29,100	23,800	16,800
2 1/4	92.0	19,100	9,540	38,200	33,100	27,000	19,100
2 1/2	107.0	22,000	11,000	43,900	38,000	31,100	22,000
2 5/8	120.0	24,800	12,400	49,700	43,000	35,100	24,800

See Figs. N-184-4 and N-184-5 for sling configuration descriptions.

1910.184(h)(2)

Safe operating temperatures. Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range from minus 20 deg. F to plus 180 deg. F without decreasing the working load limit. For operations outside this temperature range and for wet frozen slings, the sling manufacturer's recommendations shall be followed.

1910.184(h)(3)

Splicing. Spliced fiber rope slings shall not be used unless they have been spliced in accordance with the following minimum requirements and in accordance with any additional recommendations of the manufacturer:

1910.184(h)(3)(i)

In manila rope, eye splices shall consist of at least three full tucks, and short splices shall consist of at least six full tucks, three on each side of the splice center line.

1910.184(h)(3)(ii)

In synthetic fiber rope, eye splices shall consist of at least four full tucks, and short splices shall consist of at least eight full tucks, four on each side of the center line.

..1910.184(h)(3)(iii)

1910.184(h)(3)(iii)

Strand end tails shall not be trimmed flush with the surface of the rope immediately adjacent to the full tucks. This applies to all types of fiber rope and both eye and short splices. For fiber rope under one inch in diameter, the tail shall project at least six rope diameters beyond the last full tuck. For fiber rope one inch in diameter and larger, the tail shall project at least six inches beyond the last full tuck. Where a projecting tail interferes with the use of the sling, the tail shall be tapered and spliced into the body of the rope using at least two additional tucks (which will require a tail length of approximately six rope diameters beyond the last full tuck).

1910.184(h)(3)(iv)

Fiber rope slings shall have a minimum clear length of rope between eye splices equal to 10 times the rope diameter.

1910.184(h)(3)(v)

Knots shall not be used in lieu of splices.

1910.184(h)(3)(vi)

Clamps not designed specifically for fiber ropes shall not be used for splicing.

1910.184(h)(3)(vii)

For all eye splices, the eye shall be of such size to provide an included angle of not greater than 60 degrees at the splice when the eye is placed over the load or support.

1910.184(h)(4)

End attachments. Fiber rope slings shall not be used if end attachments in contact with the rope have sharp edges or projections.

1910.184(h)(5)

Removal from service. Natural and synthetic fiber rope slings shall be immediately removed from service if any of the following conditions are present:

1910.184(h)(5)(i)

Abnormal wear.

1910.184(h)(5)(ii)

Powdered fiber between strands.

..1910.184(h)(5)(iii)

1910.184(h)(5)(iii)

Broken or cut fibers.

1910.184(h)(5)(iv)

Variations in the size or roundness of strands.

1910.184(h)(5)(v)

Discoloration or rotting.

1910.184(h)(5)(vi)

Distortion of hardware in the sling.

1910.184(h)(6)

Repairs. Only fiber rope slings made from new rope shall be used. Use of repaired or reconditioned fiber rope slings is prohibited.

1910.184(i)

Synthetic web slings --

1910.184(i)(1)

Sling identification. Each sling shall be marked or coded to show the rated capacities for each type of hitch and type of synthetic web material.

1910.184(i)(2)

Webbing. Synthetic webbing shall be of uniform thickness and width and selvage edges shall not be split from the webbing's width.

1910.184(i)(3)

Fittings. Fittings shall be:

1910.184(i)(3)(i)

Of a minimum breaking strength equal to that of the sling; and

1910.184(i)(3)(ii)

Free of all sharp edges that could in any way damage the webbing.

..1910.184(i)(4)

1910.184(i)(4)

Attachment of end fittings to webbing and formation of eyes. Stitching shall be the only method used to attach end fittings to webbing and to form eyes. The thread shall be in an even pattern and contain a sufficient number of stitches to develop the full breaking strength of the sling.

1910.184(i)(5)

Sling use. Synthetic web slings illustrated in Fig. N-184-6 shall not be used with loads in excess of the rated capacities specified in Tables N-184-20 through N-184-22. Slings not included in these tables shall be used only in accordance with the manufacturer's recommendations.

1910.184(i)(6)

Environmental conditions. When synthetic web slings are used, the following precautions shall be taken:

1910.184(i)(6)(i)

Nylon web slings shall not be used where fumes, vapors, sprays, mists or liquids of acids or phenolics are present.

1910.184(i)(6)(ii)

Polyester and polypropylene web slings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

1910.184(i)(6)(iii)

Web slings with aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of caustics are present.

FIGURE N-184-6 Basic Synthetic Web Sling Constructions
(For Figure N-184-6, Click Here)

TABLE N-184-20. -- SYNTHETIC WEB SLINGS
-- 1,000 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

Sling body width, inches	Triangle -- Choker slings, type I: Triangle -- Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	1,000	750	2,000	1,700	1,400	1,000
2.......	2,000	1,500	4,000	3,500	2,800	2,000
3.......	3,000	2,200	6,000	5,200	4,200	3,000
4.......	4,000	3,000	8,000	6,900	5,700	4,000
5.......	5,000	3,700	10,000	8,700	7,100	5,000
6.......	6,000	4,500	12,000	10,400	8,500	6,000

TABLE N-184-20. -- SYNTHETIC WEB SLINGS
-- 1,000 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Endless slings, type V					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	1,600	1,300	3,200	2,800	2,300	1,600
2.......	3,200	2,600	6,400	5,500	4,500	3,200
3.......	4,800	3,800	9,600	8,300	6,800	4,800
4.......	6,400	5,100	12,800	11,100	9,000	6,400
5.......	8,000	6,400	16,000	13,900	11,300	8,000
6.......	9,600	7,700	19,200	16,600	13,600	9,600

TABLE N-184-20. -- SYNTHETIC WEB SLINGS

-- 1,000 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Return eye slings, type VI					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	800	650	1,600	1,400	1,150	800
2.......	1,600	1,300	3,200	2,800	2,300	1,600
3.......	2,400	1,950	4,800	4,150	3,400	2,400
4.......	3,200	2,600	6,400	5,500	4,500	3,200
5.......	4,000	3,250	8,000	6,900	5,650	4,000
6.......	4,800	3,800	9,600	8,300	6,800	4,800

NOTES: 1. All angles shown are measured from the vertical.
2. Capacities for intermediate widths not shown may be obtained by interpolation.

TABLE N-184-21. -- SYNTHETIC WEB SLINGS
-- 1,200 Pounds Per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

Sling body width, inches	Triangle -- Choker slings, type I: Triangle -- Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	1,200	900	2,400	2,100	1,700	1,200
2.......	2,400	1,800	4,800	4,200	3,400	2,400
3.......	3,600	2,700	7,200	6,200	5,100	3,600
4.......	4,800	3,600	9,600	8,300	6,800	4,800
5.......	6,000	4,500	12,000	10,400	8,500	6,000
6.......	7,200	5,400	14,400	12,500	10,200	7,200

TABLE N-184-21. -- SYNTHETIC WEB SLINGS
-- 1,200 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Endless slings, type V					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	1,900	1,500	3,800	3,300	2,700	1,900
2.......	3,800	3,000	7,600	6,600	5,400	3,800
3.......	5,800	4,600	11,600	10,000	8,200	5,800

4.......	7,700	6,200	15,400	13,300	10,900	7,700
5.......	9,600	7,700	19,200	16,600	13,600	9,600
6.......	11,500	9,200	23,000	19,900	16,300	11,500

TABLE N-184-21. -- SYNTHETIC WEB SLINGS
-- 1,200 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Return eye slings, type VI					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	950	750	1,900	1,650	1,350	950
2.......	1,900	1,500	3,800	3,300	2,700	1,900
3.......	2,850	2,250	5,700	4,950	4,050	2,850
4.......	3,800	3,000	7,600	6,600	5,400	3,800
5.......	4,750	3,750	9,500	8,250	6,750	4,750
6.......	5,800	4,600	11,600	10,000	8,200	5,800

NOTES: 1. All angles shown are measured from the vertical.
2. Capacities for intermediate widths not shown may be obtained by interpolation.

TABLE N-184-22. -- SYNTHETIC WEB SLINGS
-- 1,600 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

Sling body width, inches	Triangle -- Choker slings, type I: Triangle -- Triangle slings, type II: Eye and eye with flat eye slings, type III: Eye and eye with twisted eye slings, type IV					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	1,600	1,200	3,200	2,800	2,300	1,600
2.......	3,200	2,400	6,400	5,500	4,500	3,200
3.......	4,800	3,600	9,600	8,300	6,800	4,800
4.......	6,400	4,800	12,800	11,100	9,000	6,400
5.......	8,000	6,000	16,000	13,800	11,300	8,000
6.......	9,600	7,200	19,200	16,600	13,600	9,600

TABLE N-184-22. -- SYNTHETIC WEB SLINGS
-- 1,600 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width,	Endless slings, type V					

inches	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	2,600	2,100	5,200	4,500	3,700	2,600
2.......	5,100	4,100	10,200	8,800	7,200	5,100
3.......	7,700	6,200	15,400	13,300	10,900	7,700
4.......	10,100	8,200	20,400	17,700	14,400	10,200
5.......	12,800	10,200	25,600	22,200	18,100	12,800
6.......	15,400	12,300	30,800	26,700	21,800	15,400

TABLE N-184-22. -- SYNTHETIC WEB SLINGS
-- 1,600 Pounds per Inch of Width
-- Single-Ply

[Rated capacity in pounds]

(Continued)

Sling body width, inches	Return eye slings, type VI					
	Vert.	Choker	Vert. basket	30 deg. basket	45 deg. basket	60 deg. basket
1.......	1,050	1,050	2,600	2,250	1,850	1,300
2.......	2,600	2,100	5,200	4,500	3,700	2,600
3.......	3,900	3,150	7,800	6,750	5,500	3,900
4.......	5,100	4,100	10,200	8,800	7,200	5,100
5.......	6,400	5,150	12,800	11,050	9,050	6,400
6.......	7,700	6,200	15,400	13,300	10,900	7,700

NOTES: 1. All angles shown are measured from the vertical.
2. Capacities for intermediate widths not shown may be obtained by interpolation.

1910.184(i)(7)

Safe operating temperatures. Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180 deg. F. Polypropylene web slings shall not be used at temperatures in excess of 200 deg. F.

..1910.184(i)(8)

1910.184(i)(8)

Repairs.

1910.184(i)(8)(i)

Synthetic web slings which are repaired shall not be used unless repaired by a sling manufacturer or an equivalent entity.

1910.184(i)(8)(ii)

Each repaired sling shall be proof tested by the manufacturer or equivalent entity to twice the rated capacity prior to its return to service. The employer shall retain a certificate of the proof test and make it available for examination.

1910.184(i)(8)(iii)

Slings, including webbing and fittings, which have been repaired in a temporary manner shall not be used.

1910.184(i)(9)

Removal from service. Synthetic web slings shall be immediately removed from service if any of the following conditions are present:

1910.184(i)(9)(i)

Acid or caustic burns;

1910.184(i)(9)(ii)

Melting or charring of any part of the sling surface;

1910.184(i)(9)(iii)

Snags, punctures, tears or cuts;

1910.184(i)(9)(iv)

Broken or worn stitches; or

1910.184(i)(9)(v)

Distortion of fittings.

[40 FR 27369, June 27, 1975, as amended at 40 FR 31598, July 28, 1975; 41 FR 13353, Mar. 30, 1976; 58 FR 35309, June 30, 1993; 61 FR 9227, March 7, 1996]

Next Standard (1910 Subpart O)

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

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NASA STANDARD 8719.9

Excerpts

Sections:

10.0 through 10.7

(Rigging)

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10. SLINGS AND RIGGING

10.1 General. This section establishes minimum standards for the design, testing, inspection, maintenance, personnel certification, and operation of slings. This includes slings constructed of wire rope, alloy steel chain, metal mesh, synthetic rope, synthetic web, linear fiber, structural slings, and associated equipment such as shackles, turnbuckles, and eyebolts.

10.2 Safety and Design Aspects.

10.2.1 Design Criteria that should be emphasized during sling design are contained in the documents listed in Section 2. Sling design shall be in accordance with industry standards and meet the applicable requirements of OSHA and ASME. Sling design shall maintain the minimum design factors listed in Table 10-1.

Table 10-1 Minimum Design Factors for Slings

Equipment	Design Load Safety Factor
Alloy Steel Chain Slings	5
Wire Rope Slings	5
Metal Mesh Slings	5
Synthetic Rope Slings	5
Synthetic Web Slings	5
Linear Fiber Slings	5
Structural Slings	Lesser of 3 times yield or 5 times ultimate
Shackles, D-rings, Turnbuckles, Eye Bolts, Lifting Lugs, Safety Hoist Rings, etc.	5

Note: Design factor based on ultimate material strength, except for structural slings.

10.2.2 Labeling/Tagging of Slings. Certification/recertification tags are required as described in paragraph 10.3.5. A system shall be developed to identify slings used in critical lift applications. Completely assembled slings that have the necessary design features and maintenance/inspection, and test intervals to lift critical loads will be marked conspicuously so that the operator and assurance personnel can distinguish that the sling is qualified for critical lifts.

10.3 Testing. The following proof load and periodic load tests apply to slings except as noted in paragraph 10.3.3. Turnbuckles shall be tested at the open position as a minimum. It is recommended that turnbuckles be tested at the open, closed, and midway positions. These tests shall be performed by qualified personnel according to written (specific or general) technical operating procedures. The acceptable tolerance for load test accuracy is +5/-0 percent. When slings are composed of major components that fall into more than one of the categories listed in Table 10-2, the components shall be tested individually according to applicable requirements and then as a system to the lowest test value (if practical). An inspection shall be performed after each load test and prior to release for service to ensure there is no damage. A periodic load test requirement can be fulfilled by a concurrent proof load test. The load shall be held for a minimum of 3 minutes for load tests.

10.3.1 Proof Load Test. Before first use, all new, extensively modified, repaired, or altered slings shall undergo a proof load test at a specified factor of the rated load according to

Table 10-2. Proof load tests performed by the manufacturer prior to delivery are acceptable, if the necessary load test papers are provided to verify the extent and thoroughness of the test on the specific item. A proof load test also may be performed at a prescribed time when there is a question in design or previous testing. All components shall be tested together as a system, if practical. Prior to first use, all lifting interfaces such as eyebolts, D-rings, and lifting lugs permanently attached to the load shall be proof load tested if feasible. For lifting interfaces, when deemed unfeasible by the responsible design organization and accepted by the user organization, based on possible overloading of structural members not required during lifting or other considerations, this proof load test can be eliminated. However, design analysis and inspection shall be used to verify the integrity of the interface.

Table 10-2 Proof Load Test Factors
(Based on Manufacturers' Rated Load)

Equipment	Proof Load Test Factor
Alloy Steel Chain Slings	2.0
Wire Rope Slings	2.0
Metal Mesh Slings	2.0
Synthetic Rope Slings	2.0
Synthetic Web Slings	2.0
Linear Fiber Slings	2.0
Structural Slings	2.0*
Shackles, D-rings, Turnbuckles, Eye Bolts, Lifing Lugs, Safety Hoist Rings, etc.	2.0

* Unless otherwise specified by design, due to material characteristics, geometry, design factors, etc., but in any case, at least 125 percent of the sling's rated capacity.

10.3.2 Periodic Load Test. Slings shall undergo periodic load tests at least every 4 years at a specific load test factor of the design rated load as given in Table 10-3. All components shall be tested together as a system, if practical. Slings used for critical lifts shall be load tested at least once per year. Slings used infrequently for critical lifts shall be load tested before each critical lift if it has been over a year since the last load test. Lifting interfaces such as eyebolts, D-rings, and lifting lugs permanently attached to the load are exempt from periodic load testing.

Table 10-3 Periodic Load Test Factors
(Based on Manufacturers' Rated Load)

Equipment	Periodic Load Test Factor
Alloy Steel Chain Slings	1.00
Wire Rope Slings	1.00
Metal Mesh Slings	1.00
Synthetic Rope Slings	1.00*
Synthetic Web Slings	1.00
Linear Fiber Slings	1.00
Structural Slings	1.00
Shackles, D-rings, Turnbuckles, Eye Bolts, Lifting Lugs, Safety Hoist Rings, etc.	1.00

* Critical lift rope slings of synthetic material shall not be used beyond 50 percent of the manufacturer's rating to maintain an equivalent design factor in the load system.

10.3.3 Non-Load Test Slings. Due to unique design and usage requirements, a sling may be designated as a non-load test sling by the LDEM, with concurrence from the affected/responsible program/project office, the responsible safety, design engineering, systems engineering, operations, and maintenance organizations. Such slings do not require periodic load tests. Inspections shall be conducted in accordance with paragraph 10.4. This non-load test designation shall be formally documented by each installation and the sling marked accordingly to designate it as a non-load test sling.

10.3.4 Sling Rated Load. Rated loads for slings shall be based on the periodic load test weight divided by the periodic load test factor (see Table 10-3). For metal mesh slings, the rated capacity will be noted for vertical basket and choker hitch configurations. For synthetic rope slings, used in noncritical lifts, a 50-percent derating for use is recommended. For synthetic rope slings used in critical lifts, a 50-percent derating is required.

10.3.5 Test Reports and Periodic Recertification Tags.

a. Written, dated, and signed reports shall be prepared after each test. Inadequacies shall be documented and, if determined to be a hazard, corrected prior to further use. These reports shall be kept on file by the owner organization for a minimum of two test cycles and shall be made readily available.

b. Following the load test, all slings shall be given a permanently affixed tag identifying the equipment (part number) and stating the rated capacity based on the load test value and the next periodic load test due date or load test expiration date. For alloy steel chains, size, grade, and reach shall be stated along with the rated load. For synthetic rope slings used for critical lifts, the marked rated load shall be 50 percent of the manufacturer's rated load. The type of material shall also be stated. All load bearing components shall be traceable to the most recent load test. This may be accomplished by clearly marking/coding or tethering all components of the assembly, through configuration control, or other procedures. (NOTE: Load bearing components not traceable to load test will invalidate the load test of the whole assembly.)

10.4 Inspection.

10.4.1 Inspections, as described below, shall be performed on all slings. Inspections shall be performed according to this section, the manufacturers' recommendations, and ASME B30.9. Visual inspections for cracks, deformations, gouges, galling, kinks, crushed areas, corrosion, and proper configuration shall be performed each day the sling is used, prior to first use. An indepth inspection shall be performed annually or when a sling is suspected to have even a small loss of strength or is repaired. Inspections shall be performed by qualified personnel according to approved technical operating procedures. Inadequacies shall be documented and, if determined to be a safety hazard, tagged out and corrected prior to further use.

10.4.2 All new, extensively repaired, or modified slings shall be given a daily and a periodic inspection prior to first use. For component repair on slings, only the inspections that apply to the repaired portion need to be performed prior to first use unless a periodic inspection interval expires during the downtime (see paragraph 10.4.5).

10.4.3 Slings in regular service (used at least once a month) shall be inspected as required in paragraphs 10.4.4 and 10.4.5. Idle and standby slings shall be inspected according to paragraph 10.4.6.

10.4.4 <u>Daily Inspections</u>. These inspections shall be performed prior to first use each day the sling is used and shall include the following:

a. Check for defects such as cracks, deformations, gouges, galling, kinks, crushed areas, and corrosion.

b. Check for proper configuration (the lifting assembly and associated hardware, as proof load tested).

10.4.5 <u>Periodic Inspections</u>. The following inspections shall be performed at least once a year, unless otherwise specified below. The need to replace or repair slings shall be determined by a certified or otherwise qualified person based on an evaluation of inspection results. Any discrepancy (deterioration or damage) is sufficient reason for questioning continued use of the sling (see Wire Rope Users Manual for additional information on wire rope inspections):

a. Alloy Steel Chain

(1) Inspect each link individually to ensure every link hangs freely with adjoining link.

(2) Ensure that wear, corrosion, or deformities at any point on chain do not exceed 20 percent of original dimensions.

(3) Ensure that master links are not deformed.

b. Wire Rope Slings

(1) Ensure that there are fewer than 10 randomly distributed broken wires in one rope lay or 5 broken wires in 1 strand in 1 lay.

(2) Ensure wear or scraping is less than 1/3 the original diameter of outside individual wires.

(3) Inspect for kinking, crushing, bird caging, or any other distortion of the rope structure.

(4) Inspect for excessive heat damage.

(5) Inspect for cracked, deformed, or worn end attachments.

(6) Inspect for significantly corroded rope or end attachments.

c. Metal Mesh Slings

(1) Ensure that there are no broken welds or brazed joints along the sling edge.

(2) Ensure that reduction in wire diameter does not exceed 25 percent due to abrasion or 15 percent due to corrosion.

(3) Inspect for lack of flexibility due to distortion of the fabric.

(4) Ensure that there is no more than a 25 percent reduction of the original cross-sectional area of metal at any point around handle eyes.

(5) Inspect for distortion of either handle out of plane, more than 10-percent decrease in eye width, and more than 10-percent increase in the receiving handle slot depth.

d. Synthetic Rope Slings

(1) Inspect for abnormal wear.

(2) Ensure that there is no powdered fiber between stands.

(3) Inspect for broken or cut fibers.

(4) Ensure that there is no rotting or acid or caustic burns.

(5) Inspect for distortion of associated hardware.

e. Synthetic Web and Linear Fiber Slings

(1) Ensure that there are no acid or caustic burns.

(2) Inspect for melting or charring of any part of surface.

(3) Inspect for snags, punctures, tears, and cuts.

(4) Inspect for broken or worn stitches and rotting.

(5) Ensure that wear or elongation does not exceed amount recommended by the manufacturer.

(6) Perform all inspections provided for by the sling manufacturer. This may include red fibers used as a wear indicator, or a fiber optic sling damage indicator, or some other NDT method designed into the sling.

f. Structural Slings

(1) Verify overall that there is no evidence of damage, gouges in metal, loose bolts, rivets, connections, or deformations such as galling or gouges in pins, eyes, and end connections.

(2) Ensure that there are no bent, deformed, cracked, or excessively corroded support or main members.

(3) Without disassembly, inspect load bearing bolts for evidence of deterioration. Verify that assemblies are intact and that there has been no shifting or relative motion of parts.

(4) Inspect attachment and lifting lugs for visual deformation and evidence of local yielding.

(5) Ensure that there are no elongated attachment or lifting holes.

(6) Inspect around fasteners for local yielding and deformation.

(7) Remove and inspect load bearing slip pins for deformation, evidence of bending, abnormal defects such as galling, scoring, brinelling, and diameters not within design tolerances. Verify that there are no cracks by performing a surface NDT.

(8) Inspect pin bores for deformation, local yielding, scoring, galling, brinelling, and diameters not within design tolerances. Verify that there are no cracks by performing a surface NDT.

(9) Inspect welds for cracks, evidence of deformation, deterioration, damage, or other defects by:

(a) Visual inspection of all welds.

(b) Ultrasonics, radiography, magnetic particle, liquid penetrant, or eddy current as appropriate for critical welds as identified on the design drawings. Inspect a minimum of 1/2 inch on each side of the weld to ensure the heat affected zone is included. Verify that there are no cracks.

(10) Inspect all parts, particularly bare metal, for corrosion. Corrosion-protect all surfaces that are not to be painted, lubricated, or coated with strippable vinyl. Do not paint over uninspected areas, or cracks, deformations, deterioration, or other damage until engineering assessment has been made.

(11) Inspect hooks for deformations or cracks (see Section 7).

g. Rejected Slings. All slings rejected during inspection shall be marked. An engineering assessment will be made to determine if the sling is repairable. Non-repairable slings will be destroyed as soon as possible to avoid unintentional use.

10.4.6 Idle and Standby Slings. Idle and standby slings shall be inspected prior to first use according to the requirements in paragraphs 10.4.4 and 10.4.5 unless these daily and periodic inspections were performed at required intervals during the idle/standby period.

10.4.7 Inspection Reports. Written, dated, and signed inspection reports shall be prepared after each periodic inspection. Inadequacies shall be documented and, if determined to be a hazard, corrected prior to further use. These reports shall be filed and made readily available by the organizational element responsible for inspecting sling(s).

10.5 Maintenance. A maintenance program based on manufacturers' recommendations, integrating proactive, reactive, preventive, and predictive maintenance shall be established to increase the probability the sling will function in the required manner over its design life cycle with a minimum of maintenance. The program shall include procedures and a scheduling system for normal periodic maintenance items, adjustments, replacements, and repairs. The program shall also ensure that records are kept and unsafe test and inspection discrepancies are documented and corrected. Any sling found in an unsafe operating condition shall be tagged out and removed from service until repaired. All repairs shall be made by qualified personnel in accordance with the manufacturers' instructions. The need to repair or replace slings shall be determined by a certified or otherwise qualified person based on an evaluation of inspection results.

10.6 Personnel Certification.

10.6.1 Program. Only certified (licensed) and trained riggers are authorized to perform rigging tasks for lifting devices, equipment, and/or operations. A comprehensive training, examination, and licensing program shall be established or made available. For those NASA installations/initiatives or sponsored programs and activities that do not have a training program, these requirements may be provided by a third party that is proficient in the principles of rigging. The rigging certification program will be reviewed at least annually to assure that the contents, training material, testing, and examination elements are up-to-date with current methods and techniques; and that any "lessons-learned" are adequately addressed. Personnel performing NDT shall be qualified and certified in accordance with paragraph 1.9. Training shall be provided to observers and flagmen. All participants in the lifting operation shall have clearly defined roles and responsibilities.

10.6.2 The certification program for rigging operations shall include the following and may be included in the operator training for the individual lifting device training and certification . If the general rigging is included in the specific lifting device certification and training program, sufficient rigging details shall be included in the training, testing and "hands-on" examination portion of that lifting device training program to assure that each individual understands and demonstrates proficiency in the required rigging techniques and methods.

The following shall be addressed in the qualification of individuals for "rigging certification."

a. Training

(1) Classroom training in rigging safety, techniques, and methods, pre-use inspection, slings, and attachment devices (for initial certification and as needed).

(2) Hands-on training (for initial certification and as needed).

(3) An annual review by supervision or other designated personnel of each individual's performance as a rigger or operator/rigger to assure adequate proficiency in performing the necessary rigging tasks in a

manner consistent with the principals, methods, and techniques associated with safe rigging practices.

b. Examination

(1) Physical examination (criteria to be determined by the cognizant medical official based upon the related requirements associated with performing rigging tasks).

(2) Written examination.

(3) Operational (practical) demonstration test (for initial certification only or to address new techniques or methods as required). Each individual shall demonstrate the ability to adequate determine and/or apply load weight, center of gravity and apply special articulating devices essential to the safe and successful lift operation. Riggers must demonstrate the ability to apply proper rigging principals, methods, and techniques using simulated loads of various weights, sizes, and configurations.

c. Rigger Licensing/Certification

(1) An organization element shall be designated to issue rigger licenses/certifications. Provisions shall be made to suspend/revoke licenses or certifications for violation of safety requirements, failure to meet medical requirements, or acts of negligence in rigging. A program element to assure current rigger certification status of persons performing rigging tasks shall be established and implemented. The method of licensing is the responsibility of the organization element that is designated to issue the rigger licenses/certifications. Generally this will involve the use of “License/Certification Cards” issued to each individual or maintaining a master list of licensed/certified riggers that is readily available to assurance and supervisory personnel.

(2) Renewal of all rigger licenses/certifications shall require demonstration of proficiency or approval of supervision that proficiency is adequate and current. Licenses/certifications will expire at least every 4 years. Renewal procedures and requirements will be established by the organizational element responsible for issuing rigger licenses/certifications and will include those requirements established in paragraphs 10.6.2 a. and 10.6.2 b.

10.7 <u>Operations</u>. Slings shall be operated according to this section, the manufacturers' recommendations, and ASME B30.9. The following practices shall be followed for sling operations:

a. Select a sling of suitable rated capacity, use proper hitch, and attach the sling securely to the load. For critical lifts, rope slings of synthetic construction shall not be used beyond 50 percent of their rated load. (The minimum design factors for determining rated load are provided in Table 10-1.)

b. Avoid kinks, loops, or twists in the sling legs.

c. Start lift slowly to avoid shock loading the slings.

d. Do not pull a sling from under a load when the load is resting on the sling. Block the load up to remove the sling.

e. Slings shall be shortened only by methods approved by the sling manufacturer or a qualified person.

f. Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire rope clips or knots.

g. The following materials and techniques shall not be used in slings or rigging hardware to hoist personnel or loads: natural rope, wire rope clips, the fold back metal pressed sleeve or clip technique.

h. Keep metallic slings lubricated/painted to prevent corrosion.

i. Slings shall not be loaded beyond rated load except for required testing.

j. Particular attention shall be given to preventing corrosion. Slings shall be stored such that they will not be damaged by moisture, heat, sunlight, or chemicals. Nylon shall not be used in an acid or phenolic environment. Polyester, polypropylene, and aluminum shall not be used in a caustic environment.

k. Precautions shall be taken to ensure proper sling assembly and that the proper configuration is maintained. Slings shall be used according to design and/or manufacturers' instructions.

l. The user shall ensure that the sling is within the inspection and periodic recertification intervals and that all load bearing components are traceable to the most recent load test by examination of the tags and/or documentation.

m. Sling repair shall maintain the minimum design factors based on ultimate material strength. These factors are listed in Table 10-1.

n. Slings shall be padded or protected from the sharp edges of their loads.

o. Wire rope slings should be used in accordance with the Wire Rope Sling Users Manual.

p. For lifting, safety hoist rings are strongly recommended for use instead of eye bolts.

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Bridge

Load Bock

Hoist

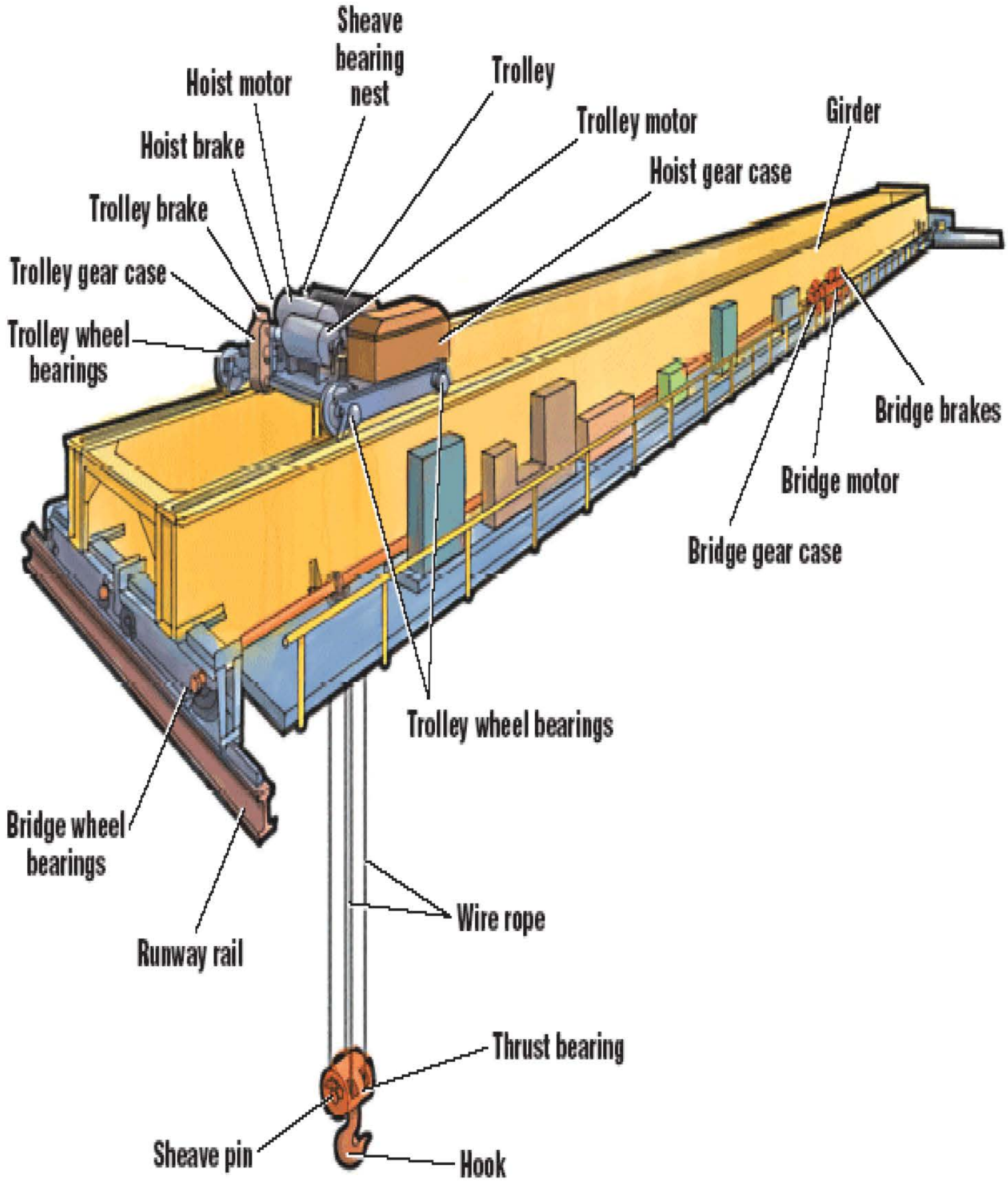
Common Overhead Crane Terminology

Reeving

Hook

Trolley

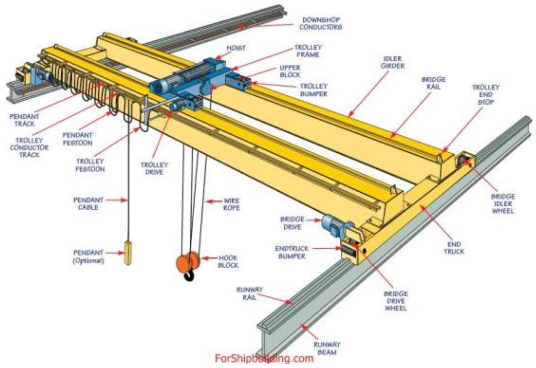
Common Overhead Crane Terminology

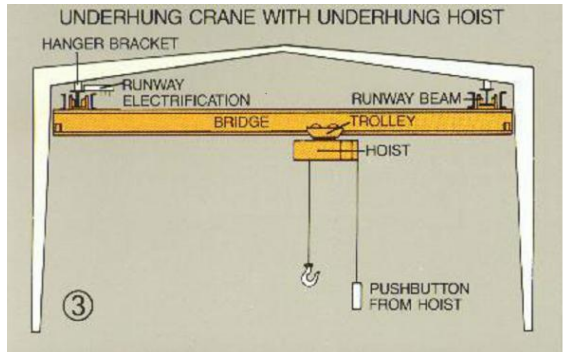


All Overhead Cranes Consist Of -3- General Components:

1.) Bridge

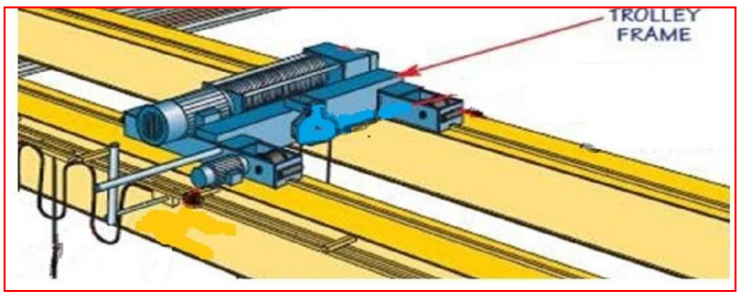
The Bridge is the main structural member used to span the width of the runway area. It travels the length of the runway on rails fastened to the runway steel.





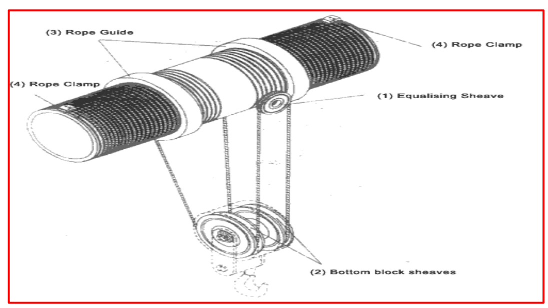
2.) Trolley

The Trolley is the motor driven vehicle, which travels along the rails fastened to the bridge girders load Beam(s) or suspended from the bottom flange(s) of the Bridge Girder Load beam(s).



3.) Hoist

The Hoist unit is an apparatus which exerts a force for lifting or lowering of the load. It is normally power driven through a gear reducer and hoist drum/pocket wheel (chain) with the bottom block suspended from the hoist rope/chain reeved through a series of sheaves or Pocket wheel(s) (chain) and dead ended at the hoist/trolley frame.

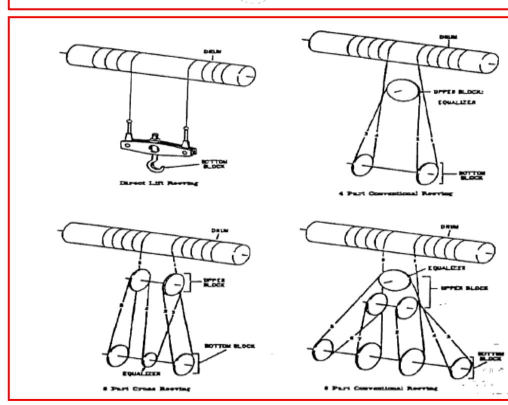


Reeving

The following reeving methods are commonly used on Overhead Hoist.

There are more extensive reeving methods as well as special applications.

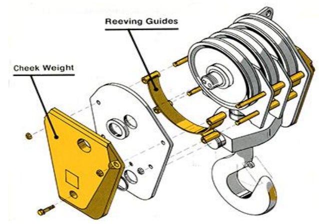
Check your crane manual for the exact reeving style and method for your crane.



NOTE THE USE OF EQUALIZERS SHEAVES IN EACH REEVING CONFIGURATION ABOVE

Load Blocks and Hooks

Hoist blocks should be inspected regularly for sheave conditions and bent housing.



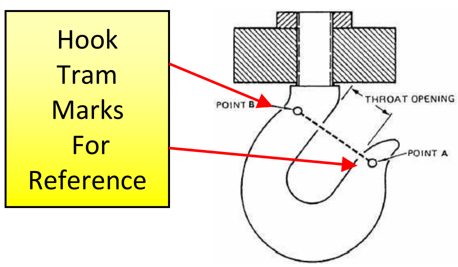
Hooks

Check the hook nut, mounting surface (Trunion) and swivel bearing to make sure they are intact and that the hook spins freely.

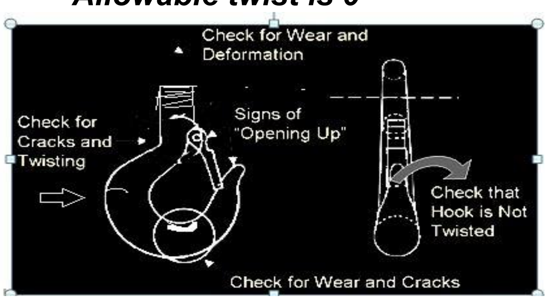
Hook Deformation

The amount of allowable hook deformation may depend on the regulatory body that governs your crane use. Commonly accepted dimensional changes such as the following are sufficient cause to remove the hook from service.

(a)Throat opening - Any distortion causing an increase in throat opening of 5% but not to exceed 1⁄4 in. (6 mm) from original dimension - (or as recommended by the manufacturer).



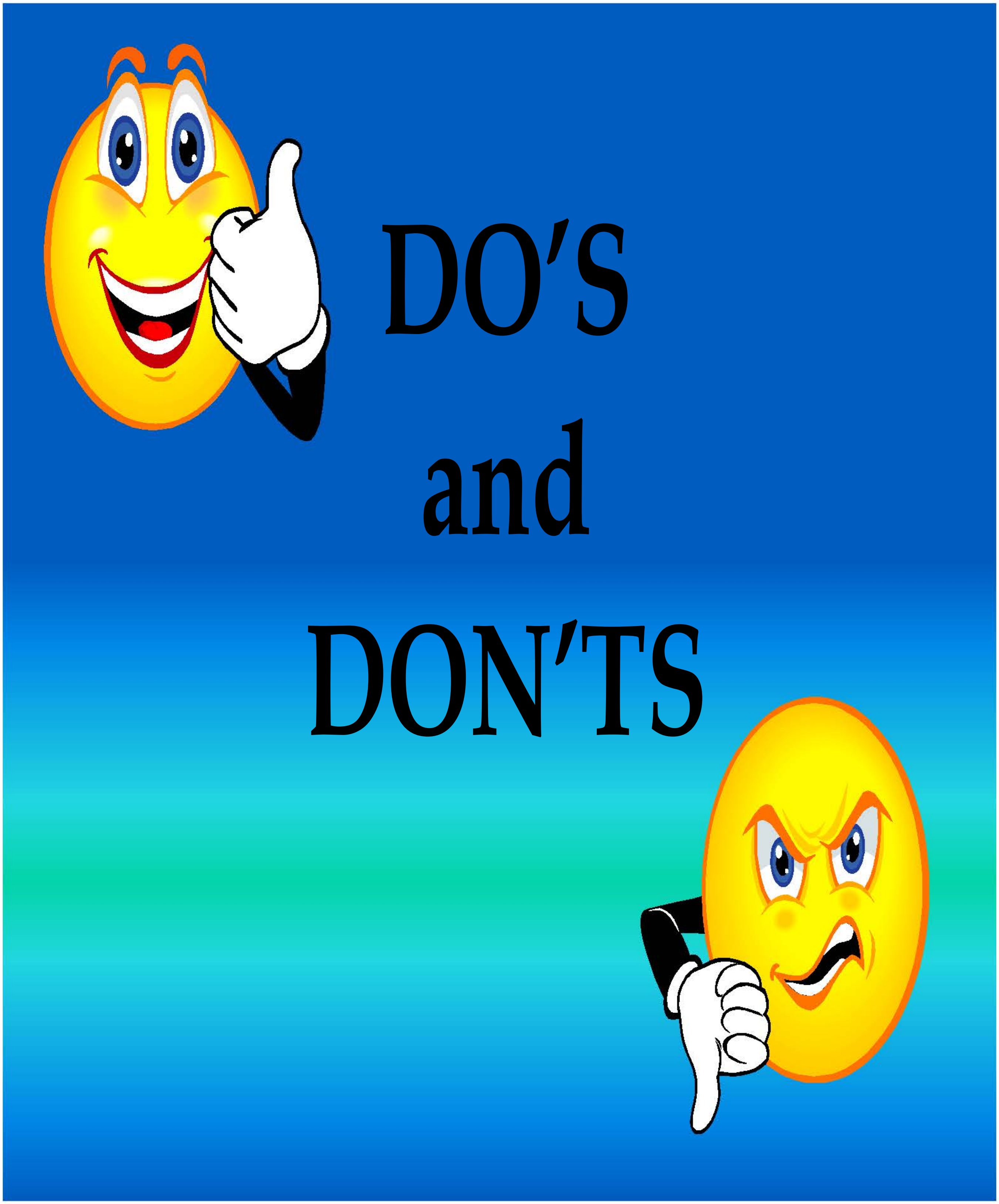
b) Any visibly apparent bend or twist from the plane of the unbent hook
Allowable twist is 0º



(3) Hook surface wear

Any wear exceeding 10% (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.

- **Do not weld on hooks or attempt to repair a damaged hook.**
- **Where one of the items above is found, the hook should be removed from service**
- **Do not weld on hooks or attempt to repair a damaged hook**
- **Check the hook for excessive wear, gouging, or visible cracks and where suspect a non-destructive testing method performed to detect subsurface or lateral stress cracks**


DO'S
and
DON'TS

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DO'S AND DON'TS

- DO'S
  - Do read and follow manufacturer's instruction, installation and maintenance manuals. When repairing or maintaining a crane, use only manufacturer's recommended parts and material.
  - Do read and follow all instruction and warning information on or attached to a crane.
  - Remove the crane from service and thoroughly inspect and repair as necessary if unusual performance or visual defects (such as peculiar noise, jerky operations, or travel in improper direction or obviously damaged parts) are noticed.
  - Establish a regular schedule of inspection and maintain records for all cranes with special attention given to hooks, ropes, brakes and limit switches.

DO'S AND DON'TS

- DO'S
  - Check operation of brakes for excessive drift.
  - Check operation of limit switches.
  - Check for damaged hooks or ropes.
  - Keep wire rope clean and well lubricated.
  - Check the wire rope or chain for improper seating, twisting, kinking, wear or other defects before operating the crane.
  - Check for broken wires in wire rope. Twelve randomly distributed broken wires in one rope lay or four broken wires in one strand in one rope lay are sufficient cause for replacement.

DO'S AND DON'TS

- DO'S
  - Make sure a load clears neighboring stock piles, machinery, or other obstructions when raising, lowering, or traveling the load.
  - Center the hook over the load before operating.
  - Avoid swinging of load or load hook when traveling the crane.
  - Be sure the load attachment is properly seated in the bowl of the hook. Balance load properly before handling. NEVER TIP LOAD.
  - Lift in a straight line, so that neither hoist body nor load ropes are angled to the load being lifted.
  - Take up slack slowly so as not do shock load the hoist or any load supporting components.

DO'S AND DON'TS

- DON'TS
  - Do Not operate crane if you are not physically fit or on medication that will impair concentration.
  - Do Not operate crane to extreme limits of wire rope.
  - Avoid sharp contact between two cranes, between crane and end stop.
  - Do Not tamper with any parts of the crane.
  - Never use the crane rope as a sling.
  - Do Not divert attention from load while operating crane.
  - Never leave a suspended load unattended.
  - Do Not attempt to repair damaged wire rope.
    - Wire Rope Cannot be Repaired. IT MUST BE REPLACED!!

DO'S AND DON'TS

- DON'TS
  - Never lift or transport a load until all personnel are clear.
  - Do Not allow unqualified personnel to operate crane.
  - Never Pick up a load beyond the capacity appearing on the crane. Overloading can be caused by jerking as well as by static overload.
  - Never carry personnel on the hook or the load.
  - Do Not use rope as ground for welding. NEVER touch a live welding electrode to the crane or rope.

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Excerpts From

OSHA 1910.179
Overhead and Gantry Cranes

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1910.179(f)
Brakes -
1910.179(f)(1)
Brakes for hoists

1910.179(f)(1)(i)
Each independent hoisting unit of a crane shall be equipped with at least one self-setting brake, hereafter referred to as a holding brake, applied directly to the motor shaft or some part of the gear train.

1910.179(f)(1)(ii)
Each independent hoisting unit of a crane, except worm-geared hoists, the angle of whose worm is such as to prevent the load from accelerating in the lowering direction shall, in addition to a holding brake, be equipped with control braking means to prevent over speeding.

1910.179(f)(2)
Holding brakes

1910.179(f)(2)(i)
Holding brakes for hoist motors shall have not less than the following percentage of the full load hoisting torque at the point where the brake is applied.

1910.179(f)(2)(i)(a)
125 percent when used with a control braking means other than mechanical.

1910.179(f)(2)(i)(b)
100 percent when used in conjunction with a mechanical control braking means.

1910.179(f)(2)(i)(c)
100 percent each if two holding brakes are provided

1910.179(f)(2)(ii)
Holding brakes on hoists shall have ample thermal capacity for the frequency of operation required by the service.

1910.179(f)(2)(iii)
Holding brakes on hoists shall be applied automatically when power is removed.

1910.179(f)(2)(iv)
Where necessary holding brakes shall be provided with adjustment means to compensate for wear.

1910.179(f)(2)(v)
The wearing surface of all holding-brake drums or discs shall be smooth.

1910.179(f)(2)(vi)
Each independent hoisting unit of a crane handling hot metal and having power control braking means shall be equipped with at least two holding brakes.

1910.179(f)(3)
Control braking means.

1910.179(f)(3)(i)
A power control braking means such as regenerative, dynamic or counter-torque braking, or a mechanically controlled braking means shall be capable of maintaining safe lowering speeds of rated loads.

1910.179(f)(3)(ii)
The control braking means shall have ample thermal capacity for the frequency of operation required by service.

1910.179(j)
Inspection –

1910.179(j)(1)
Inspection classification

1910.179(j)(1)(i)
Initial inspection
Prior to initial use all new and altered cranes shall be inspected to insure compliance with the provisions of this section.

1910.179(j)(1)(ii)
Inspection procedure for cranes in regular service is divided into two general classifications based upon the intervals at which inspection should be performed. The intervals in turn are dependent upon the nature of the critical components of the crane and the degree of their exposure to wear, deterioration, or malfunction. The two general classifications are herein designated as "frequent" and "periodic" with respective intervals between inspections as defined below:

1910.179(j)(1)(ii)(a)
Frequent inspection
Daily to monthly intervals

1910.179(j)(1)(ii)(b)
Periodic inspection
1 to 12 month intervals

Excerpts From

OSHA 1910.179
Overhead and Gantry Cranes

1910.179(j)(2)
Frequent inspection
The following items shall be inspected for defects at intervals as defined in paragraph (j)(1)(ii) of this section or as specifically indicated, including observation during operation for any defects which might appear between regular inspections. All deficiencies such as listed shall be carefully examined and determination made as to whether they constitute a safety hazard:

1910.179(j)(2)(i)
All functional operating mechanisms for maladjustment interfering with proper operation
Daily

1910.179(j)(2)(ii)
Deterioration or leakage in lines, tanks, valves, drains, pumps, and other parts of air or hydraulic systems
Daily

1910.179(j)(2)(iii)
Hooks with deformation or cracks. Visual inspection daily; monthly inspection with a certification record which includes the date of inspection, the signature of the person who performed the inspection and the serial number, or other identifier, of the hook inspected.
* For hooks with cracks or having more than 15 percent in excess of normal throat opening or more than 10° twist from the plane of the unbent hook refer to paragraph (l)(3)(iii)(a) of this section.

1910.179(j)(2)(iv)
Hoist chains, including end connections, for excessive wear, twist, distorted links interfering with proper function, or stretch beyond manufacturer's recommendations. Visual inspection daily; monthly inspection with a certification record which includes the date of inspection, the signature of the person who performed the inspection and an identifier of the chain which was inspected.

1910.179(j)(2)(v)
[Reserved]

1910.179(j)(2)(vi)
All functional operating mechanisms for excessive wear of components

1910.179(j)(2)(vii)
Rope reeving for noncompliance with manufacturer's recommendations

* **ASME B30.10, For hooks with cracks or having more than states 5% in excess of normal throat opening and 0º twist from the plane of the unbent hook**

1910.179(j)(3)
Periodic inspection
Complete inspections of the crane shall be performed at intervals as generally defined in paragraph (j)(1)(ii)(b) of this section, depending upon its activity, severity of service, and environment, or as specifically indicated below. These inspections shall include the requirements of paragraph (j)(2) of this section and in addition, the following items. Any deficiencies such as listed shall be carefully examined and determination made as to whether they constitute a safety hazard:

1910.179(j)(3)(i)
Deformed, cracked, or corroded members

1910.179(j)(3)(ii)
Loose bolts or rivets

1910.179(j)(3)(iii)
Cracked or worn sheaves and drums

1910.179(j)(3)(iv)
Worn, cracked or distorted parts such as pins, bearings, shafts, gears, rollers, locking and clamping devices

1910.179(j)(3)(v)
Excessive wear on brake system parts, linings, pawls, and ratchets

1910.179(j)(3)(vi)
Load, wind, and other indicators over their full range, for any significant inaccuracies

1910.179(j)(3)(vii)
Gasoline, diesel, electric, or other power plants for improper performance or noncompliance with applicable safety requirements

1910.179(j)(3)(viii)
Excessive wear of chain drive sprockets and excessive chain stretch

1910.179(j)(3)(ix)
[Reserved]

1910.179(j)(3)(x)
Electrical apparatus, for signs of pitting or any deterioration of controller contactors, limit switches and pushbutton stations.

1910.179(j)(4)
Cranes not in regular use

1910.179(j)(4)(i)
A crane which has been idle for a period of 1 month or more, but less than 6 months, shall be given an inspection conforming with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section before placing in service.

1910.179(j)(4)(ii)
A crane which has been idle for a period of over 6 months shall be given a complete inspection conforming with requirements of paragraphs (j)(2) and (3) of this section and paragraph (m)(2) of this section before placing in service.

1910.179(j)(4)(iii)
Standby cranes shall be inspected at least semi-annually in accordance with requirements of paragraph (j)(2) of this section and paragraph (m)(2) of this section.

1910.179(k)
Testing –

1910.179(k)(1)
Operational tests

1910.179(k)(1)(i)
Prior to initial use all new and altered cranes shall be tested to insure compliance with this section including the following functions:

1910.179(k)(1)(i)(a)
Hoisting and lowering

1910.179(k)(1)(i)(b)
Trolley travel

1910.179(k)(1)(i)(c)
Bridge travel

1910.179(k)(1)(i)(d)
Limit switches, locking and safety devices

1910.179(k)(1)(ii)
The trip setting of hoist limit switches shall be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch shall be located so that it will trip the switch, under all conditions, in sufficient time to prevent contacting the hook or hook block with any part of the trolley.

1910.179(k)(2)
Rated load test.
Test loads shall not be more than 125 percent of the rated load unless otherwise recommended by the manufacturer. The test reports shall be placed on file where readily available to appointed personnel.

1910.179(m)
Rope inspection

1910.179(m)(1)
Running ropes.
A thorough inspection of all ropes shall be made at least once a month and a certification record which includes the date of inspection, the signature of the person who performed the inspection and an identifier for the ropes which were inspected shall be kept on file where readily available to appointed personnel. Any deterioration, resulting in appreciable loss of original strength, shall be carefully observed and determination made as to whether further use of the rope would constitute a safety hazard. Some of the conditions that could result in an appreciable loss of strength are the following:

1910.179(m)(1)(i)
Reduction of rope diameter below nominal diameter due to loss of core support, internal or external corrosion, or wear of outside wires

1910.179(m)(1)(ii)
A number of broken outside wires and the degree of distribution or concentration of such broken wires

1910.179(m)(1)(iii)
Worn outside wires

1910.179(m)(1)(iv)
Corroded or broken wires at end connections

1910.179(m)(1)(v)
Corroded, cracked, bent, worn, or improperly applied end connections.

1910.179(m)(1)(vi)
Severe kinking, crushing, cutting, or un-stranding

1910.179(m)(2)
Other ropes
All rope which has been idle for a period of a month or more due to shutdown or storage of a crane on which it is installed shall be given a thorough inspection before it is used. This inspection shall be for all types of deterioration and shall be performed by an appointed person whose approval shall be required for further use of the rope. A certification record shall be available for inspection which includes the date of inspection, the signature of the person who performed the inspection and an identifier for the rope which was inspected.

1910.179(n)
Handling the load

1910.179(n)(1)
Size of load
The crane shall not be loaded beyond its rated load except for test purposes as provided in paragraph (k) of this section.

1910.179(n)(2)
Attaching the load

1910.179(n)(2)(i)
The hoist chain or hoist rope shall be free from kinks or twists and shall not be wrapped around the load.

1910.179(n)(2)(ii)
The load shall be attached to the load block hook by means of slings or other approved devices.

1910.179(n)(2)(iii)
Care shall be taken to make certain that the sling clears all obstacles.

1910.179(n)(3)
Moving the load

1910.179(n)(3)(i)
The load shall be well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

1910.179(n)(3)(ii)
Before starting to hoist the following conditions shall be noted:

1910.179(n)(3)(ii)(a)
Hoist rope shall not be kinked.

1910.179(n)(3)(ii)(b)
Multiple part lines shall not be twisted around each other.

1910.179(n)(3)(ii)(c)
The hook shall be brought over the load in such a manner as to prevent swinging.

1910.179(n)(3)(iii)
During hoisting care shall be taken that:

1910.179(n)(3)(iii)(a)
There is no sudden acceleration or deceleration of the moving load.

1910.179(n)(3)(iii)(b)
The load does not contact any obstructions.

1910.179(n)(3)(iv)
Cranes shall not be used for side pulls except when specifically authorized by a responsible person who has determined that the stability of the crane is not thereby endangered and that various parts of the crane will not be overstressed.

1910.179(n)(3)(v)
While any employee is on the load or hook, there shall be no hoisting, lowering, or traveling.

1910.179(n)(3)(vi)
The employer shall require that the operator avoid carrying loads over people.

1910.179(n)(3)(vii)
The operator shall test the brakes each time a load approaching the rated load is handled. The brakes shall be tested by raising the load a few inches and applying the brakes.

1910.179(n)(3)(viii)
The load shall not be lowered below the point where less than two full wraps of rope remain on the hoisting drum.

1910.179(n)(3)(ix)
When two or more cranes are used to lift a load one qualified responsible person shall be in charge of the operation. He shall analyze the operation and instruct all personnel involved in the proper positioning, rigging of the load, and the movements to be made.

1910.179(n)(3)(x)
The employer shall insure that the operator does not leave his position at the controls while the load is suspended.

1910.179(n)(3)(xi)
When starting the bridge and when the load or hook approaches near or over personnel, the warning signal shall be sounded.

1910.179(n)(4)
Hoist limit switch.

1910.179(n)(4)(i)
At the beginning of each operator's shift, the upper limit switch of each hoist shall be tried out under no load. Extreme care shall be exercised; the block shall be "inched" into the limit or run in at slow speed. If the switch does not operate properly, the appointed person shall be immediately notified.

1910.179(n)(4)(ii)
The hoist limit switch which controls the upper limit of travel of the load block shall never be used as an operating control.

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HYBRID

National Aeronautics and
Space Administration

May 9, 2002

STANDARD FOR
LIFTING DEVICES AND EQUIPMENT

NASA TECHNICAL STANDARD

STANDARD FOR LIFTING DEVICES AND EQUIPMENT

1. SCOPE

1.1 Scope. This standard applies to overhead and gantry cranes (including top running monorail, underhung, and jib cranes) mobile cranes, derricks, hoists, winches, special hoist supported personnel lifting devices, hydra-sets, load measuring devices, hooks, slings and rigging, mobile aerial platforms, powered industrial trucks, and jacks. This document does not include coverage for front-end loaders and elevators.

1.2 Purpose. This standard establishes NASA's minimum requirements for the design, testing, inspection, maintenance, personnel certification, and operation of lifting devices and equipment (LDE) described in paragraph 1.1.

1.3 Applicability. Compliance with this standard is mandatory for all NASA-owned and NASA contractor-supplied equipment used in support of NASA operations at NASA installations and NASA operations in host countries. The individual installation Lifting Devices and Equipment Manager (LDEM) and safety organizations are responsible for implementation and enforcement. This document establishes minimum requirements; NASA installations should assess their individual programs and develop additional requirements as needed. The need for compliance with this standard at contractor installations performing NASA work should be evaluated and made a contractual requirement where deemed necessary by the contracting officer and the responsible NASA installation/program safety office. Rented or leased LDE is exempt from this standard only by the decision of the contracting officer, the responsible NASA installation/program safety office, and the LDEM. If determined that rented or leased LDE will be used for a critical lift, this standard applies.

1.3.1 The testing, inspection, maintenance, operational, and operator and rigger certification/recertification/licensing requirements apply to new and existing lifting devices and equipment.

1.3.2 The design/hardware requirements contained in this document are applicable to new lifting devices/equipment purchased after 6 months from the issue date of this document. Existing equipment and that purchased during the first 6 months from issue of this document shall be reviewed for compliance with all design/hardware aspects of this standard within 12 months of its issue and the need to update such equipment shall be evaluated.

1.3.3 Deviations/waivers from the requirements of this document (including design/hardware requirements for both new and existing equipment) shall be approved as outlined in paragraph 1.7. The deviation/waiver documentation shall include any alternate or special criteria or procedures that will be imposed to ensure safe design and operations for those devices that do not meet the applicable requirements.

1.3.4 Portions of this standard refer to various national consensus codes/standards for equipment design/hardware requirements (e.g., ASME, CMAA, etc.). Lifting devices and equipment purchased after the initial review required in paragraph 1.3.2 shall comply with the specified codes/standards in effect at the time of manufacture. Each installation shall periodically review subsequent codes/standards and evaluate the need to update existing equipment. Based on an evaluation of NASA's overall safe lifting program and any significant changes in the consensus codes/standards, the NASA Safety and Risk Management Division with concurrence from the field installations shall decide when the next complete review (as described in paragraph 1.3.2) is warranted.

1.4 Relation to Occupational and Safety Health Administration (OSHA) Requirements. This document is not a substitute for OSHA requirements. OSHA requirements apply to all NASA operations. This document meets or exceeds Federal OSHA requirements. Some States have their own OSHA programs that must comply with Federal OSHA and may be stricter. All NASA installations are responsible for keeping up to date with the Federal and State OSHA requirements that apply to their operations. This standard contains some OSHA requirements where deemed necessary to stress the importance of the requirement, clarify the requirement, document interpretation of the requirement, and/or define NASA's program for meeting the requirement. The NASA Safety and Risk Management Division, with assistance from the field installations, shall monitor subsequent OSHA requirements for any impact on NASA's safe lifting program.

1.5 Critical and Noncritical Lifting Operations. There are two categories of lifting operations for the purposes of this standard, critical and noncritical.

1.5.1 Critical lifts are lifts where failure/loss of control could result in loss of life, loss of or damage to flight hardware, or a lift involving special high dollar items, such as spacecraft, one-of-a-kind articles, or major facility components, whose loss would have serious programmatic or institutional impact. Critical lifts also include the lifting of personnel with a crane, lifts where personnel are required to work under a suspended load, and operations with special personnel and equipment safety concerns beyond normal lifting hazards. Personnel shall not be located under suspended or moving loads unless the operation adheres to the OSHA-approved NASA Alternate Standard for Suspended Load Operations (see Appendix A). Lifting of personnel with a crane shall be in accordance with 29 CFR 1926.550 (see Appendix C).

a. Each installation or program shall develop a process to identify critical lifting operations and lifting devices/equipment that must meet critical lift requirements. Input shall be gathered from facility, program, user, and assurance personnel. The results of the process shall be documented and approved, as a minimum, by the installation LDEM.

b. It is NASA policy that the comprehensive safeguards outlined in this standard be provided for critical lifting operations. This includes special design features, maintenance, inspection, and test intervals for the lifting devices/equipment used to make critical lifts.

c. Specific written procedures shall be prepared and followed for all critical lifts.

d. During critical lifts there shall be one person present (NASA or contractor) that is designated as responsible for the safety of the operations. That person may be a safety professional, a supervisor, an engineer, or a task leader.

1.5.2 Noncritical lifts typically involve routine lifting operations and are governed by standard industry rules and practices except as supplemented with unique NASA testing, operations, maintenance, inspection, and personnel licensing requirements contained in this standard.

1.5.3 The requirements for critical and noncritical lifts outlined in this standard shall be followed unless a specific deviation/waiver is approved as outlined in paragraph 1.7. Different levels of risks associated shall be evaluated using the risk determination criteria in NPG 8715.3.

1.6 Recordkeeping and Trend Analysis. A data collection system shall be established at each installation or location to support NASA-wide lifting device trend and data analysis. Data entered locally would typically be associated with type and manufacturer of the equipment, age, maintenance history, operational problems and their corrective actions, lifting mishaps, safety notices, inspection discrepancies, waivers, and proof and load test results.

1.7 Safety Variances.

1.7.1 If a mandatory requirement cannot be met, a safety variance shall be prepared in accordance with NPG 8715.3.

1.7.2 The NASA variance process does not apply to Federal and applicable State/local regulations (e.g., OSHA, Cal OSHA). Any variance of a Federal or State/local regulation must be approved by the appropriate Federal/State/local agency (e.g., NASA Alternate Safety Standard for Suspended Load Operations approved by OSHA). The NASA Safety and Risk Management Division shall review all proposed safety variances of Federal regulations before submittal for approval.

1.7.3 Example: A variance request to a requirement in this standard that uses the word shall would be routed through the Center Safety Director for concurrence and approved or denied by the Center Director. A copy would then be sent to the NASA Safety and Risk Management Division within 14 days along with detailed rationale for its approval and other documentation.

1.8 Lifting Devices and Equipment Committee.

1.8.1 NASA LDE Committee. Each installation Director shall designate in writing at least one person and an alternate, with appropriate background in lifting devices, lifting operations, lifting equipment industry standards and an understanding of lifting safety, as the installation LDEM, to participate as a member of the NASA LDE Committee. The committee is chaired by the Director, Safety and Risk Management Division, or designee, and is responsible for reviewing proposed changes to this standard and addressing general LDE safety issues. The LDEM is responsible for overall management of the installation LDE program, coordinating with appropriate personnel at their installation on lifting issues and providing the NASA LDE Committee with their installation's position on LDE issues.

1.8.2 Installation LDE Committee. Each installation shall establish a LDE Committee, to ensure this standard is understood and applied across other organizations at the installation and to resolve any issues and provide a forum to exchange information. The Installation LDE Committee shall be chaired by the LDEM, with representation from all organizations at the installation that are responsible for and/or involved with LDE.

1.9 Personnel Performing Nondestructive Testing. Personnel performing lifting devices and equipment nondestructive testing (NDT), including visual inspections, shall be qualified and certified in accordance with written practices meeting the requirements contained in American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

2. APPLICABLE DOCUMENTS

2.1 General. The applicable documents cited in this standard are listed in this section for reference only. The specified technical requirements listed in the body of this document must be met whether or not the source document is listed in this section.

2.2 Government Documents.

2.2.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issuances in effect on date of invitation for bids or request for proposal shall apply.

DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910, Subpart I, Personal Protective Equipment.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.29, Manually Propelled Mobile Ladder Stands and Scaffolds (Towers).

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.67, Vehicle-Mounted Elevating and Rotating Work Platforms.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.178, Powered Industrial Trucks.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.179, Overhead and Gantry Cranes.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.180, Crawler, Locomotive, and Truck Cranes.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.181, Derricks.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.184, Slings.

OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1926.550, Cranes and Derricks.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA Specifications Kept Intact (SPECSINTACT), Standard Construction Specification System.

NASA SPECSINTACT, Section 14370, Monorails and Hoists.

NASA SPECSINTACT, Section 14380, Electric Overhead Cranes.

(Copies of OSHA standards are available at: http://www.osha.gov/comp-links.html, copies of NASA Standards are available at http://standards.nasa.gov.)

2.2.2 Other Government Documents, Drawings, and Publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issuances in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA Procedures and Guidelines 8715.3, NASA Safety Manual.

NASA Procedures and Guidelines 8820.2C, Facility Project Implementation Handbook.

(Copies of NASA directives are available at http://nodis.hq.nasa.gov/Welcome.html.)

2.3 Non-Government Publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issuances in effect on date of invitation for bids or request for proposals shall apply.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC.

“Manual of Steel Construction,” 400 North Michigan Avenue, Chicago, Illinois 60611.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING

SNC-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME), AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.22, Safety Requirements for Rope Guided and Nonguided Worker’s Hoists.

ANSI/SIA A92.2, Vehicle Mounted Elevating and Rotating Aerial Devices.

ANSI/SIA A92.3, Manually Propelled Elevating Aerial Platforms.

ANSI/SIA A92.5, Boom Supported Elevating Work Platforms.

ANSI/SIA A92.6, Self Propelled Elevating Work Platforms.

ANSI/ISA S84.01, Electrical, Electronic, Programmable Electronic Systems in Safety Applications.

ASME B30.1, Jacks.

ASME B30.2, Overhead and Gantry Cranes.

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, Handlings Loads Suspended from Rotorcraft.

ASME B30.14, Side Boom Tractors.

ASME B30.16, Overhead Hoists.

ASME B30.17, Overhead and Gantry Cranes.

ASME B30.19, Cableways.

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

ASME B30.21, Manually Lever Operated Hoists.

ASME B30.22, Articulating Boom Cranes.

ASME B30.23, Personnel Lifting Systems.

ASME B56.1, Safety Standard for Low Lift and High Lift Trucks.

ASME HST-1, Performance Standard for Electric Chain Hoists.

ASME HST-2, Performance Standard for Hand Chain Manually Operated Chain Hoists.

ASME HST-3, Performance Standard for Manually Lever Operated Chain Hoists.

ASME HST-4, Performance Standard for Overhead Electric Wire Rope Hoists.

ASME HST-5, Performance Standard for Air Chain Hoists.

ASME HST-6, Performance Standard for Air Wire Rope Hoists.

AMERICAN WELDING SOCIETY

D1.1, Structural Welding and Cutting Code.

D1.2, Structural Welding Code – Aluminum.

D14.1, Specifications for Welding Industrial and Mill Cranes.

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA Specification No. 70, Specifications for Electric Overhead Traveling Cranes.

CMAA Specification No. 74, Specification for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA No. 70, National Electric Code.

POWER CRANE AND SHOVEL ASSOCIATION (PCSA)

PCSA, Standards No. 4 and No. 5.

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J765, Crane Load Stability Test Code.

WIRE ROPE TECHNICAL BOARD

Wire Rope Users Manual

Wire Rope Sling Users Manual

2.4 Order of Precedence. Where this document is adopted or imposed by contract on a program or project, the technical guidelines of this document take precedence, in the case of conflict, over the technical guidelines cited in other referenced documents.

3. DEFINITIONS AND ACRONYMS

3.1 Definitions Used in this Standard

3.1.1 Brake: A device used for retarding or stopping motion.

3.1.2 Certification: That situation when the lifting device or equipment maintenance, test, or other operational checks have been performed and are current.

3.1.3 Control Braking Means: A method of controlling speed by removing energy from the moving body or by imparting energy in the opposite direction.

3.1.4 Crane: A machine for lifting and lowering a load and moving it horizontally, with the hoisting mechanism an integral part of the machine.

3.1.5 Critical Lift: A lift where failure/loss of control could result in loss of life, loss of or damage to flight hardware, or a lift involving special, high dollar items, such as spacecraft, one-of-a-kind articles, or major facility components, whose loss would have serious programmatic or institutional impact. Critical lifts also include the lifting of personnel with a crane, lifts where personnel are required to work under a suspended load, and operations with special personnel and equipment safety concerns beyond normal lifting hazards.

3.1.6 Critical Weld: A weld where the single failure of which could result in injury to personnel or damage to property or flight hardware by dropping or losing control of the load.

3.1.7 Derrick: An apparatus with a mast or member held at the head by guys or braces, with or without a boom and that uses a hoisting mechanism and operating ropes for lifting or lowering a load.

3.1.8 Designated Person: Any person who has been selected or assigned (in writing) by the responsible NASA organizational element or the using contractor as being qualified to perform specific duties. A licensed operator may serve as a designated person for the equipment he/she is licensed to operate.

3.1.9 Design Load: The value used by the manufacturer as the maximum load around which the device or equipment is designed and built based on specified design factors and limits. This is also the load referred to as the "Manufacturer's Rated Load."

3.1.10 Design Factor: A numeric term that is broadly used. It is usually expressed as a ratio of the ultimate stress, or yield stress, to the capacity of a component, or to the service load, or its rated capacity. It is also used or includes factors in calculations to quantify variations found in the properties of materials, manufacturing tolerances, operating conditions, and design assumptions.

3.1.11 Design Safety Factor: See Design Factor.

3.1.12 Deviation: A variance that authorizes departure from a particular safety requirement that does not strictly apply or where the intent of the requirement is being met through alternate means that provide an equivalent level of safety with no additional risk.

3.1.13 Dummy Load: A test load, to simulate the real load; typically a test weight.

3.1.14 Eddy Current Brake (control braking means): A method of controlling or reducing speed by means of an electrical induction load brake.

3.1.15 Emergency Stop (E-Stop): A manually operated switch or valve to cut off electric power or control fluid power independently of the regular operating controls.

3.1.16 Failure Modes and Effects Analysis (FMEA): A systematic, methodical analysis performed to identify and document all identifiable failure modes at a prescribed level and to specify the resultant effect of the modes of failure.

3.1.17 Frequently: For the purpose of this document, the term "frequently" is used to mean once or more per year.

3.1.18 Hazard: Any real or potential condition that can cause injury or death to personnel, or damage to or loss of equipment or property.

3.1.19 Hoist: A machinery unit device used for lifting and lowering a load.

3.1.20 Hoist Supported Personnel Lifting Device: Lifting equipment such as a platform, bucket, or cage supported by hoist(s) that is designed, built, tested, maintained, inspected, and certified as having sufficient reliability for safely lifting and lowering personnel.

3.1.21 Holding Brake: A brake that automatically prevents motion when power is off.

3.1.22 Hydra-set: Trade name for a closed circuit hydraulically operated instrument installed between hook and payload that allows precise control of lifting operations and provides an indication of the applied load. It will be used in the general sense in this standard as a means of identifying precision load positioning devices.

3.1.23 Idle Lifting Device: Lifting device that has no projected use for the next 12 months.

3.1.24 Infrequently: For the purpose of this document, the term "infrequently" is used to mean less than once per year.

3.1.25 Jack: A mechanism with a base and load point designed for controlled linear movement.

3.1.26 Licensed Operator: Any person who has successfully completed the examination for crane, hoist, or heavy equipment operator and has been authorized to operate such equipment. (NOTE: This term includes certified and/or authorized operator.)

3.1.27 Lifting Devices and Equipment: Devices such as overhead and gantry cranes (including top running monorail, underhung, and jib cranes), mobile cranes, derricks, hoists, winches, special hoist supported personnel lifting devices, hydra-sets, load measuring devices, hooks, slings and rigging, mobile aerial platforms, powered industrial trucks, and jacks used for lifting and lowering.

3.1.28 Lifting Devices and Equipment Manager (LDEM): Person responsible for overall management of the installation lifting devices and equipment program, coordinating with appropriate personnel at their installation on lifting issues and providing their installation's position on lifting devices and equipment safety issues.

3.1.29 Linear Fiber Sling: A sling where load bearing fibers are bundled in a linear fashion.

3.1.30 Load: The total load, including the sling or structural sling, below the hoisting device hook, being raised or moved.

3.1.31 Load Measuring Device: A measuring device below the hook that is part of the load path for lifting operations.

3.1.32 Mobile Aerial Platform: A mobile device that has an adjustable position platform, supported from ground level by a structure.

3.1.33 NASA Operation: Any activity or process that is under NASA direct control or includes major NASA involvement.

3.1.34 Noncritical Lift: A lift involving routine lifting operations governed by standard industry rules and practices except as supplemented with unique NASA testing, operations, maintenance, inspection, and personnel licensing requirements contained in this standard.

3.1.35 Nondestructive Testing (NDT): The development and application of technical methods to examine materials or components in ways that do not impair future usefulness and serviceability in order to detect, locate, measure, and evaluate flaws; to assess integrity, properties, and composition; and to measure geometrical characteristics.

3.1.36 Operational or Working Load: A value representing the weight of the load actually being handled plus the weight of the attaching equipment (slings, Hydra-set, spreader bars, etc.).

3.1.37 Operational Test: A test to determine if the equipment (limit switches, emergency stop controls, brakes, etc.) is functioning properly.

3.1.38 Payload: The actual object, below the sling or structural sling, being raised or moved.

3.1.39 Periodic Load Test: A load test performed at predetermined intervals with load greater than or equal to the rated load, but less than the proof load.

3.1.40 Personnel Certification: A means to assure an individual is qualified to perform a designated task.

3.1.41 Personnel Lift: For the purposes of this document, a working platform that will lift, lower, sustain, and transport people.

3.1.42 Platform Hoist: A dedicated hoist whose only purpose is to raise and lower a platform not carrying personnel.

3.1.43 Proof Load: The specific load or weight applied in performance of a proof load test and is greater than the rated load.

3.1.44 Proof Load Test: A load test performed prior to first use, after major modification of the load path or at other prescribed times. This test verifies material strength, construction, and workmanship and uses a load greater than the rated load. Proof load test, as used in this standard, is equivalent to the OSHA rated load test.

3.1.45 Rated Load or Safe Working Load or Rated Capacity: An assigned weight that is the maximum load the device or equipment shall operationally handle and maintain. This value is marked on the device indicating maximum working capacity. This is also the load referred to as “safe working load” or “working load limit.” If the device has never been downrated or uprated, this also is the “manufacturer’s rated load.”

3.1.46 Regular Service Lifting Device: Lifting device that is being used one or more times per month.

3.1.47 Remote Emergency Stop (Remote E-Stop): An emergency stop remotely located from the regular operator controls.

3.1.48 Side Pull: That portion of the hoist pull acting horizontally when the hoist lines are not operating vertically.

3.1.49 Side Load: A load applied at an angle to the vertical plane of the hoist line.

3.1.50 Single Failure Point: A single item or component whose failure would cause an undesired event such as dropping a load or loss of control.

3.1.51 Shall: The word “shall” indicates that the rule is mandatory and must be followed.

3.1.52 Should: The word “should” indicates that the rule is a recommendation, the advisability of which depends on the facts in each situation.

3.1.53 Sling: A lifting assembly and associated hardware used between the actual object being lifted and hoisting device hook.

3.1.54 Special Hoist Supported Personnel Lifting Device: Device specifically designed to lift and lower persons via a hoist. These devices include hoist supported platforms where personnel occupy the platform during movement. These devices do not including elevators, lifting personnel with a crane, mobile aerial platforms, or platforms or others items hoisted unoccupied to a position and anchored or restrained to a stationary structure before personnel occupy the platform.

3.1.55 Standby Lifting Device: Lifting device that is not in regular service but used occasionally or intermittently as required. Intermittent use is defined as a lifting device which has not been used for a period of one month or more, but less than 6 months.

3.1.56 Structural Sling: A rigid or semi-rigid fixture that is used between the actual object being lifted and hoisting device hook. Examples are spreader bars, equalizer bars, and lifting beams.

3.1.57 Surface Nondestructive Testing: Test and inspection methods used to examine the surface of equipment/materials; e.g., magnetic particle and liquid penetrant.

3.1.58 Tagline: A line used to restrain or control undesirable motion of a suspended load.

3.1.59 Valley Break: A broken wire in a wire rope in which the outside wire of a strand breaks in the immediate vicinity of the point where it contacts a wire or wires of an adjacent strand, generally at a point not visible when the wire rope is examined externally. One end of the broken wire is long enough to reach from one valley to the next one and the other end of the broken wire generally cannot be seen.

3.1.60 Variance: Documented and approved permission to perform some act contrary to established requirements.

3.1.61 Volumetric Nondestructive Testing: Test and inspection methods used to examine the interior of equipment/materials; e.g., ultrasonic and radiographic.

3.1.62 Waiver: A variance that authorizes departure from a specific safety requirement, where a special level of risk has been documented and accepted.

3.1.63 Winch: A stationary motor-driven or hand-powered hoisting machine having a drum around which is wound a rope, chain, or web used for lifting and lowering a load (does not apply to winches used for horizontal pulls).

3.1.64 Wire Rope Slings: Wire ropes made into forms, with or without fittings, for handling loads and so made as to permit the attachment of an operating rope.

3.1.65 Working Load: If the device has never been downrated or uprated, this also is the "manufacturer's rated load."

3.2 Abbreviations and Acronyms Used in this Standard

3.2.1	AC	Alternating Current
3.2.2	AGMA	American Gear Manufacturers Association
3.2.3	ANSI	American National Standards Institute
3.2.4	ASME	American Society of Mechanical Engineers
3.2.5	cm	centimeter
3.2.6	CMAA	Crane Manufacturers Association of America, Inc.
3.2.7	DC	Direct Current
3.2.8	FMEA	Failure Modes and Effects Analysis
3.2.9	km/hr	kilometer/hour
3.2.10	LDEM	Lifting Device and Equipment Manager
3.2.11	m	meter
3.2.12	mm	millimeter
3.2.13	mph	mile/hour

3.2.14 NEMA National Electrical Manufacturers Association

3.2.15 NFPA National Fire Protection Association

3.2.16 NPG NASA Procedures and Guidelines

3.2.17 OEM Original Equipment Manufacturer

3.2.18 OSHA Occupational Safety and Health Administration

3.2.19 O&SHA Operating and Support Hazard Analysis

3.2.20 PCSA Power Crane and Shovel Association

3.2.21 RCM Reliability Centered Maintenance

3.2.22 SPECSINTACT Specifications Kept Intact

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Section 4
Overhead Cranes

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4.6 **Personnel Certification.**

4.6.1 Program.

Only certified (licensed) and trained operators shall be authorized to use/ operate cranes. A Training, examination, and licensing program shall be established or made available. For those NASA installations that do not have a training program, all crane operators shall be trained and certified by a recognized crane certification organization that normally performs this function. The operator certification program will be reviewed at least annually to assure that the contents, training material, testing, and examination elements are up-to-date with current methods and techniques; and that any “lessons-learned” are adequately addressed. Riggers (see Section 10) and personnel performing NDT (see paragraph 1.9) shall be certified in their discipline. Training shall be provided to observers and flagmen. All participants in the lifting operation shall have clearly defined roles and responsibilities.

4.6.2 Levels.

Two levels of operator training and proficiency will be established. Operations where critical lifts are involved will require a more rigid operator certification program than those operations that involve more routine lifts that do not involve critical hardware or unique hazards.

a. Noncritical Lifts. The certification program for noncritical lift operators shall include the following:

(1) Training

(a) Classroom training in safety, lifting equipment emergency procedures, general performance standards, requirements, preoperational checks, and safety-related defects and symptoms (for initial certification and as needed).

(b) Hands-on training (for initial certification and as needed).

(c) An annual review of the items in paragraph 4.6.2.a (1) above. (This may be conducted informally by local supervisory personnel.)

(2) Examination

a. Physical examination (criteria to be determined by the cognizant medical official and should comply with ASME B30.2).

b. Written examination

c. Operational demonstration (for initial certification only).

d. Proficiency examination for recertification.

(3) Licensing/Operator Certification

(a) An organizational element shall be designated to issue operator licenses/operator certification. Provisions shall be made to revoke licenses for negligence, violations of safety requirements, or failure to meet medical standards. Provisions shall be made for periodic checks of operators to verify they have licenses in their possession. The licenses shall indicate the type of crane the holder is qualified to operate. Alternately, the organizational element may elect to maintain a master list of licensed operators instead of issuing individual licenses, providing copies of the list are readily available to assurance and supervisory personnel at the work site.

(b) Renewal of all licenses shall require demonstration of proficiency or approval of supervision that proficiency is adequate and current. Licenses or certifications will expire at least every 4 years. Renewal procedures will be established by each licensing organization but, as a minimum, will include items in paragraphs 4.6.2.a.(1) and 4.6.2.a.(2).

c. Critical Lifts. Besides the training, examination, licensing, and renewal requirements for noncritical lifts, operators that are being certified to perform critical lifts must be trained in the specific hazards and special procedures associated with the lift. Operators also must demonstrate proficiency and operating finesse with the crane using a test load as appropriate for the initial certification or alternately be directly supervised by a certified operator during the first initial lifting period. The licenses will indicate specific cranes for which the operator is certified.

4.7 Operations.

Cranes shall be operated according to this section, the manufacturers' recommendations, and ASME B30.2. The following practices shall be followed for crane operations:

a. General operating procedures describing crane operation, emergency steps, communication requirements, and special requirements including checklists and inspection requirements shall be prepared, approved, and followed for each crane. There must be a formal system for review, approval, and update to maintain valid operating procedures. Emergency procedures shall be developed for contingency actions such as power loss, brake failure, or other emergencies (also, see paragraph 1.5.1.c).

b. Operations shall be analyzed for hazards. The analysis shall consider the environment in which the operation occurs, hazards associated with crane maintenance, and, in general, a safety analysis of the equipment, facility, load, human factors, and interfaces as a whole in support of the lifting operation.

c. Methods and procedures shall be developed for lowering a load in the event of crane failure or other contingencies. These should be demonstrated and verified if practical.

d. A crane shall not be loaded beyond its rated load (capacity) except for required testing.

e. Cranes shall not be used to load test items such as slings, platforms, or lifting fixtures unless specifically identified to do so based on a specified percentage of rated load, and a safety analysis approved by the LDEM and the responsible safety, engineering, operations, and maintenance organizations. Test procedures shall be approved by the responsible safety, engineering, operations, and maintenance organizations. This is to ensure that the crane is not damaged due to sudden unloading should the test article fail. Appendix D, crane/hoist requirements to load test other lifting equipment, shall be followed.

f. Cranes shall not be used for side pulls unless specifically designed to do so.

g. There shall be a system for documenting crane problems/discrepancies. Prior to an operation, the operator shall review any previously noted problems/discrepancies to determine possible impact on planned activity.

h. The operator shall ensure that the crane is within inspection and testing intervals by examination of the periodic recertification test tags and/or documentation. The operator shall adhere to all tags placed on the crane controls.

i. Before each lift or series of lifts, the operator shall perform a preoperational check to demonstrate operational readiness. If controls do not operate properly, the operator is responsible for notifying the supervisor. Repairs and adjustments shall be made before operations begin.

j. The operator shall establish safety zones before initiating operations. Safety zones should have appropriate barriers (rope, cones, or other) established prior to lift. Personnel on the crane should be minimized during crane movement. Any personnel on the crane shall be made aware of and avoid pinch points at their respective location.

k. Before each lift or series of lifts, the operator shall functionally test proper operation of the upper limit switch with no load on the hook. Upper limit switches shall not be used as operating controls.

l. Before starting to hoist, the following conditions shall be noted: the hoist rope shall not be kinked, multiple part ropes shall not be twisted around each other, and the hook shall be centered over the load in such a manner as to prevent swinging or side pulls.

m. The operator shall know the weight of the working load. When raising loads that approach 75% of the rated capacity of the crane, the operator shall test the holding brakes. The brakes shall be tested by raising the load minimally above the surface and holding the load with the brake. The load should be held long enough to allow any dynamics to dampen out.

n. If radio communications are to be used, operators and/or lift supervisors shall test the communication system prior to each operation. Operations shall stop immediately upon communication loss and shall not continue until communication is restored.

o. If hand signals are required, only standard signals shall be used according to Appendix B. Hand signals shall be posted in a conspicuous location.

p. Crane crew emergency egress routes should be verified to be free of obstructions prior to hazardous operations. The availability of crane crew protective equipment should be verified prior to hazardous operations.

q. If there is a slack rope condition, it shall be determined that the rope is properly seated on the drum and in the sheaves before starting the hoist.

r. During hoisting, care shall be taken that there is no sudden acceleration or deceleration of the moving load and that the load does not contact any obstructions.

s. Loads shall be secured, balanced, and controlled with proper slings. The use of tag lines to keep the load stabilized shall be required whenever load swinging is anticipated to be a viable hazard. Tag line personnel shall take care not to impart undesirable motion to the load.

t. Person(s) shall not ride the hook or load at anytime. If conventional means of reaching a worksite such as an aerial platform, ladder, stairs, or scaffold would be more hazardous or not possible because of structural design or worksite conditions, 29 CFR 1926.550 and ASME B30.23 shall be followed for lifting of personnel with a crane, which is considered a critical lift (see Appendix C).

u. Personnel shall not be located under suspended or moving loads unless the operation adheres to the OSHA-approved NASA Alternate Standard for Suspended Load Operations (see Appendix A).

v. The load shall not be lowered below the point where less than two full wraps of rope remain on the hoist drum.

w. A responsible person shall be in charge of the operation and shall instruct all personnel involved in the proper positioning, rigging, and moving to be done.

x. An operator shall be at the crane controls at all times while a load is suspended (OSHA requirement). Due to the length of some NASA operations, an operator change may be required while a load is suspended. This shall be accomplished via a procedure designed for the specific crane and operation, ensuring that the crane controls are manned at all times.

y. Hands shall be free from encumbrances while personnel are using crane ladders. Articles that are too large to be carried in pockets or belts shall be lifted and lowered by hand line.

z. Necessary clothing and personal belongings in crane cab shall be stored so as not to interfere with access or operations. Tools, oil can, waste, extra fuses, and other necessary articles shall be stored properly and shall not be permitted to lie loose in the cab or on the crane. Operators shall be familiar with the operation and care of the fire extinguisher provided.

aa. Crane crew discipline shall be maintained at all times during a crane operation. There shall be no eating, drinking, or rowdiness during crane operation.

ab. Outdoor hoisting operations should not commence if winds are above 20 knots (23 mph, 37 km/hr) steady state or if gusts exceed 35 knots (40 mph, 65 km/hr). Consideration shall also be given to sail area and weather conditions such as lightning or snow before commencing operations.

ac. A carbon dioxide, dry chemical or equivalent fire extinguisher shall be kept in the cab or in the immediately available vicinity of the crane.

ad. Wire rope should be used in accordance with the Wire Rope Users Manual.

4.8 Special Criteria.

4.8.1 Handling Explosives or Electro-Explosive Devices (EED's). Special precautions shall be taken while handling explosives or EED's.
a. DOT-packaged explosives shall be handled in accordance with approved hazardous operating procedures. Barricades and warning signs shall be erected to control access.

b. Explosives and EED's that are not within DOT-approved containers shall be handled in accordance with approved hazardous operations procedures. In addition to system configuration controls, these procedures shall ensure the following requirements are met:

(1) Voltage checks on crane hooks that will handle explosives or EED's shall be performed prior to the start of operations; all crane motions shall be checked.

(2) For static sensitive systems, the crane hook shall be connected to facility ground before connecting to explosives or EED's. Electrical grounding of the hook and load shall be accomplished prior to lifting operations. If a ground connection must be disconnected to facilitate operations, an alternate ground should be connected prior to disconnecting the existing ground. The final attachment/detachment must be at least 10 feet (3 m) from exposed propellant grain, explosives, or EED's.

(3) The danger potential for radio transmissions near explosives shall be evaluated prior to the operation.

(4) Personnel limits, protective clothing, warning signs and barricades shall be used as required.

(5) Safety surveillance requirements shall be followed.

4.8.2

Policy shall be developed and enforced for crane operation during electrical storms. Operations are generally permitted without restriction within enclosed metal or framed buildings that are properly grounded. Restrictions are necessary for outside operations or for those that cannot tolerate power failure/loss.

Goddard Procedural Requirement

GPR 8834.1B

Lifting Operations Requirements

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Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	GPR 8834.1B	**APPROVED BY Signature:**	***Original signed by Arthur F. Obenschain for***
EFFECTIVE DATE:	September 29, 2009	**NAME:**	Robert Strain
EXPIRATION DATE:	September 29, 2014	**TITLE:**	Director

COMPLIANCE IS MANDATORY

Responsible Office: 540/Mechanical Systems Division

Title: Lifting Operations Requirements

TABLE OF CONTENTS

PREFACE

P.1 PURPOSE

The purpose of this GPR is to define the process, requirements, and responsibilities for conducting safe lifting operations at Goddard Space Flight Center (GSFC).

P.2 APPLICABILITY

a. This directive is applicable to all operations associated with Lifting Devices and Equipment (LDE), including rented or leased LDE and LDE provided by on-site Support Services Contractors to the extent provided in their contracts, at Greenbelt, Wallops Flight Facility (WFF), and other areas under GSFC cognizance unless specifically excluded by this directive. It also applies to institutional lifts and manual lifts.

b. This directive does not apply to tenants and their contract personnel operating in facilities exclusively used for non-NASA operations and controlled by the tenant under a Center-level agreement provided NASA personnel are not placed at risk.

c. When invoked as a contractual requirement by the applicable project, this directive is applicable to the extent specified in the contract for off-site contractor installations supporting GSFC activities.

d. Lifting operations under privatization clauses shall be subjected to the provisions of this directive to the extent provided by the contract, and the requirements shall be clearly specified therein.

e. The responsible Contracting Officer and the Project Manager shall apply requirements of this directive to any contractor, tenant, or customer if non-NASA lifting operations place NASA personnel, facilities, or equipment at risk.

f. This directive does not apply to contractor lifting operations using contractor-provided LDE which are exclusively associated with facility construction activities where the activities take place exclusively within an area to which access by the general population of NASA employees is excluded.

P.3 AUTHORITY

NASA-STD-8719.9, Standard for Lifting Devices and Equipment

P.4 REFERENCES

a. NPR 8715.3, NASA General Safety Program Requirements
b. GPR 1400.1 Waiver Processing
c. GPR 1410.2, Configuration Management
d. GPR 5330.1, Product Processing, Inspection and Test
e. GPR 8621.1, Reporting of Mishaps and Close Calls
f. GPR 8719.1, Certification and Recertification of Lifting Devices and Equipment
g. GSFC WM-001, Workmanship Manual for Electrostatic Discharge (ESD) Control
h. GSFC Form 23-60, Task Safety Analysis Worksheet
i. NASA-STD-8719.9, Standard for Lifting Devices and Equipment
j. Department of Health and Human Services (DHHS)/National Institute for Occupational Safety and Health (NIOSH) Publication No. 94-110, Applications Manual for the Revised NIOSH Lifting Equation
k. OSHA 1910.135 (a)(1), Head Protection
l. ASME B30.23, Personnel Lifting Systems

P.5 CANCELLATION

GPR 8834.1A, Lifting Operations Requirements

P.6 SAFETY

Safety requirements are described throughout this GPR.

P.7 TRAINING

Supervisors shall ensure that:

a. Personnel involved in manual lifts are trained or briefed on proper lifting techniques;
b. All individuals designated to participate in a lifting operation are qualified to perform their role safely and effectively, based on training, prior experience, and physical ability to do the operation. This includes designated observers, safety representatives, LDE operators, communicators, and all other participants; and

c. LDE Operators are trained and certified in accordance with GPR 8719.1 for the type of lifting operations required, and that training and certifications are current.

P.8 RECORDS

Record Title	Record Custodian	Retention
Critical Lift Procedure(s)	Project Office	* NRRS 8/103: Temporary. Destroy/delete between 5 and 30 years after program/project termination.
Completed checklists	Project Office	* NRRS 8/103
Stress/Stability Analyses	Project Office	* NRRS 8/103
Variances/Waivers	Project Office	* NRRS 8/103
User documents (e.g., technical interface information, analyses, problem records, and other relevant lift-specific information	Project Office	* NRRS 8/103
Audit results (see P.9 Metrics) and corrective actions	Applicable Safety Office	* NRRS 8/103
RECERT follow-up actions to metrics	RECERT	* NRRS 8/103

**NRRS – NASA Records Retention Schedules (NPR 1441.1)*

Contractors generating records as required by this procedure shall retain the records and turn them over to NASA as specified in the contract.

P.9 METRICS

Safety organizations shall, on an annual basis, audit an appropriate number of executed lift procedures (and associated documentation) of different projects and activities under their cognizance for compliance with this Directive. Each applicable safety office shall determine which procedures to audit, such that the audit results will, in their judgment, give good representation of typical lift activities. Audit results shall be analyzed by the safety organization for continual improvement. Corrective actions shall be implemented by the affected project/organization, and tracked to closure by the safety organization. Audit results shall be submitted to the Recertification Program (RECERT) Manager for appropriate follow up actions, such as trend analysis, lessons learned dissemination, and directive revision.

P.10 DEFINITIONS

Most of the terms used in this directive are defined in NPR 8715.3, NASA-STD-8719.9, and GPR 8719.1. Those that are unique or essential to this directive are listed below.

a. Certified – An individual who has documented evidence that he/she has completed required training, and has specific knowledge or proficiency in a skill that has been demonstrated, documented, and approved by an accepted authority. Certification expires after a specified time period and must be renewed to remain current. Certification, in the context of this GPR, requires approval by the RECERT Manager.

b. Critical Hardware – Hardware whose loss would have serious programmatic or institutional impact, and has been identified by the directorate, or project as being critical.

c. Critical Lift Coordinator (CLC) – An individual who is assigned to direct and give instructions to the crane operator during critical crane operations due to specific project requirements, and who has obtained the necessary training and is certified by the RECERT Manager. The CLC is an optional position, used only when a project desires to have its own lifting expert. The role of the CLC shall be specified in the Critical Lift Procedure.

d. Critical Lift Procedure – A specific step-by-step procedure to be followed by the lift team to perform a Critical Lift operation. The procedure also defines the roles and responsibilities of all lift team members, and pertinent items to be verified prior to the lift. See Section 3.3.

e. Customer – A non-NASA, government or private sector entity or organization that owns, sponsors, or otherwise champions a project brought onto GSFC property by a current NASA contractor exercising a contractual provision permitting such an arrangement for the purposes of utilizing NASA facilities and/or test equipment on a lease or rental basis.

f. Flight Hardware – Hardware designed and fabricated for ultimate use in a vehicle intended to fly.

g. Hazardous Operating Procedures (HOP) – Detailed, documented procedures listing step-by-step functions or tasks to be performed on a system or equipment to ensure safe and efficient operations. A HOP may address such topics as special precautions, start and stop times or conditions, necessary sequences of steps, approving official(s), etc.

h. Institutional Lift – A lift performed as part of the day-to-day operations of the Center, such as lifting a section of pipe or moving a pallet of office supplies. It is not a manual lift, although a manual lift may be included as part of an institutional lift. NOTE: an Institutional Lift can also be classified as "critical," depending on the hardware involved.

i. LDE Certification – The documented status of LDE that a set of requirements have been and continues to be met. As used in this GPR, certification and recertification is a process performed by the RECERT Manager that leads to the initial, or continuation of, certification that LDE is safe to use within specific certification parameters, and includes, but is not limited to, LDE compliance and documentation reviews, tests, inspections, nondestructive testing, and analyses.

j. LDE Operator Certification – The documented status of LDE operators validating that they are trained and qualified in accordance with NASA-STD-8719.9 and GPR 8719.1, and certified by the RECERT Manager at Greenbelt or the Deputy RECERT Manager at Wallops.

k. Lift Analysis – Analysis performed to determine the maximum load the LDE is expected to experience during the worst case lift.

l. Lift Categories – The category of lifting operations determines the number and qualifications of personnel involved, documentation requirements, and safety requirements. The following categories of lifts are addressed:

   (1) Critical Lift – A lift where failure/loss of control could result in loss of life, loss of or damage to critical hardware, or other items such as spacecraft, one-of-a-kind articles, or major facility components whose loss would have serious programmatic or institutional impact. Operations involving the lifting of personnel with a crane, and lifts where personnel are required to work under a suspended load, shall always be defined as critical lifts (see NASA-STD-8719.9). Operations with special personnel and equipment safety concerns beyond normal lifting hazards shall also be designated as critical. See Appendix C for a "Process for Lifting Category Determination."

   (2) Non-Critical Lift – A lift involving routine lifting operations governed by standard industry rules and practices except as supplemented with unique NASA testing, operations, maintenance, inspection, and personnel licensing requirements contained in NASA-STD-8719.9 and this directive.

m. Lifting Devices and Equipment (LDE) – The collective term that includes both Lifting Devices (LD) and Lifting Equipment (LE). LDs are machines such as overhead and gantry cranes (including top running, monorail, underhung, and jib cranes), mobile cranes, derricks, gantries, hoists, winches, special hoist-supported personnel lifting devices, Hydra Sets, mobile aerial platforms, powered industrial trucks, and jacks. LE includes the slings and sling assemblies, strongbacks, shackles, load-measuring devices, and hardware components used to attach the load(s) to the lifting device(s).

n. Manual Lift – A lift where a person lifts, holds, and/or moves an item.

o. Mechanical Lift – A lift that employs the use of equipment (e.g., crane, chain fall, fork lift, etc.) to raise, lower, or move loads.

p. Off Load Operation with Constraints (OLOC) – A handling operation where LDE is used to relieve a portion of the weight of a constrained load, i.e., a piece of hardware or an item to be lifted, due to the impossibility of safe blocking or support of the load from the ground or floor. An example would be off-loading the weight of a piece of hardware attached to a handling/holding fixture (i.e., constrained) prior to releasing the attachment fasteners. See Section 2.6, Special Requirements for OLOC.

q. Person in Charge (PIC) – The individual designated by the Lifting Service User to be in charge of the operation.

r. Personal Protective Equipment PPE) – Safety equipment such as hard hats, goggles, steel-toed shoes, etc.

s. Pre-lift Briefing – A briefing of involved personnel held prior to the commencement of a critical lift or other designated lift.

t. RECERT – An established GSFC process that provides certification and recertification expertise, management, and oversight for lifting devices and equipment at GSFC or by GSFC contractors (see P.2). The RECERT manager has overall responsibility for RECERT functions. The processes of certification/recertification of LDE and operators are described in GPR 8719.1.

u. Rigger – An individual who selects and attaches lifting equipment to an item to be lifted. At GSFC, a rigger is a certified LDE operator.

v. Safety Representative – An individual who is selected to make judgments concerning personnel, equipment, or systems safety. The safety representative shall be qualified on the basis of a certificate, professional standing, and/or demonstrated competence in the types of lifts they take part in. The Safety Representative shall be selected by mutual agreement of the Lifting Service Provider (LSP) and User, who together determine the necessary qualifications for the assigned task. The applicable safety organization (Safety and Environmental Division, Systems Reliability and Safety Office, or the Wallops Safety Office) shall concur with or deny the selected Safety Representative.

w. Tenant – A non-NASA entity or organization that has obtained GSFC's permission to reside on Center. The entity or organization has total control of, and responsibility for, its own operations and activities within the agreed-upon boundaries, as long as NASA personnel or property are not put at risk.

x. Waiver/Variance – Written authorization to depart from a specific requirement.

P.11 ACRONYMS

ASME	American Society of Mechanical Engineers
CLC	Critical Lift Coordinator
CG	Center of Gravity
CMS	Constant Micro Speed
DHHS	Department of Health and Human Services
DOT	Department of Transportation
EED	Electro-Explosive Device
ESD	Electrostatic Discharge
FOM	Facility Operations Manager

GSFC	Goddard Space Flight Center
HOP	Hazardous Operating Procedures
LD	Lifting Device
LDE	Lifting Devices and Equipment
LE	Lifting Equipment
LSP	Lifting Service Provider
NIOSH	National Institute for Occupational Safety and Health
OEM	Original Equipment Manufacturer
OLOC	Off Load Operation with Constraints
OSHA	Occupational Safety and Health Administration
PIC	Person In Charge
PPE	Personal Protective Equipment
QA	Quality Assurance
RECERT	Recertification Program
SWL	Safe Working Load
WFF	Wallops Flight Facility
WOA	Work Order Authorization

PROCEDURES

In this document, a requirement is identified by "shall," a good practice by "should," permission by "may" or "can," expectation by "will" and descriptive material by "is."

This directive establishes GSFC requirements for lifting operations. It complements NASA-STD-8719.9 to ensure the safety of all personnel and equipment involved in lifting operations at all levels of complexity.

For use at a contractor's facility, the requirements of this directive may be tailored and reissued as a project document and controlled in accordance with GPR 1410.2, and invoked in the applicable contract(s).

1.0 RESPONSIBILITIES

1.1 Lifting Service Provider (LSP)

The LSP is the organization that provides a lifting service to a user, and is usually the owner/operator of the facility where the lift service is performed. The LSP may provide their own LDE and/or operators, or task supporting organizations or contractors to provide LDE and/or operators. The LSP shall be responsible for the following:

a. Verifying that LDE operators and supporting personnel are properly designated, authorized, trained, and certified (see GPR 8719.1) at the time lifting operations are performed;
b. Verifying that lift procedures and checklists, when needed (see Section 3.1), are available and understood for lifting operations;

c. Verifying that deficient LDE or other lifting equipment that is removed from service is locked out or tagged out-of-service, and that RECERT is promptly notified;
d. Coordinating outages for load testing and inspections of lifting devices with RECERT to minimize conflicts with ongoing operations;
e. Providing lifting devices and/or lifting equipment, when requested by the Lifting Service User, appropriate for the lifting operation, i.e., certified for critical (and non-critical) lifts, or certified for non-critical lifts only;
f. Notifying the Facility Operations Manager (FOM) of any operations that may have unusual hazards or safety implications (see 1.11); and
g. Safe conduct of all lifting operations.

For **Critical Lifts**, the LSP shall also:

h. Provide expert advice and assistance on lifting operations;
i. Support the User in developing the Critical Lift Procedure(s) for User equipment;
j. Support the User in developing variance requests, when required;
k. Verify that all required LDE and associated tools are available, in correct operating condition, and certified as required;
l. Review and verify lift and critical lift procedures with the User prior to the lift operation; and
m. Certify, to the User, that all above requirements have been met prior to the lift operation.

1.2 Lifting Service User

The Lifting Service User (hereinafter referred to as “User”) is the Program or Project Manager or their Representative that is the owner of the hardware being lifted or handled. The User is ultimately responsible for their hardware, and therefore has key responsibilities in the lifting operations. Users shall coordinate closely with the LSP for the conduct of lifting operations that affect their hardware.

Many Users are flight projects that use special lifting devices or fixtures and require specialized engineering support. They may provide their own lifting equipment and/or operators, or task supporting organizations or contractors to provide equipment and/or operators.

Users shall be responsible for the following for all lifting operations of their hardware:

a. Providing input to the RECERT Manager to identify the category of lifts for their hardware, i.e., critical or non-critical, so that compliance requirements for lifting operations can be established. Appendix C “Process for Lifting Category Determination” shall be used for this determination and input shall be obtained from the LSP, the applicable safety organization(s), and facility personnel (if appropriate);
b. Selecting LDE for a lift based upon the maximum load it would experience in the worst case scenario during the lift;
c. Developing or verifying availability of lifting procedures and HOPs that address the safety of their personnel and hardware (see Section 3.1). For lifting or handling equipment not covered by NASA-

STD-8719.9, consult and follow the equipment manufacturers' recommendations with documented concurrence from the applicable safety representative;

d. Designating a Person In Charge with the responsibilities described in 1.4 below;
e. Developing and approving Critical Lift Procedure(s) prior to beginning lift operations, and concurring with changes during the lift;
f. Verifying that the LSP's LDE and operators have current certifications as required by GPR 8719.1 for the type of lifting operations required;
g. Verifying that all applicable safety analyses (e.g., stability analysis, lift analysis, etc.) or assessments are completed and are sufficient per the requirements of NASA-STD-8719.9, and that lift points are above the established Center of Gravity (CG);
h. Initiating a Waiver/Variance request if any NASA or GSFC safety requirements are not met, in accordance with NPR 8715.3 or GPR 1400.1 as applicable;
i. Providing engineering support as needed by the LSP for User hardware;
j. Providing for appropriate Safety Representative support as described in Section 1.5;
k. Providing Work Order Authorization(s) (WOAs) as required by GPR 5330.1;
l. Notifying the FOM of any operations that may have unusual hazards or safety implications (see 1.11);
m. Stopping lifting operations in the event of an actual or reported failure or unsafe condition;
n. Providing concurrence to resume operations once failures or unsafe conditions are corrected;
o. Determining the applicability of NASA-STD-8719.9 and this procedure to off-site contractors, and ensure that sufficient requirements are invoked in the contracts; and
p. The safe conduct of all lifting operations.

1.3 Person In Charge (PIC)

The PIC shall take overall responsibility for the conduct of the lifting operation. The PIC shall be from the User organization or the LSP, and may be an I&T Manager, Lead Engineer, LDE Operator, the Rigger, a Critical Lift Coordinator (CLC), supervisor, or any other individual selected and specified in the critical lift or other applicable procedure. The PIC shall:

a. Verify that all involved parties meet the lift requirements;
b. Verify that all tools and equipment are adequate for the lift requirements;
c. Fill out Appendix C "Process for Lifting Category Determination";
d. For any critical lift, or for any lift determined by the LSP or User to need a pre-lift briefing and walk-through, conduct a pre-lift briefing/walk-through with all required participants. See Section 2.3;
e. Verify that adequate communications and direction are available, particularly for the LDE operator(s); and
f. Manage the lifting operation.

1.4 Safety Representative(s)

The qualified safety representative(s) shall be responsible for the following:

a. Maintaining qualification in terms of competence, experience, training, etc.;

b. Verifying that all applicable safety analyses or assessments are completed in accordance with requirements of NASA-STD-8719.9;
c. Advising all personnel involved in the lifting operations of any additional hazard(s) and appropriate methods of hazard control prior to and throughout the entire lifting operation;
d. Verifying that Incident/Mishap Reports are initiated and submitted in accordance with this document and the requirements of GPR 8621.1;
e. Providing input to the User organization to identify the lifting operations as critical or non-critical;
f. Reviewing and approving all critical lift procedures, HOPs, and WOAs pertaining to critical lifting operations;
g. Ensuring appropriate hazard controls have been addressed in the HOPs and/or WOAs;
h. Ensuring that the lifting operation adheres to this directive and all applicable NASA, Occupational Safety and Health Administration (OSHA), and processing facility safety regulations (where appropriate);
i. Providing concurrence to proceed with a hazardous lifting operation and, upon completion, concurrence to open the controlled area and resume normal operations; and
j. Reviewing and concurring with/denying project-initiated safety waiver/variance requests (see NPR 8715.3 or GPR 1400.1) prior to submittal to the RECERT Manager.

1.5 Lift Team Members

Lift team members shall:

a. Participate in Pre-Lift Briefings as described in Section 2.3;
b. Understand their roles and the roles of other lift team members for a given operation;
c. Ensure that they fully understand all applicable procedures and safety requirements; and
d. Wear the appropriate Personal Protective Equipment (PPE).

1.6 Office of System Safety and Mission Assurance at Greenbelt and the Safety Office at Wallops

The Office of System Safety and Mission Assurance at Greenbelt and the Safety Office at Wallops shall:

a. Audit executed lift procedures and associated documentation as specified in Section P.9;
b. Concur with/deny Waiver/Variance requests submitted; and
c. Concur with/deny selected Safety Representative.

1.7 Safety and Environmental Division at Greenbelt and the Safety Office at Wallops

The Safety and Environmental Division at Greenbelt and the Safety Office at Wallops shall:

a. Provide oversight for Center industrial or institutional lifting operations for compliance with GSFC, NASA, and OSHA requirements;
b. Monitor compliance of institutional lifting operations and operators to the requirements herein;
c. Monitor compliance to institutional safety requirements;

d. Audit executed lift procedures and associated documentation as specified in Section P.9;
e. Concur with/deny Waiver/Variance requests submitted; and
f. Concur with/deny selected Safety Representative.

1.8 RECERT Manager

The RECERT Manager shall, in addition to the responsibilities described in GPR 8719.1, be responsible for:

a. All RECERT functions described herein;
b. Reviewing results of executed lift procedure audits by the safety offices, and implementing appropriate follow-up actions as required by Section P.9;
c. Reviewing and concurring or denying safety waiver/variance requests prior to the originator's submittal to other appropriate authorities and Center Director for approval; and
d. Receiving input from facility, program, user, and safety assurance personnel regarding the lifting operation to identify the category of a lift as either critical or non-critical.

1.9 Deputy RECERT Manager.

The Deputy RECERT Manager shall serve as the RECERT Manager's alternate and represent the RECERT Manager at WFF for day-to-day operations by performing the duties in Section 1.9.

1.10 Building Facility Operations Manager (FOM).

FOMs are responsible for notifying building occupants of potential safety hazards in and around facilities under their cognizance. When notified by the LSP or User of a lifting operation with unusual hazards or safety implications (i.e., potential to affect occupants beyond the immediate lift area), he/she shall review the proposed lifting operation(s) and concur prior to commencing the lifting operation(s).

1.11 Certified Critical Lift Coordinator (CLC).

CLCs shall be responsible for:

a. Maintaining a current certification as required by GPR 8719.1;
b. Coordinating the preparation and execution of the lift(s) with the PIC; and
c. When indicated in the Critical Lift Procedure, directing and commanding the lifting operation for their organization's hardware.

2.0 REQUIREMENTS

2.1 General Requirements for All Lifting Operations

2.1.1 Prior to any lifting operation:

a. The LDE operator shall:

(1) Inspect all LDE in accordance with NASA-STD-8719.9, manufacturers recommendations, and GSFC procedures;
(2) Verify appropriate PPE (e.g., hard hats, eye protection, etc.) are available and used properly; and
(3) Verify the load's weight and the location of the CG.

b. The PIC shall:

(1) Analyze the lift for all unmitigated hazards, including lift stability. For non-hazardous mechanical lifts, a Job Hazards Analysis or checklist may be used to document hazards in lieu of a lift stability analysis; GSFC Form 23-60 may be used to satisfy this requirement. For routine hazardous lifts, a one-time analysis can be done where risk mitigation controls are written into a standard procedure for the operation;
(2) Verify that the operational requirements for the type of lifting devices and/or equipment being used comply with NASA-STD-8719.9;
(3) Verify that all LDE are certified as described in GPR 8719.1 for the category of lift to be performed; and
(4) Verify that all operators and riggers involved in the lift are certified for the category of lift to be performed.

2.1.2 Suspended load operations

Suspended load operations, as defined in NASA-STD-8719.9, are discouraged at GSFC. However, if a suspended load operation cannot be avoided, the operation shall comply with NASA-STD-8719.9, Appendix A, "NASA Alternate Standard for Suspended Load Operations." Prior to any suspended load operation, the User shall prepare analysis documentation of the operation (see NASA-STD-8719.9) and submit it to the RECERT Manager for concurrence. The RECERT Manager shall, in turn, consult with the NASA HQ Office of Safety and Mission Assurance per HQ requirements.

2.1.3 Loads Containing Components Sensitive to Electrostatic Discharge (ESD)

The User shall be responsible for ESD protection of the load. The User shall address and coordinate ESD protection with the LSP to ensure that the ESD requirements of the load are fully understood and protective measures are taken. If special handling requirements are needed to ensure ESD protection, they shall be addressed in documented procedures (see Section 3.1). Procedures shall address and comply with the requirements of NASA-STD-8719.9 and GSFC WM-001.

2.1.4 Loads Containing Explosives or Electro-Explosive Devices (EEDs)

The User shall be responsible for all lifting operations involving loads containing explosives or EEDs. Such lifts shall be classified as critical unless a documented risk assessment is performed that indicates otherwise and is concurred by responsible user management and the applicable safety representative. If it is indicated as non-critical, it shall be classified as hazardous.

2.1.5 Loads Containing Pressurized Containers

The User shall be responsible for all lifting operations involving loads containing pressurized containers which do not conform to the Department of Transportation (DOT) or the American Society of Mechanical Engineers (ASME) requirements. Such lifts shall be classified as critical unless a documented risk assessment is performed that indicates otherwise and is concurred to by responsible user management and the applicable safety representative. If it is indicated as non-critical and the pressure containers do not conform to DOT or ASME requirements, it shall be classified as hazardous.

2.1.6 Loads Containing Hazardous Materials

The User shall be responsible for all lifting operations involving loads containing hazardous materials which are contained in containers which do not conform to DOT or ASME requirements or the hazardous material has been removed from the Original Equipment Manufacturer's (OEM) packaging. Such lifts shall be classified as critical unless a documented risk assessment is performed that indicates otherwise and is concurred to by responsible user management and the applicable safety representative. If it is indicated as non-critical and the containers do not conform to DOT or ASME requirements, or if the hazardous material has been removed from the OEM packaging, it shall be classified as hazardous.

2.1.7 Hazardous Lifting Operations

The User shall be responsible for all hazardous lifting operations. Hazardous lifting operations shall be conducted in accordance with the requirements of sections 3.8 and 7.4 of NPR 8715.3A.

2.1.9 Use of Hard Hats

In accordance with OSHA 1910.135 (a)(1), hard hats shall be worn when working in areas where there is a potential for injury to the head from falling objects. However, the use of hard hats may introduce risk of damage to the load from contact with a hard hat. The PIC shall examine each situation and ensure steps (e.g., chin straps or tethering) are taken to mitigate the risk.

2.2 Special Requirements for Critical Lifts

The requirements for critical lifts detailed in NASA-STD 8719.9 shall be followed in their entirety and Appendix C "Process for Lifting Category Determination" shall have been completed. The following specific requirements apply, whether the critical lift is project equipment or otherwise:

a. Prior to any critical lifting operations, the PIC shall:
   1) Verify that the LE is certified per GPR 8719.1 for critical lifts.
   2) Verify the weight and CG location to ensure that the payload maintains stability during the lift.
   3) Verify that the Critical Lift Procedures, including any required waivers/variances, are complete and approved as described in Section 3 herein.

4) Perform a pre-lift briefing (see Section 2.3 of the lift team) including the User's designated representatives, Safety Representatives, and others as appropriate to review the planned lifting operation.

b. The lifting procedure shall contain a tabulation of LDE, including slings, hoist rings, shackles, turnbuckles, spreader bars, lifting assemblies, Hydra Set, load-measuring devices, and any other hardware components used in the lifting operation. The following information shall be provided for each item attached in the load line: safe working load (SWL), expiration date, and RECERT control number;

c. Videotaping of the Critical Lift shall be the User's responsibility. Videotaping is encouraged but not mandatory;

d. A single person (NASA or contractor) shall be designated as responsible for the safety of the operation. This shall be the Safety Representative described in Section 1.5;

e. A Critical Lift shall not commence unless all team members required by the Critical Lift Procedure are present, on station, and have received the pre-lift briefing;

f. When so designated in the Critical Lift Procedure, CLCs shall be responsible for directing and giving commands to the LDE Operator during a lifting operation and;

(1) The CLC shall instruct all personnel involved in the proper preparation, lifting, and final positioning to be achieved, as a part of the pre-lift briefing.
(2) Coordination for directing the lifting operation shall be delineated in the Critical Lift Procedure and emphasized in the pre-lift briefing.
(3) Any transfer of responsibility for directing the lifting operation (e.g., from CLC to the rigger/crane operator or vice versa) shall be identified in the Critical Lift Procedure and emphasized in the pre-lift briefing.
(4) A CLC shall not perform rigging activities or hands-on operation of lifting devices.

Appendix A of this directive is a sample checklist for critical lifts.

2.3 Requirements for a Pre-Lift Briefing

A pre-lift briefing shall be performed whenever more than one person is involved in the activity, whenever a lift is considered critical, or whenever the PIC, a Safety Representative, or a supervisor in the LSP or User organization requests one. In these cases, the briefing shall be conducted, regardless of familiarization or experience of those performing the task or operation. The pre-lift briefing is generally useful for all but the most routine operations, and is primarily aimed at ensuring the safety and coordination of the personnel and equipment involved.

2.3.1 The PIC normally conducts the pre-lift briefing, although they may delegate this responsibility.

2.3.2 The pre-lift briefing shall be conducted prior to beginning lifting operations, and shall involve all personnel having a role in the operation. When Lift Team members arrive after the lift has begun, such as when a shift change occurs, the incoming personnel shall be sufficiently briefed to ensure that they fully understand their roles, the task(s) to be performed, and all relevant elements of the pre-lift briefing.

2.3.3 Prior to the Pre-Lift Briefing, the briefer shall:

a. Check weather forecast and/or storm code panel for adverse conditions that could potentially affect the lift;
b. Check LDE for proper criticality category and certification;
c. Check LDE log book(s) to verify that there are no outstanding deficiencies;
d. Verify that required lift procedures and WOAs have been approved and signed off with all required signatures;
e. Verify that any required lift stability analyses, HOPs, stress analyses, etc., are completed and available;
f. Verify that the CG and total weight of the load to be lifted are known and documented; and
g. Verify that all 2-way radios to be used during lifting operations are fully charged, functioning properly, and do not produce radio interference with other equipment in the vicinity.

2.3.4 At the Pre-Lift Briefing, the briefer shall:

a. Verify that all Lift Team members are present;
b. Verify that all Lift Team members understand their roles and responsibilities;
c. Perform a step-by-step review of the lifting operation;
d. Explain the hardware to be lifted, associated Ground Support Equipment, configuration of lifting equipment, and associated hazards;
e. Verify that all Lift Team members understand the PPE requirements and are prepared to meet them;
f. Review any applicable safety requirements or procedures; and
g. Emphasize that safety is the primary consideration during the lift.

2.4 Institutional Lifts

Institutional lifts are those lifts performed frequently and repetitively, often on a daily basis, and normally involve activities such as construction or maintenance, handling of shop materials, and other routine activities involved in the normal operation of the Center. In general, the LDE consists of cranes, forklifts, powered pallet jacks, and other material-handling equipment.

Supervisors shall require that LDE operators that perform institutional lifts are trained in the safe operation of the LDE in use, and certified or otherwise qualified as defined in GPR 8719.1. Supervisors shall also confirm that any special procedures necessary to protect personnel or high-value equipment are available and understood by operators.

If an institutional lift is determined to be a Critical Lift, Section 2.2 shall apply.

2.5 Manual Lifts

This section applies to those cases where one or more individuals manually supports or moves an object, with or without LDE. Manual lifts of small, lightweight critical items, such as circuit board panels, do not require all the safeguards described below. Other requirements may be determined by the supervisor or project manager. In such cases, supervisors or project managers shall be responsible to ensure that there is no compromise of safety to the personnel or equipment.

Manual lifts may range in complexity from handling a lightweight item of equipment to supporting an item of space flight hardware while LDE is repositioned. Operations as simple as helping someone move an item of office equipment are considered manual lifts.

2.5.1 The following safe lifting and handling load limits shall apply for each manual **critical** lift:

a. 35 lbs of manageable shape and size for one person;
b. 75 lbs of manageable shape and size for two people;
c. 100 lbs of manageable shape and size for three people;
d. No manual lift shall be performed for a load exceeding 100 lbs unless written concurrence from a qualified safety representative has been obtained; and
e. All lifts shall be within limits of comfortable balance and control.

Supervisors shall determine and document weight limits for manual **non-critical** lifts. In making this determination, supervisors shall consider the guidelines of DHHS (NIOSH) Publication No. 94-110, Applications Manual for the Revised NIOSH Lifting Equation.

2.5.2 The following rules shall apply whenever performing a manual lift. These rules may be tailored based on the situation, but shall not compromise personnel or equipment safety or permit undue risk.

a. Plan and walk through the entire lift prior to commencing the lifting operation;
b. Visually inspect the area to identify any tripping hazards and remove them, if possible, prior to starting. If a trip hazard cannot be moved prior to starting, a spotter shall be used to guide the individual(s) performing the lift when approaching the hazard;
c. Clear work area and translation path of personnel not involved in the lifting operation;
d. Pick up the load correctly to avoid injury. Minimize unnecessary bending, twisting, and lifting above the shoulders;
e. Make use of mechanical devices such as portable carts or dollies whenever possible. Inspect carts and dollies for any damage before use, and verify the device has a suitable load rating for the item to be moved;
f. Ensure that the item being lifted can be handled manually without injury to personnel or damage to the hardware and/or facility;
g. Ensure that a firm grip can be maintained from the beginning to the end of the lift;
h. Ensure that the load destination is clear of obstacles and provides a stable base to support the load;
i. When in doubt, STOP! Contact the appropriate safety representative or safety organization.

2.5.3 If a manual lift is considered complex, and high-value equipment and/or safety are at risk, a procedure and/or WOA shall be written and followed as required in Section 3. If the manual lift is considered a Critical Lift, Quality Assurance (QA) witnessing is required, but Safety witnessing is not. Manual lifts of small, lightweight critical items, such as circuit board panels, do not require QA or Safety witnessing.

2.6 Special Requirements for Off Load Operations with Constraints (OLOCs)

OLOCs (see Definitions P.10.p) present additional hazards to personnel and hardware and shall only be conducted when it is not possible to perform the same activity in a conventional, unconstrained manner. OLOCs shall be treated as critical lifts and shall comply with Section 2.2.

Since an OLOC is an unusual lift operation and poses additional risks to the hardware or item being handled, the Project Manager must assess, acknowledge and accept these risks before the operation is performed. A copy of this risk assessment shall be sent to the RECERT Manager for information purposes prior to performance of the OLOC.

An example of an OLOC (see Definitions P.10.p) would be off-loading the weight of a piece of hardware attached to a handling/holding fixture (i.e., constrained) prior to releasing the attachment fasteners. An OLOC must be treated as a critical lift and the total combined weight of the hardware handling/holding fixture, the hardware lifting equipment, and the hardware must be within the SWL of the LD (i.e., the crane or other facility equipment).

The following are additional requirements that shall apply to OLOCs to minimize the potential of hardware damage and/or exceeding the SWL of any LE or hardware component in the load path during the operation.

2.6.1 Two independent devices are required to measure the load and shall be monitored at all times by a member of the lift team other than the crane operator.

2.6.2 Crane hoist speed is absolutely critical for safe execution of the OLOC and must be able to be limited to .75 inches/minute. Thus cranes used for OLOC operations shall be equipped with a momentary ON button that controls the Constant Micro Speed (CMS) to this limit.

2.6.3 If proper CMS control is not available a Hydra Set shall be used for hoist operations. The User must be aware of potential Hydra Set issues such as hook height limitations, the lack of load release incremental control, and hydraulic fluid leaks.

2.6.4 If proper CMS control is not available and a Hydra Set cannot be used, the OLOC shall be engineered to provide another path to success – such as highly compliant LDE – and approached with extreme caution. Otherwise the OLOC must be abandoned.

2.6.5 Load measurement instrumentation configuration shall be documented in the procedure, including settings and a diagram of connections.

2.6.6 All equipment shall be used within the manufacture's specifications.

2.6.7 Personnel setting up, using, and monitoring the load measuring devices and Hydra Set shall be trained in the operation, use, and limitations of the equipment and shall be present during the operation.

2.6.8 Pre-Operation Checks

a. Perform an accuracy verification check on the load measuring devices within 24 hours of the lift by lifting a known weight.

b. Verify all settings and equipment configurations comply with the procedure.

c. Perform a load test verification check on the Hydra Set within 24 hours of the lift by lifting a known weight.

3. DOCUMENTATION REQUIREMENTS

3.1 Required Procedures

Documented procedures shall be prepared, when required, for lifting operations as defined below. Procedures shall not rely on personnel to stabilize or support any portion of a load that exceeds the manual lift limits in 2.5.1, even in conjunction with LDE.

a. Work Order Authorizations shall be processed and approved for project lifts as defined in GPR 5330.1.

b. Procedures for routine, non-critical lifts shall be available and may be generic and not lift-specific. The requirement may be satisfied by adherence to overall standards, generic lifting procedures, standard operating procedures, and/or original equipment manufacturer's operating instructions, augmented by operator training and certification.

c. Procedures for non-routine, non-critical lifts, such as a lift involving an unusually configured load with an off-center CG, shall require a stress/stability analysis and lift procedure prior to commencement of the lifting operation(s). The PIC shall determine the degree of detail and approvals required. Normally, these procedures may be similar to those described in 3.1.b, with additional detail added for non-routine situations.

d. HOPs shall be required for all operations involving unusual hazards. HOPs may be stand-alone or incorporated in the body of other procedures. HOPs shall comply with the requirements of NPR 8715.3.

e. Checklists are very effective, and their use is encouraged to supplement required procedures. Checklists for key items of LDE can reduce the work involved in producing procedures. A sample checklist for a critical lifting operation is given in Appendix A. A sample checklist for a non-critical lifting operation is given in Appendix B. Other checklists should list detailed steps in the operation. Appendix C "Process for Lifting Category Determination" is required when a decision concerning whether or not a lift is critical is to be made.

f. Institutional lift procedures are usually as described in 3.1.b and 3.1.c. Supervisors shall ensure that adequate procedures are available, and shall produce a lifting procedure and perform a pre-lift briefing for lifts having an unusual level of risk.

g. Critical Lift Procedures shall be developed for each critical lifting operation, except as provided in 2.5.

h. Waiver/variance Documentation shall be prepared and approved in accordance with GPR 1400.1 and NPR 8715.3.

The following table serves as a guideline for determining the need for lift procedures.

Criticality	Type	Description	Lift Procedure Needed?
Non-Critical	LDE	Simple or routine	No
Non-Critical	LDE	Non-routine or complex	Yes
Non-Critical	LDE	Institutional with no risks except those inherent in any lifting operation	No
Non-Critical	LDE	Institutional with risks in addition to those inherent in any lifting operation	Yes
Non-Critical	Manual	Simple	No
Non-Critical	Manual	Complex	Yes
Non-Critical	Manual	High dollar	Yes
Non-Critical	Manual	Safety risk	Yes
Critical	All	All (see 3.1.g)	Yes

3.2 Non-Critical Lift Procedures

Procedures, when required (see Section 3.1), shall be available for all LDE citing general operating instructions, operator certification or training requirements, equipment certification requirements, and other information needed to ensure safe performance of lifting operations. Procedures may be generic, and may apply to multiple types of lifts for a given facility or LDE. These procedures need not be lift-specific. They should be sufficient to ensure safe handling of lifted and lifting equipment, ensure operator safety, and minimize or eliminate risk (Ref: NASA-STD-8719.9).

3.3 Critical Lift Procedures

Critical Lift Procedures are the responsibility of the User. As a minimum, the Critical Lift Procedure shall be reviewed and approved by the LSP, User, Safety Representative, and the PIC before the lifting operation. The procedures shall address the following:

a. Description of the lift operation, location, and LDE to be used, including defining the safety keep-out zone for the operation;
b. Identification of lift team members, their roles, and responsibilities;
c. Degree and makeup of safety and mission assurance coverage;
d. Sequential operational requirements;
e. HOPs;
f. Checklists and other required documents;

g. Emergency and contingency procedures (e.g., fire, power outage, lifting during an electrical storm, outdoor lifts under windy conditions, etc.);
h. Special requirements for ESD, EEDs, and explosives;
i. PPE;
j. Contamination control requirements;
k. Stability analyses, stress analyses, variance(s) (if required), and any other analyses determined by the LSP or User to be needed before the lift;
l. Procedures for making and approving changes to the procedure after it has been approved;
m. Description of the means of communications to be used; and
n. Photo or videotape requirements.

3.4 Waiver/Variance Documentation

Safety waiver/variance Documentation, if needed, shall be prepared and approved in accordance with GPR 1400.1 and NPR 8715.3.

APPENDIX A
SAMPLE CHECKLIST
FOR CRITICAL LIFTING OPERATIONS

- ☐ 1. All Lift Team members are present.
- ☐ 2. The Lift Stability Analysis, Stress Analysis, and other required documentation are completed.
- ☐ 3. The Lift Procedure has been approved and has all required signatures.
- ☐ 4. The CG and total weight of load to be lifted are known and documented.
- ☐ 5. If 2-way radios are to be used, all units are fully charged, functioning properly, and do not produce radio interference with other equipment in the vicinity.
- ☐ 6. All team members are wearing appropriate PPE.
- ☐ 7. Weather forecast and/or storm code panel (if applicable) are checked for adverse conditions that could potentially affect the Lift.
- ☐ 8. LDE is certified for critical lifts.
- ☐ 9. The LDE Operator is certified for Critical Lifting.
- ☐ 10. The LDE Log Book indicates no outstanding deficiencies.
- ☐ 11. Conduct a Pre-Lift Briefing

______________________________________ ________________________

Signed by: Date

NOTE:

This is an example only. Developing custom checklists for lifts is encouraged because checklists aid in the planning process, they document that individual steps are taken, and they eliminate the possibility of omitting steps by mistake.

APPENDIX B
SAMPLE CHECKLIST
FOR NON-CRITICAL LIFTING OPERATIONS

☐ Determine whether the lift is simple or complex.

a. If the lift is simple and routine, the lift may be performed following industrial standards and practices, general guidelines, and operator training.

b. If the lift is complex and/or involves an unusual load configuration with an off-center CG, the PIC shall require that a stress/stability analysis and a lift procedure be developed and approved prior to the lifting operations. Also confirm the following, as appropriate:

- ☐ All Lift Team members are present.
- ☐ The Lift Procedure has been approved and signed off for all signature blocks.
- ☐ The required stress/stability analysis is completed.
- ☐ The CG and total weight of load are known and documented
- ☐ If 2-way radios are to be used, all units are fully charged, functioning properly, and do not produce radio interference with other equipment in the vicinity.
- ☐ Ensure that all Team members are wearing appropriate PPE.
- ☐ Check weather forecast and/or storm code panel (if applicable) for adverse conditions that could potentially affect the Lift.

☐ Check LDE for valid certification.
☐ Check LDE Log Book to ensure that there are no outstanding deficiencies.
☐ Verify that the LDE operator's certification is valid.

Signed by: ______________________ Date ______________

NOTE:

This is an example only. Developing custom checklists for lifts is encouraged because checklists aid in the planning process, they document that individual steps are taken, and they eliminate the possibility of omitting steps by mistake.

APPENDIX C

PROCESS
FOR LIFTING CATEGORY DETERMINATION (See Note 1)

PIC:
Date:
Project:
Organization:
Description of Lift:

For the Lift in Question	YES**
1. Will LDE failure/loss of control result in serious personnel injury or loss of life?	
2. Will LDE failure/loss of control result in damage or loss of program-critical flight hardware?	
3. Will LDE failure/loss of control result in damage or loss of one-of-a-kind articles?	
4. Will LDE failure/loss of control result in damage or loss of major facility components which will have serious institutional or programmatic impact?	
5. Will LDE failure/loss of control result in damage or loss of any article that could have serious programmatic or institutional impact?	
6. Are personnel being lifted with a crane? (see NASA-STD-8719.9, App. C & ASME B30.23)	
7. Are personnel required to work under a suspended load? (see NASA-STD-8719.9, App. A)	
8. Does the load contain explosives or EEDs ? (see 2.1.4 for exceptions)	
9. Does the load contain pressurized containers? (see 2.1.5 for exceptions)	
10. Does the load contain hazardous materials? (see 2.1.6 for exceptions)	
11. Is the lift an OLOC? (see 2.6 for explanation) – See Note 2.	
12. Are there any other personnel or equipment safety concerns that could be considered out of the ordinary?	

** If the answer to any of the questions listed above is "YES", the Lifting Operation must be declared a Critical Lift.

Concurrence: Program/Project Manager

Safety/Facilities Manager

Notes:
1. A signed copy of Appendix C shall be sent to the RECERT Manager.
2. A signed copy of the OLOC Risk Assessment shall be sent to the RECERT Manager.

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	8/8/2006	Initial Release
A	2/4/2008	Added new requirements for off-load operations with constraints, NASA document designation updates, variance processing, and other changes throughout for clarification. In P.2, clarified Applicability for contractors.
B	9/29/2009	Added Appendix C – Process for Lifting Category Determination, modified OLOC definition (P.10) and requirements (2.6), and other changes throughout for clarification.

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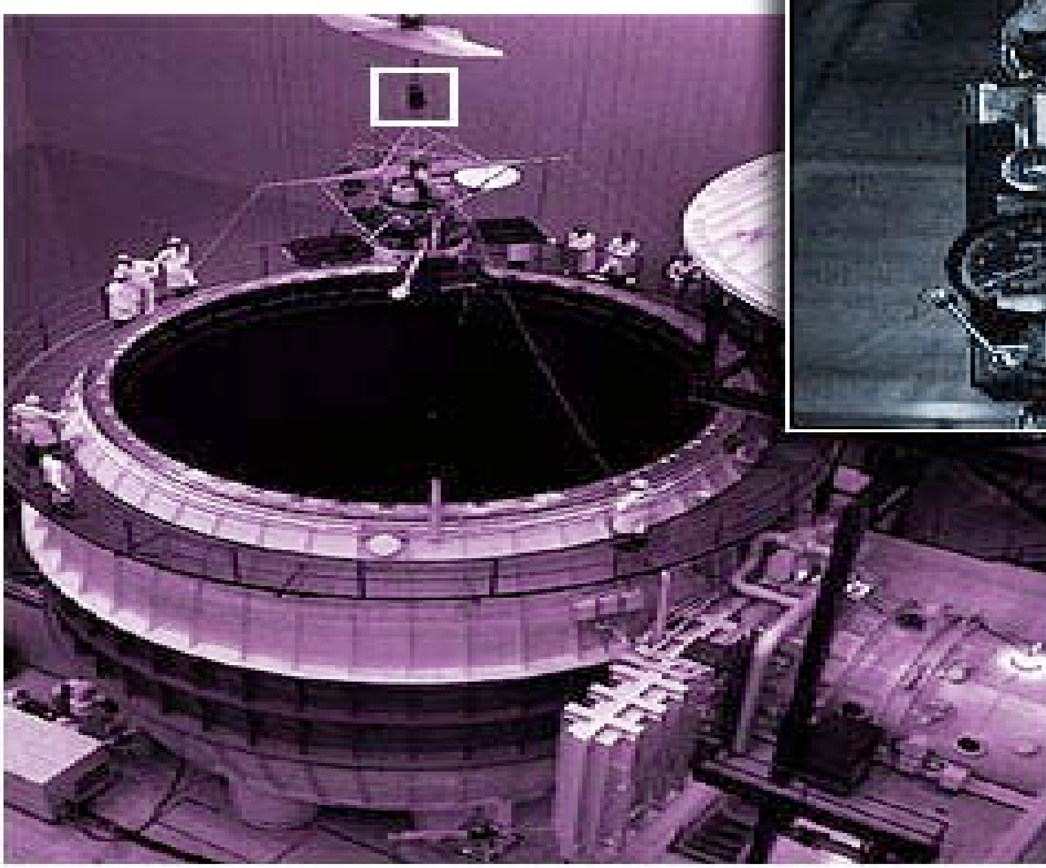
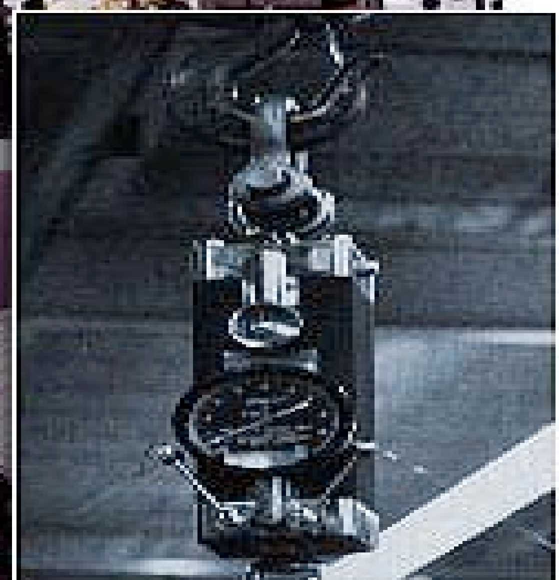
Hydra-Sets





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<u>HYDRA-SET</u>

1.0 The hydra-set is a precision positioning device that can be either manually or remotely operated.

1.1 It can be used for lifting or lowering;

1.1.A For example, to lift and relocate spacecraft equipment and spacecraft. Also, it can be used to mate/demate critical components.

1.2 It can be used as a shock absorber;

1.2.A For example, when using hydra-set to move from one location to another, it protects the item being moved from shocks created by the movement of the crane.

1.3 It can be used as a counterbalance device to suspend a load motionless until a slight force is applied.

1.3.A When positioning one item to be attached to another, the hydra-set, in a nulled position, allows this item to be raised or lowered small amounts with a slight physical effort.

1.4 It can be used as a servo-link to supply a constant strain to a load which is subject to ambient temperature changes.

1.5 It can be used as a nondestructive pull test vehicle, in either a vertical or horizontal direction.

2.0 Operation

2.1 Familiarize yourself with hydra-set to be used.

2.1.A Determine where all components are and what functions they control.

2.2 Perform preliminary checks prior to operation.

2.2.A Make sure you have the proper hydra-set for the lift.

2.2.B Check all components for certification; hoses, hydra-set, and lifting hardware.

2.2.C Be sure load is attached properly and securely.

2.3 Determine total weight of load, including lifting hardware.

2.4 Secure all components until needed for your lift, to prevent use prior to your lift.

2.1.5 Hydra-sets

2.1.5.1 Scope

This section covers Hydra-sets.

2.1.5.2 Acronyms/Definitions

1. Hydra-set—A manually operated hydraulic lifting device designed to incrementally lift and lower critical loads such as spaceflight hardware.
2. Hydra-set certification/recertification—A process performed by the RECERT Group which leads to the initial certification, or continuation of certification, validating that maintenance, test, or other operational checks have been performed and are current.
3. Hydra-set operator certification—The documented status of Hydra-set operators validating that they have been trained, and are qualified and medically fit to perform lifting and rigging operations in accordance with NASA-STD-8719.9 and certified by the RECERT Manager.

2.1.5.3 General

Hydra-sets should be used when there is a requirement for precise adjustment when lifting critical hardware and the crane is not capable of providing the precision required.

2.1.5.4 Design/Operational Requirements

1. Hydra-sets used for critical lifts shall have a 5:1 factor of safety, based on the ultimate strength for load-bearing elements.
2. The rated load shall be plainly marked on each Hydra-set.
3. Hydra-sets that have the necessary design features, maintenance/inspection, and test intervals to lift critical loads shall be conspicuously marked so that the operator and assurance personnel can distinguish that the Hydra-set is qualified for critical lift.
4. For best performance, select a Hydra-set so that the intended load is between 20% and 80% of the Hydra-set‘s capacity.
5. Exercise Hydra-Sets prior to critical lifts with a dummy load that is at least equivalent to the weight of the item to be lifted.
6. RECERT tags are issued and attached to certified/recertified equipment.
7. Only certified (licensed) operators are authorized to operate GSFC Hydra-sets. Training shall include the properties of Hydra-sets, operating procedures, hands-on training, and an operational demonstration.
8. RECERT Hydra-set checkout/return standing procedures must be followed, including completion of the Logbook.
9. Check all components for certifications: hoses, Hydra-set, and lifting hardware.

2.1.5.5 GSFC Contacts

See Section 2.1.1.5.

Hydra Set®
Model A
Auxiliary Hoist Control

Del Pub 81-1 Rev C

Operation and Maintenance Manual

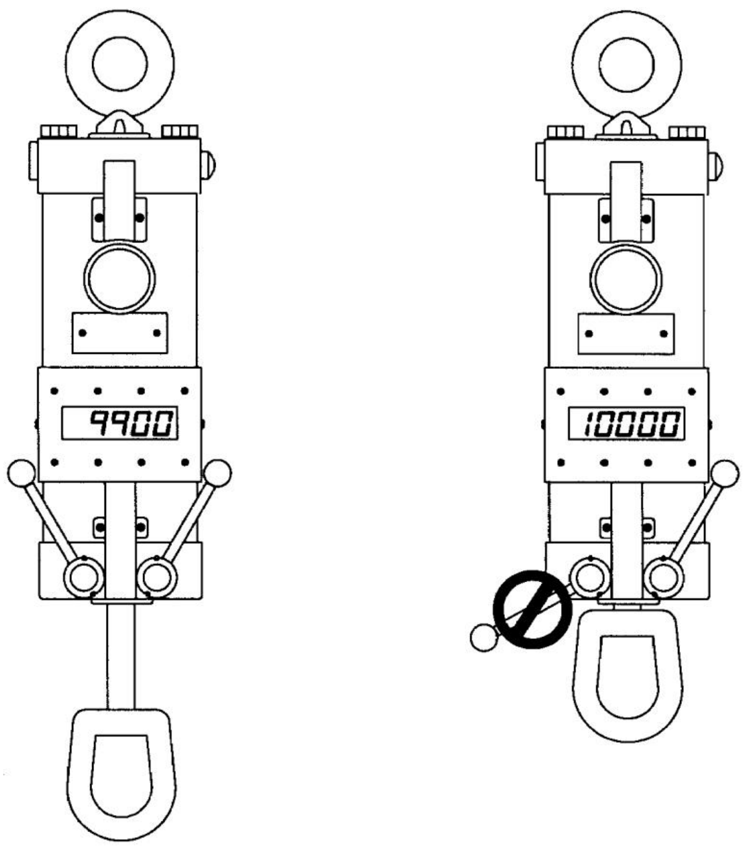
October 2004

DELMAR®

CAUTION

The LOAD GAUGE can be damaged by overloading. Use care in operating crane when using the Hydra Set® with load. Avoid jerking motions and sudden starts with crane. To protect LOAD GAUGE, avoid loads approaching 100% of Hydra Set capacity. Do not operate UP pump when Hydra Set piston is fully retracted

EXTENDED **RETRACTED**



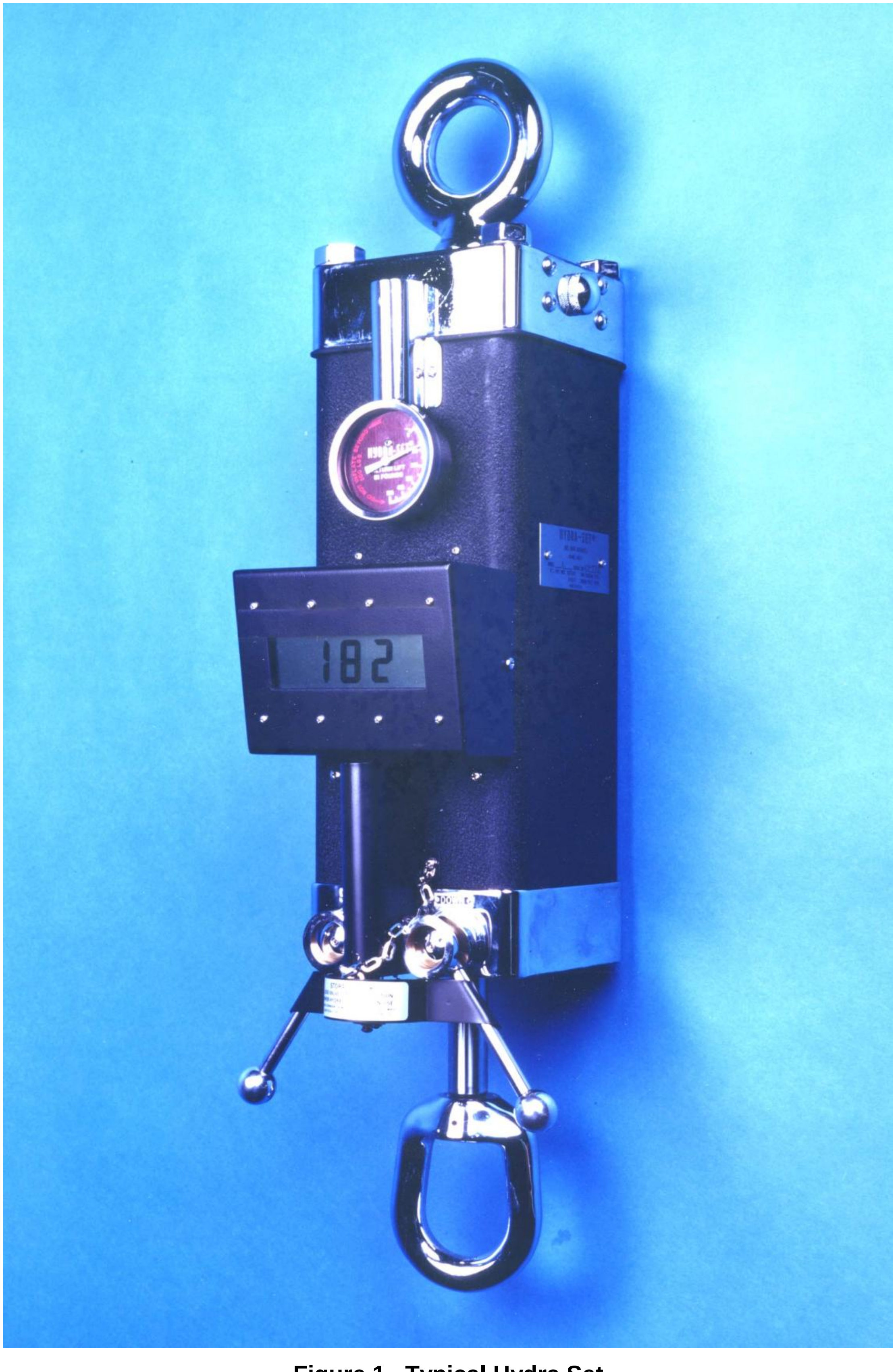


Figure 1. Typical Hydra Set

PRESSURIZING THE ACCUMULATOR

Pressurizing the accumulator provides required inlet pressure for the up pump, and return force to retract the piston rod under no load. The unit will close with slings and rigging that weigh no more than the weight indicated by the return force gauge.

The Hydra Set is shipped with the accumulator pressurized to approximately 100 pounds of return force. This pressurization provides a return force and is so indicated by the return force gauge.

CAUTION

When no load is applied to the Hydra Set, the return force is also indicated by the load gauge. This indication is completely normal and does not indicate any malfunction or inaccuracy of the unit. Do not, under any circumstances, attempt to correct for this off-zero indication of the load gauge. When a load is applied to the unit, this indication is balanced out and does not appear as an error in the load gauge indication. If a slight difference exists between the return force gauge indication and the no load indication of the load gauge, the indication of the load is correct. The return force gauge does not possess the same degree of accuracy as the load gauge.

The nominal 100 pounds of return force pressure in the accumulator is sufficient for proper operation of the unit under most conditions, and must be changed only if one of the following conditions exists:

1. If the unit is to be used to position a load that weighs less than the weight indicated by the return force gauge, pressure must be bled from the accumulator.

Note

As the piston rod is extended during operation, air space in the accumulator is reduced. This causes a corresponding increase in accumulator pressure, as indicated by the return force gauge. This is normal. When handling light loads, this increase should be anticipated and the accumulator bled to provide a return force that will not approach load weight during extension. If the return force gauge reaches its highest possible indication ('the peg') during extension, the unit has been overfilled with fluid. Refer to the specifications for the maximum fluid capacity. Draining instructions are provided in the Maintenance Instructions of this manual.

2. If the equipment is to be used with hoisting slings, spreader bars, or other accessory equipment which weighs more than the weight indicated by the return force gauge, pressure in the accumulator must be increased to enable the unit to return to the fully closed position automatically.
3. If a change in accumulator pressure is required, proceed as follows:
   a. Remove the cap from the air valve.

b. Bleed or apply pressure at the air valve, while observing the indication of the return force gauge. Use only clean, dry, nitrogen. Do not apply pressure beyond the maximum indicated on the return force gauge. This indicated maximum must not be exceeded when the piston is in the retracted position. Do not bleed pressure below 50 pounds of return force, this is the minimum pressure which will provide proper inlet pressure for the UP pump.

c. Replace the air valve cap.

INSTALLATION

The only installation required are connection of the upper connector to the crane or hoist and the connection of the lower connector to the load, with the proper sling, hook, or other fastening device.

REMOTE CONTROL CABLE INSTALLATION

If the Hydra Set is to be operated from a remote location, proceed as follows to install the remote control reels:

1. Lift the handle of the cable reel out of the hole in the case. This frees the reel so that it may be turned.
2. Connect the clip in the end to the pin in the slotted knob of the up pump.
3. Connect the other remote control reel to the down valve in the same way.
4. Reel out cable from the remote control reels as required.
5. Fold the handle of the cable reel and press it into the hole in the case. This locks the reel, which now serves as an extension handle for the up pump or down valve.

OPERATING PROCEDURE – DIGITAL LOAD GAUGE

Perform the following steps.

1. Turn the Digital Load Gauge switch to the 'on' position.
2. Verify the gauge is operational by observing a value on the LCD display.
3. Attach a load to the Hydra Set. When the load is supported by the Hydra Set, the Digital Load Gauge will display the weight of the load.
4. Turn the Digital Load Gauge switch to the 'off ' position when task is completed or the Hydra Set is not in use.

Note

When there is no weight attached to the Hydra Set, the Digital Load Gauge will display the Hydra Set Return Force load shown on the small gauge attached to the Upper Head. This is a normal indication, and will change to the ACTUAL load when weight is applied and the load is moved.

Note

Each Digital Load Gauge is matched to each Hydra Set at the factory. Modification or replacement without re-calibration will alter or nullify the accuracy.

Note

The Digital Load Gauge is equipped with an on-off switch that shuts-down the display electronics, when the Hydra Set is not in use, to prolong battery life.

SERVICE

The Digital Load Gauge is equipped with a clear bezel that will protect the liquid crystal display from foreign matter. Clean the bezel with a soft cloth.

The batteries powering the Digital Load Gauge are long lasting Lithium cells (two (2) required). They are approximately the size of a "C" cell. To change the batteries, remove the two screws on opposite sides of the Digital Load Cell housing. Carefully remove the Gauge from the rear attach bracket. Once removed, pry the batteries loose, replace and reassemble.

WARNING:

Very carefully pry the batteries from the battery holder while in the Digital Load Gauge assembly. The battery holder exerts maximum force on the batteries to retain contact during rough handling.

OPERATION

With the accumulator properly pressurized, as described under Pressurizing the Accumulator, and the Hydra Set securely installed between crane and load, proceed as follows to operate the Hydra Set:

1. Remove the storage lock from the up pump and down valve handles.

Note

The storage lock is used to hold the down valve open for prevention of pressure increase in the actuating cylinder due to fluid expansion caused by ambient temperature increases.

2. To lift the load, extend the piston by opening the down valve and raising the unit with the hoist or crane until the piston rod is sufficiently extended. Close the down valve. Stroking the up pump will now raise the load.

Note

One complete stroke of the up pump lever raises the Hydra Set piston by approximately 0.005 inch. Less movement can be obtained by a partial stroke of the up pump lever.

3. Observe the load gauge. During lifting operations (after the up force exceeds the preloading indicated by the return force gauge), the load gauge provides an accurate indication of the up force applied to the load. When the load is free of all support other than the Hydra Set, the load gauge provides an accurate indication of load weight.

Note

The load gauge will indicate binding or drag on the load as an increase above the known weight during lifting.

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4. To lower the load, open the down valve slowly. The farther the down valve is opened, the faster the load will descend.

Note

The load gauge will indicate binding or drag on the load as a decrease from known weight during lowering.

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5. When the load is fully lowered, lower the Hydra Set with the crane or hoist to provide slack in the slings or lifting harness. Disconnect the sling or harness from the load.

Note

The direction of movement can be reversed at any time during raising or lowering by operation of the desired lever. Do not operate both levers simultaneously.

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6. If it is not convenient to provide the necessary slack for uncoupling by lowering the Hydra Set with the crane or hoist, bleed all air pressure from the accumulator, hold the air valve and the down valve open and manually extend the piston rod to provide the necessary slack. After disconnecting the load, the piston may be retracted by repressurizing the accumulator.

7. When the unit is used as a prime source of power for test purposes, the procedure outlined in step 4 of this procedure can be used to extend the piston the required distance for making connections. When the accumulator is repressurized, the piston will automatically retract and take up all slack in the test rig. The accumulator must be bled of all pressure, and the air valve and down valve must be held open, whenever the piston is manually extended.

SECURING THE EQUIPMENT

Whenever the Hydra Set is not in operation, pull both the down valve, up pump levers to their extreme downward position, and lock them in this position with the storage lock. This prevents ambient temperature increases from causing pressure build-up in the unit.

PERIODIC MAINTENANCE

Del Mar Avionics recommends that the Hydra Set be stored indoors with controlled air temperature between 40 F and 140 F, and dust cover in place.

In addition, a Periodic Maintenance Program (PMP) should be implemented every 60 days as follows:

The area around the units should be inspected for sign of hydraulic fluid leakage from the unit. The unit should then be attached to an overhead crane and a dead weight equal to at least one-half of the rated capacity of the unit should be suspended from the lower connector. Each unit should be operated manually using UP pumps, and DOWN valves such that the load is lowered and raised through the full 12-inch stroke range a number of times. A small amount of WD 40 brand lubricant may be sprayed in each UP/DOWN lever to prevent freezing, if necessary.

Following the above procedure, lower the piston 1/2 way with the load attached. If equipped with Travel Dial Indicators, set at °0" and leave load suspended for 5 minutes, (Dial Indicator with magnetic bases may be substituted in lieu of the foregoing). Constant down travel of the indicator indicates a possible internal leak in the unit and the factory should be consulted.

FLUID RESERVOIR TOP-OFF

Proceed as follows to top-off the reservoir with Hydra Set fluid (if prior leakage or draining requires):

CAUTION

When adding oil, topping off reservoir, or draining, uses the oil for your specific unit as shown on the Hydraulic_Fluid Label. Mil-H-5606A ONLY.

1. Vent all air pressure from the accumulator through the air valve and hold the air valve open.

2. Open the down valve and manually extend the piston rod approximately four inches.

3. Remove the plug from the fluid fill port.

CONFIDENCE CHECK

1. Make sure the Hydra Set unit is stabilized at ambient temperature. Unit should be cycled up and down (operated) a few times prior to test. Make sure the controls are in the operating position.

2. Suspend a 1,000-pound load from the instrument and extend the piston to approximately mid-position in the cycle.

3. Mount a dial indicator between the piston shaft and the lower head. Indicator must be mounted firmly.

4. Establish a set point on the indicator.

5. Allow load to stress unit for at least 20 minutes to allow seals to seat.

6. Reset the indicator.

7. Observe the indicator for one-hour after resetting for movement. Indicator should not move more than .001 inch. Some up or down movement may occur over an extended time, however, due to temperature variations in material, but this does not indicate an internal leak.

ILLUSTRATED PARTS BREAKDOWN

This section contains exploded view illustrations and parts list for the Hydra Set Illustrations are provided for the overall unit, the up pump, the down valve, the load gauge, the return force gauge, the remote control reels, and the storage stand and/or case.

The end connections illustrated in this manual are not necessarily the same as the end connections furnished on your unit. If end connections require replacement or change, write the factory stating the unit model and serial number. Always order parts by full part numbers, descriptions, and state the unit and serial numbers of the Hydra Set in which they are to be installed.

START UP

Check capacity of hoist and shackles. Check unit for obvious physical damage. Check for oil leaks at breather, bushing, pump and valve. Check air pressure and adjust if necessary. To avoid overloading unit, lift unknown weight slowly until full weight is suspended. Use weight to fully cycle piston several times before starting a critical lift. When unit is not in use, be sure to lock handles down with storage lock.

NOTE

Return Force Gauge displays return force in pounds of force, not PSI. Primary Load Gauge will reflect approximate reading of Return Force Gauge until a load is applied. The Return Force Gauge is not calibrated, which accounts for any difference between the two gauge readings

TROUBLE	CAUSE/REMEDY
Gauge doesn't read exact weight (of known load) or shifts slightly after a few minutes **DEL MAR CALIBRATION ON UNIT SHOULD BE DATED WITHIN 12 MONTHS**	Shackle weight and gauge tolerance accounts for weight differences. O-ring friction (especially on smaller units) causes a slight difference that will correct as rings seat. Exercising unit several times before using helps
Piston will retract part-way with no return force	Air in oil.
Load slowly drifts down slightly when first operated.	Differences in temperature may cause compression of hydraulic fluid until stabilized. Air in oil will cause more serious drift.
Pump raises load only slightly or operates intermittently.	Loss of prime. Increase Return Force (RF) pressure or extend shaft until RF pressure rises to full scale and then depress DOWN valve handle while operating UP pump repeatedly.
Piston does not retract fully.	Low fluid or air level.
Oil in breather port.	Piston ring failure.
Oil in accumulator.	Separator ring seal failure.
Loss of air pressure.	Ring failure at separator or in upper head; leak at return force gauge or air valve.
Oil on shaft and/or lower connector.	Failure of rod bushing seal.
Pump or valve handle fails to return properly	Defective torsion spring or inadequate return force. Contamination or damage to front of pump or valve can also impede operation.
Load will not lower with valve open.	Air pressure higher than load or there is too much oil in unit.

Load Measuring Devices

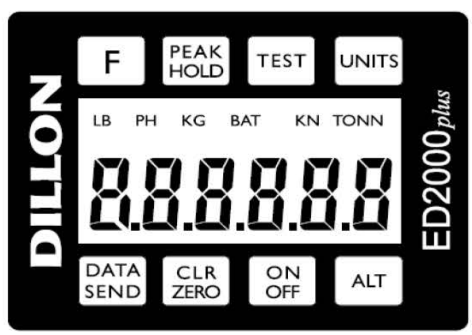

Figure 1
Electronic Dynamometer Front Panel

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DILLON

Force Measurement Equipment

ED Series Crane Scales

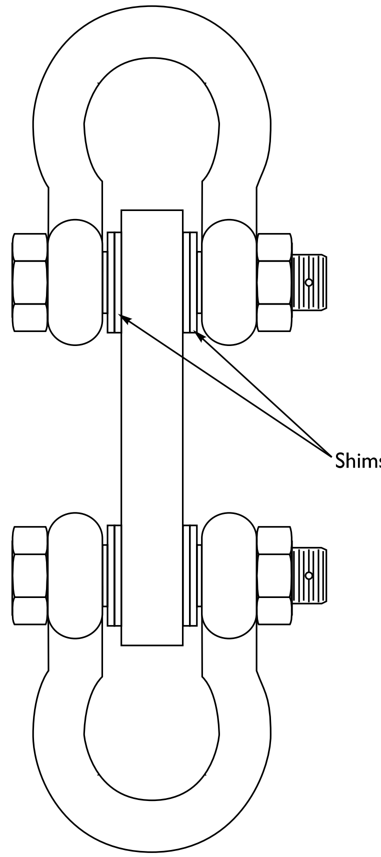
EDxtreme & EDjunior Crane Scales

Appendix - Weighing and Force Measurement Practice

The basis for all electronic force measurement or weighing is measurement of stress in a loadcell body. To obtain optimal results it is necessary to establish a few basic rules, otherwise the effect may be a nonlinear or nonrepeatable response. Read and follow these tips and see the illustrations on the next page.

Load Centering

For accurate performance the force acting on the unit must be in line with the unit. Centering the load is accomplished by using the shims on each side of the load cell so that it is centered on the shackle pin. See the illustration at right. The 20, 50, and 100 Klb ED-2000plus also include spacers supplied with shackles.



Good Pin Fit

A good fitting pin is important in order to generate an even stress distribution and avoid yield stresses. The ED-2000plus are designed with the recommended shackle pin hole sizes for the Crosby shackle capacity. To achieve published accuracy you must use the shackle pins and centering spacers provided by Dillon.

Torque and Bending

Torque and bending should be avoided. Use swivels on the lifting wire for antitorque and avoid side forces.

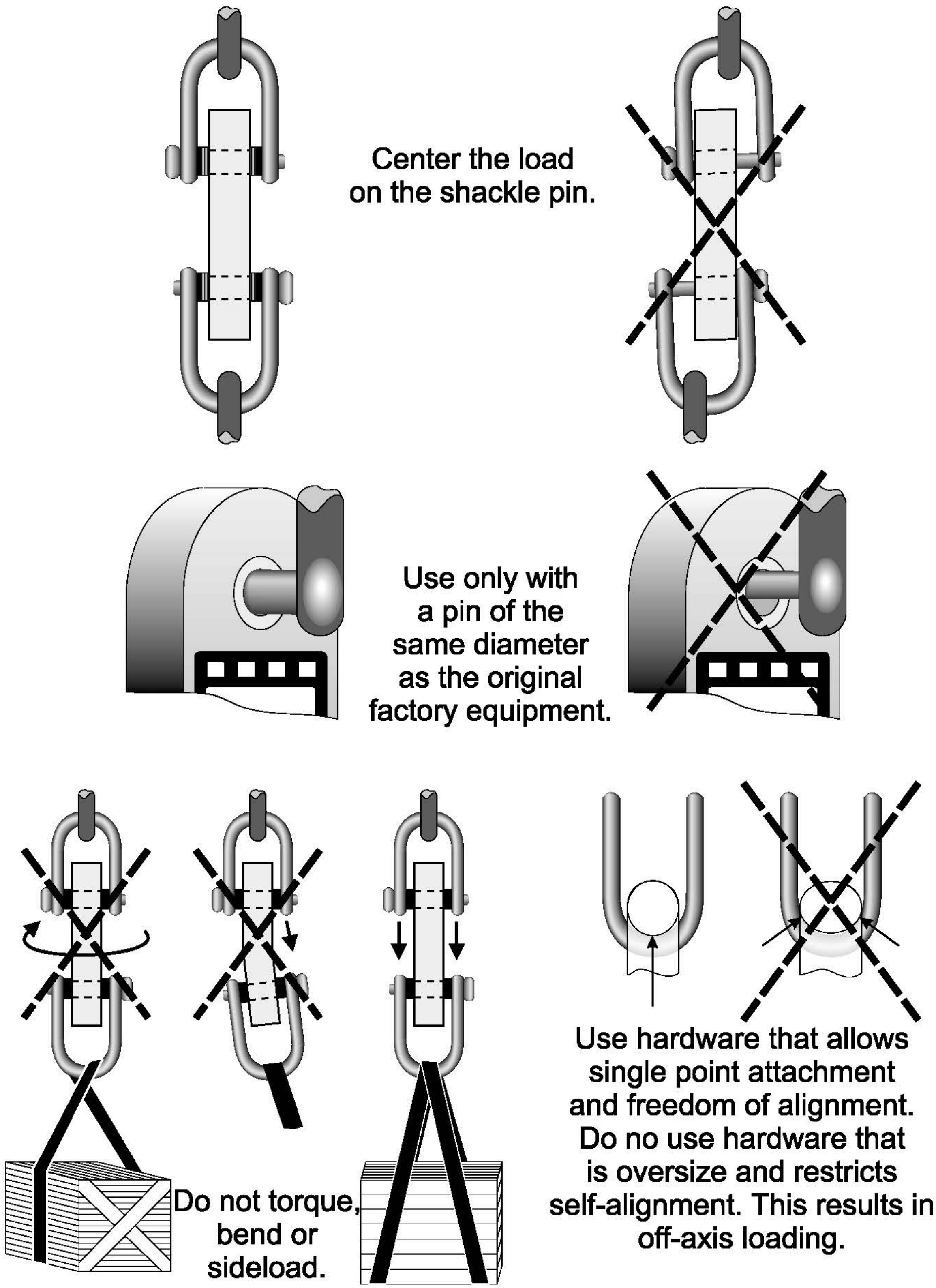
Certified Gear

Certified shackles and lifting gear should always be used in accordance to local laws and federal legislation.

Safety

Safety is always a concern in overhead lifting and tensioning applications. To limit your liability always insist upon factory supplied shackles and pins and factory tested and certified safe optional equipment. All DILLON products are designed to meet the published Safe Working Load (SWL) and Ultimate Safety Factor (USF) standards of the United States Military.

Good Force Measurement Practice



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MSI9300

Porta-Weigh+ Crane Scale

User Guide

Measurement Systems International

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SECTION 1 – INTRODUCTION & INSTALLATION

INTRODUCTION

The Measurement Systems International Model 9300 Porta-Weigh Plus Crane Scale is designed to provide a rugged weight indicator and data system for any type and size of crane used in industry. The 9300 combines CellScale technology with MSI's advanced Crane Scale architecture providing both a local and remote display capability. Combined with other CellScale components, the 9300 is an advanced data gathering network suitable for process control, customer billing, safety monitoring, and any other weight related data gathering.

The 9300 circuitry is fully shock-mounted and water-proof making a rugged and reliable overhead scale for use indoors and out. The large 1.2" (30mm) digits are sunlight visible, and are readable at distances up to 50' (15m).

The 9300 can communicate with CellScale family indicators and modems at distances up to 1000' (300m) outdoors (even further with gain antennas). Both fixed and handheld indicators are available, as well as Modems for direct connection to computers.

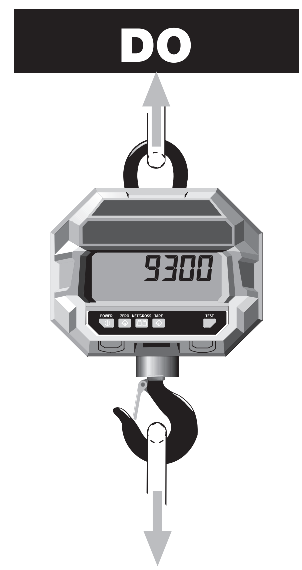
INSTALLATION

The 9300 installs easily by hanging it on the crane, using properly sized shackles. Follow proper loading procedures to ensure that side loading is eliminated. Please refer to MSI's brochure, "Crane Safety" when installing model 9300.

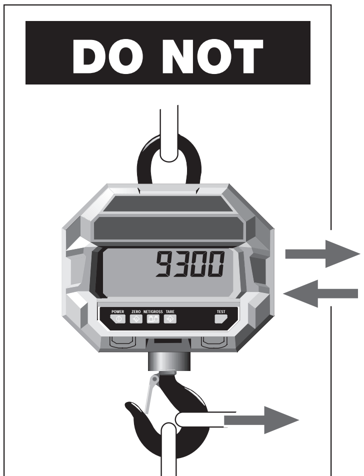
One of the most common installation problems is using an oversize shackle or too large a hook to interface with the 9300. This can cause off center loading and stress points that will reduce the life of the 9300 lifting eye or hook. Use the appropriate interface hardware for the capacity of the scale. If your interface hardware does not fit properly, MSI can supply the 9300 with oversize lifting eyes or shackle interfaces. If the crane hook is too large to fit in the lifting eye with single point interface, then install the scale using adaptive rigging.

If multiple attachments are needed, use a shackle or ring to attach the multiple lines to thus keeping a single point attachment to the scale. Single point attachments are necessary to ensure the safety and accuracy of the scale system.

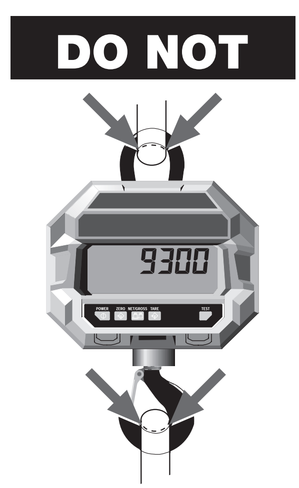
Regular maintenance inspections of the lifting system should be performed to ensure safety. Pay particular attention for signs of stress on any element in the load train.



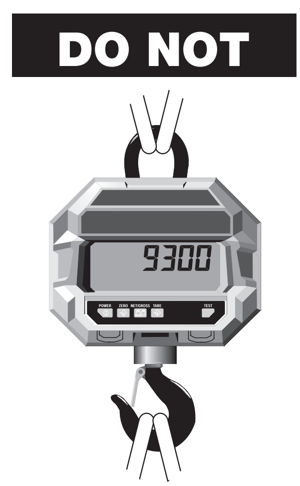
USE HARDWARE THAT CREATES SINGLE POINT ATTACHMENTS AND ALLOWS THE SCALE FREEDOM OF ALIGNMENT.



1. DO NOT PUSH OR PULL ON LOADED SCALE. **2.** DO NOT PULL LATERALLY ON HOOK WITH SCALE LOADED.



DO NOT INTERFACE HARDWARE (SHACKLES, HOOKS ETC.) THAT ARE OVERSIZED AND RESTRICT SINGLE POINT LOADING AND SELF-ALIGNMENT WHICH CAN RESULT IN OFF-AXIS LOADING.

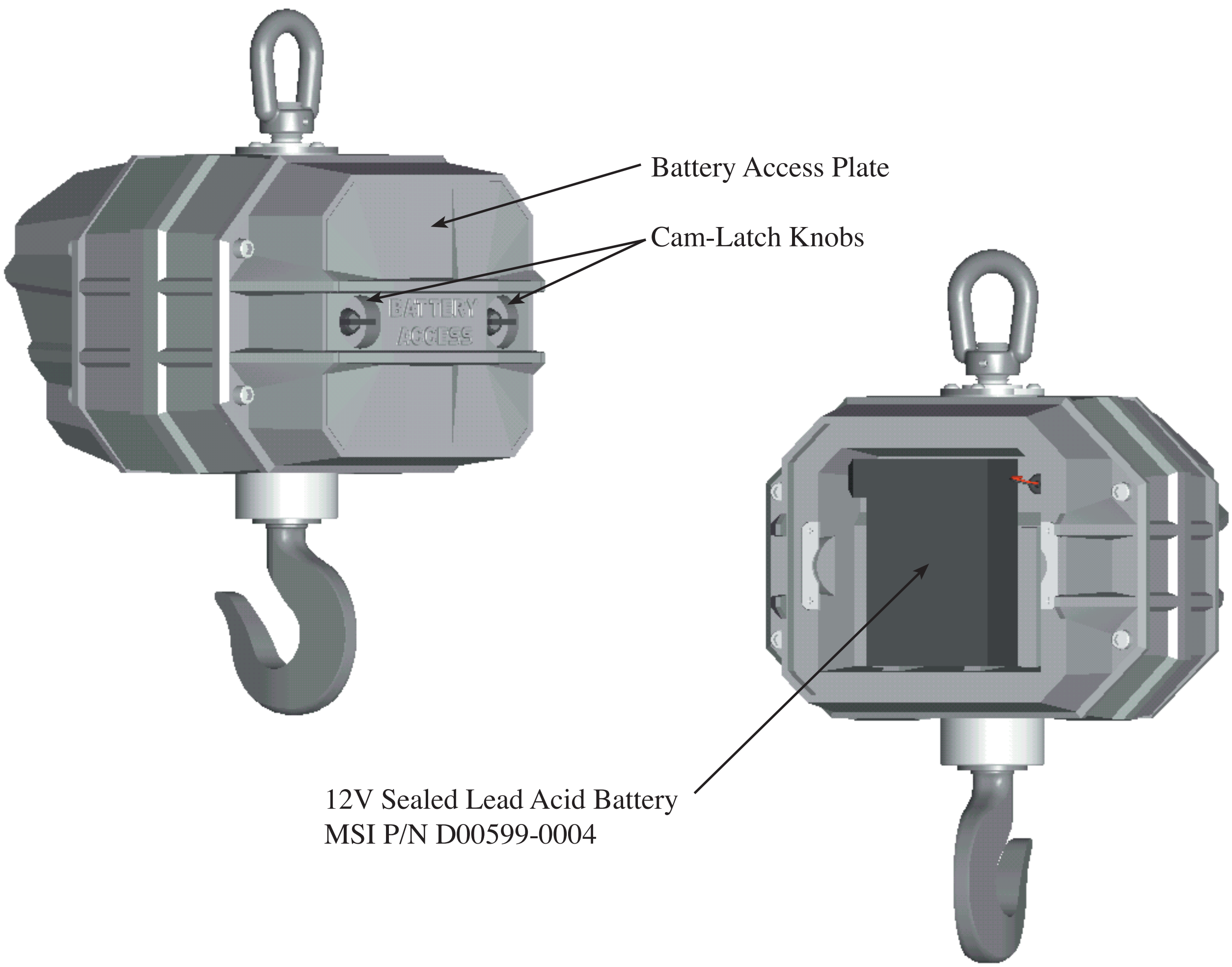


DO NOT USE MULTIPLE ATTACHMENTS.

9300 Porta-Weigh + Crane Scale

BATTERY REMOVAL & REPLACEMENT

1) Turn the 9300 Off.
2) With one hand, hold the battery access to prevent it from falling.
3) Rotate the two cam-latch knobs counter-clockwise until the plate latches disengage.
4) Carefully back the plate out of the battery well. The battery might be loose and subject to falling.
5) Remove the battery by pulling straight back.
6) Install a fully charged battery by plugging it in to the exposed battery jacks. The 9300 will turn on briefly then turn itself off.
7) Reseat the access panel.
8) Turn the cam-latch knobs clockwise until the plate is reseated. Make sure the plate is firmly in place.



The Battery Access Plate and the Sealed Lead Acid Battery are potential falling hazards. When opening the battery access, be sure to hold the battery to prevent it from falling. This battery contains Lead and should be recycled when it has reached its end of life.

Goddard Procedural Requirement

GPR 8719.1B

Certification and Recertification of Lifting Devices and Equipment and Its Operators

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Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	GPR 8719.1B	**APPROVED BY Signature:**	*Original Signed By*
EFFECTIVE DATE:	May 29, 2012	**NAME:**	Dennis Andrucyk
EXPIRATION DATE:	May 29, 2017	**TITLE:**	Director of AETD

COMPLIANCE IS MANDATORY

Responsible Office: 540/Mechanical Systems Division

Title: Certification of Lifting Device Equipment and Its Operators

TABLE OF CONTENTS

PREFACE

P.1 PURPOSE

This directive implements the requirements of NASA Standard 8719.9 "Standard for Lifting Devices and Equipment" for the GSFC Recertification Program (RECERT) in providing Center organizations with frequent and periodic inspection, certification, and recertification of lifting devices and equipment (LDE). Requirements are established for LDE Operators of cranes, mobile aerial platforms (MAP), and powered industrial trucks (PIT), and Critical Lift Coordinator (CLC) training and certification. This Center program improves safety, and minimizes or prevents potential personnel injury or fatality, and damage or loss of hardware and facilities.

This directive is not a substitute for applicable Occupational Safety and Health Administration (OSHA) and national consensus codes and standards (NCS) requirements. OSHA and NCS requirements apply to all GSFC LDE, LDE Operators, and their respective operations.

P.2 APPLICABILITY

a. This directive is applicable to all LDE at Greenbelt, Wallops Flight Facility (WFF), and other areas under GSFC cognizance, regardless of ownership, that are operated or used by NASA employees or GSFC support services contractors, to the extent required in their respective contracts, unless specifically excluded by this directive or by the RECERT Manager.

b. When invoked as a contractual requirement by a project, this directive is applicable to the extent specified in the contract for off-site contractor installations supporting GSFC activities.

c. Lifting operations under privatization clauses shall be subjected to the provisions of this directive to the extent provided by the contract, and the requirements shall be clearly specified therein.

d. The responsible Contracting Officer and the Project Manager shall apply requirements of this directive to any contractor, tenant, or customer if non-NASA lifting operations place NASA personnel, facilities, or equipment at risk through incorporation into their respective contracts.

P.3 AUTHORITIES

NASA-STD-8719.9, Standard for Lifting Devices and Equipment

P.4 APPLICABLE DOCUMENTS

The references as listed within the NASA-STD 8719.9 are applicable:
a. 29 CFR 1926.1400, OSHA, Cranes & Derricks in Construction
b. 29 CFR 1910, Occupational Safety and Health Standards
c. NASA-STD 1800.1, NASA Occupational Health Program Procedures

d. NASA-STD-8709.20. Management of Safety and Mission Assurance Technical Authority (SMATAA) Requirements
e. NASA-STD 8709.22, Safety and Mission Assurance Acronyms, Abbreviations, and Definitions
f. GPR 1400.1, Waiver Processing
g. GPR 1700.5 Control of Hazardous Energy (Lockout/Tagout)
h. GPR 3410.2I, Employee Task-Specific, Required and Mandatory Training Requirements
i. GPR 8621.4, Mishap Preparedness and Contingency Plan
j. GPR 8715.3 Fall Protection Requirements for GSFC
k. GPR 8834.1, Lifting Operations Requirements
l. 540-WI-8719.1.3, Sample Lifting Device Inspection Forms
m. ASME PALD, Safety Standard for Portable Automotive Lifting Devices
n. ASME B30 Safety Standards for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

P.5 CANCELLATION

GPR 8719.1A, Certification and Recertification of Lifting Devices and Equipment and its Operators

P.6 SAFETY

Detailed safety requirements are contained in applicable test and inspection procedure.

P.7 TRAINING

Training requirements are specified in Section 3.

P.8 RECORDS

Record Title	Record Custodian	Retention
Test & Inspection Reports for: ▪ LDE	RECERT Manager at Greenbelt, Deputy RECERT Manager at WFF	Permanent – pending approval of record schedule. *NRRS 8/56.5A
Operator Certifications: ▪ LDE ▪ CLC	RECERT Manager at Greenbelt, Deputy RECERT Manager at WFF	*NRRS 3/33G Destroy 5 years after separation of employee or when no longer needed.
Jack Operator Training	Operator Supervisor	*NRRS 3/33G Destroy 5 years after separation of employee or when no longer needed.
Completed Daily Checklists	Property Custodian	Permanent. NRRS 8/56.5D
RECERT documentation	RECERT Manager	*NRRS 3/33G
Safety Analysis	Property Custodian	Permanent. NRRS 8/56.5D
LDEC Meeting Minutes	RECERT Manager	Permanent. *NRRS 1/14B (1) (a)

		Retire to FRC when 2 years old. Transfer to NARA when 20 years old.
GSFC 17-112, Employee Task-Specific Training Requirement for civil servant employees	Supervisor	Permanent – Maintained in the Employee Performance File in the IDP/Training Related Information section on the right side.

**NRRS – NASA Records Retention Schedules (NPR 1441.1)*

P.9 MEASUREMENT/VERIFICATION

The RECERT Manager shall document the percentage of scheduled test and inspections completed, and the pass/fail percentage of LDE.

PROCEDURES

In this document, a requirement is identified by "shall," a good practice by "should," permission by "may" or "can," expectation by "will" and descriptive material by "is."

1. Responsibilities

1.1 Center Director appoints the RECERT Manager and Deputy RECERT Manager/WFF for LDE.

1.2 RECERT Manager shall

a. Maintain overall responsibility for the management, implementation, and enforcement of the Center's LDE Program;
b. Provide direction to the Deputy RECERT Manager;
c. Tasks the RECERT Support Contractor in the maintenance of Section 1.2 of this directive;
d. Serve as the GSFC interface with NASA Headquarters (HQ) and other NASA Centers on matters pertaining to LDE;
e. Serve as the GSFC representative on the NASA LDE committee;
f. Chair the Center LDE Committee;
g. Serve as the Certifying Authority for the certification and recertification of LDE to which this directive is applicable;
h. Serve as the final authority on interpretation of, and compliance with, this directive and its references;
i. Establish and maintain a system for periodic inspection of LDE including review of logbooks, daily inspection forms, identification of deficiencies, and completion of corrective actions;
j. Ensure that certification and/or recertification tests and inspections are performed by personnel properly trained and qualified in accordance with applicable codes and standards;

k. Provide consultation to the center for design, specification, testing, maintenance, operation, and modification of LDE to owners and operators;
l. Approve the re-rating of LDs;
m. Review and concur/non-concur with waiver requests per GPR 1400.1;
n. Review and concur/non-concur with specifications prior to procurement of LDs;
o. Establish and maintain a RECERT configuration management system for LDE;
p. Review, approve, and monitor the training courses for qualifying LDE Operators, and define their training and retraining requirements;
q. Certify and recertify LDE Operators;
r. Perform compliance spot checks of LDE Operators to ensure that the requirements of this GPR are being followed;
s. Provide Division Offices with an inventory of Division LDs for review and update, when requested;
t. Coordinate with affected Center safety offices on issues of mutual interest;
u. Coordinates with the Office of Human Capital Management (OHCM) to ensure all RECERT training classes are entered in SATERN at least 30 days prior to the start of each class.
v. Notify supervisors of training and certification requirements for civil servant employees to be documented on the GSFC 17-112, Employee Task-Specific Training Requirements Form
w. Maintain oversight, for safety and compliance, of all Lifting Devices, including mobile cranes brought onsite, for lifting, setting and delivering equipment to center; and
x. Review the use of lifting equipment (slings, strong-backs, etc.) brought onsite to support the lifting device operations delineated in item u, above.

1.3 Deputy RECERT Manager/WFF

The Deputy RECERT Manager shall serve as the RECERT Manager's alternate and represent the RECERT Manager at WFF for day-to-day operations by performing duties in Section 1.2.

1.4 LDE Owners and/or Division Offices shall

a. Ensure documented compliance to this directive by maintaining records of LDE and the Operators;
b. Submit LDE specifications to the RECERT Manager for review and concurrence prior to purchase;
c. Ensure that LDEs are certified by the RECERT Manager prior to use;
d. Provide resources for training and ensure that LDE operators are certified;
e. Ensure that LDE for which the division is responsible is appropriately certified for critical or noncritical lifts, and notify RECERT, as required by NASA-STD 8719.9;
f. Determine the appropriate LD usage category, i.e., Active, Standby, or Idle; and classification, i.e., Critical or Noncritical, based on current and projected operational requirements;
g. Maintain a current inventory of LDE (including slings, shackles, turnbuckles, D-rings, load measuring devices, and other LE) owned and operated by the division;
h. Manage and control uncertified or expired LDE to preclude inadvertent use;
i. Request that RECERT perform certification of new or transferred LDE from offsite locations prior to their use;

j. Notify the RECERT Manager immediately of all LDE deficiencies and failures, and initiate the appropriate Incident/Mishap Report in accordance with GPR 8621.4;
k. Initiate repair for LDE deficiencies found during OSHA and NASA-STD 8719.9 required tests and inspections;
l. Ensure that Original Equipment Manufacturer (OEM)-recommended maintenance is performed on LDE and that the daily checklist conforms with the OEM;
m. Submit requirements to the appropriate budget to bring Division LDE into compliance with this directive;
n. Maintain responsibility for day-to-day operations of LDE under their cognizance;
o. Coordinate outages for load testing and inspections of inventoried LDE with RECERT to minimize conflicts with ongoing operations;
p. Notify RECERT of any LDE that is removed from service or any change in use status per Section 2.3.2 of this directive;
q. Perform daily LDE inspections and document such inspections on the Daily Checklist;
r. Establish administrative controls over their LDE to preclude unauthorized operation. Such controls may include administratively controlling access to areas in which LDE are located, or administratively locking out LDE to all but authorized users by using GSFC Administrative locking procedures as defined in GPR 1700.5;
s. Require civil servant supervisors to document task-specific training requirements on the GSFC 17-112, Employee Task-Specific Training Requirements Form for civil servant employees as required by GPR 3410.2;
t. Notify RECERT Manager when rented or leased equipment is brought on center; and
u. Review and document operator training of Overhead Crane, Mobile Crane, MAP, and PIT assigned to the division on an annual basis and submit to RECERT manager for review.

1.5 Occupational Safety and Health Division/Code 350 and Wallops Safety Office/Code 803 shall:

a. Notify RECERT Manager if construction activities are not in compliance with OSHA (as it relates to LDE) and NASA-STD 8719.9 requirements.
b. Provide comments on construction lift plans as requested by the RECERT Manager.

1.6 Medical and Environmental Management Division/Code 250

Shall provide medical expertise via the Medical Director to establish LDE operator medical examination criteria using applicable NASA and American National Standards Institute requirements.

1.7 Facilities Management Division (FMD)

FMD shall notify, in writing, the RECERT Manager of any planned LDE acquisition, installation, upgrade, and/or removal as part of a FMD facilities project. To ensure compliance and certifiability, all LDE designs and specifications shall be supplied to the RECERT Manager for review and approval prior to contract implementation. Assure that mobile cranes coming on center for facility construction comply with OSHA 1926.1400. Notify the RECERT Manager and Safety (Code 350/803) of any construction activities requiring the use of a leased/rented LDE.

1.8 Office of Human Capital Management (OHCM)

a. Coordinate with RECERT Manager to document training offerings in SATERN;
b. Coordinate with RECERT Manager in approving participants in SATERN;
c. Provide RECERT manager official training roster for each training offered; and
d. Update SATERN to ensure civil servant participants receive training credit and it is properly recorded in their learning history

1.9 Certified Crane Operators shall

a. Ensure that the load is properly and safely rigged;
b. Verify the GSFC RECERT certification status of the LDE is current before commencing lifting operations (using uncertified LDE is a violation of Center policy);
c. Perform crane daily inspections and tests in accordance with RECERT approved procedures;
d. Perform LE inspection before use;
e. Provide entry in the LD (including Hydra-set) log book for all inspections, tests, and operations; and
f. Perform LDE lock out procedures in accordance with GSFC Administrative locking procedures as defined in GPR 1700.5, if any deficiencies are observed and immediately enter the deficiencies into the log book, and notify the RECERT Manager; and
g. Have the final approval on the lift. If the Crane Operator is not comfortable or satisfied that all aspects are correct or complete prior to the lift, the Crane Operator does not have to perform the lift, and shall contact the RECERT manager immediately.

1.10 Certified Critical Lift Coordinators (CLC)

Certified CLC's may be responsible for directing and giving commands to the Crane Operator during a lifting operation if so designated in the Critical Lift Procedure. If the CLC is in charge of the lifting operation, they shall, in a pre-lift briefing, instruct personnel in the proper preparation, rigging, lifting, and final positioning of the load. Coordination for directing the lifting operation shall be delineated in the Critical Lift Procedure and re-emphasized in the pre-lift briefing. A CLC shall not perform rigging activities or hands-on operation of LDs.

1.11 Certified MAP and PIT Operators and Authorized Jack (Critical) Operators shall

a. Verify the GSFC RECERT certification status of equipment is current before commencing operations (using uncertified LDE is a violation of Center policy);
b. Perform daily inspection in accordance with daily checklist before operation;
c. Provide entries in the equipment log book for all inspections, tests, and operations; and
d. If any deficiencies are observed, lock out the equipment using GSFC Administrative locking procedures as defined in GPR 1700.5, immediately enter the deficiencies into the log book, and notify the RECERT Manager.

2. Equipment Requirements

2.1 Types and Traceability

2.1.1 Items Subject to RECERT. The following items are included in the RECERT Program and shall be subjected to formal certification and recertification. Other items may be included if deemed necessary by the RECERT Manager.

- Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist, and Jib Cranes)
- Mobile Cranes**
- Base Mounted Drum Hoists
- Monorails and Under hung Cranes and Hoists
- Manually Operated Level Hoists
- Special Hoist-Supported Personnel Lifting Devices
- Hydra-sets
- Crane Hooks
- Wire Rope Slings
- Alloy Steel Chain Slings
- Metal Mesh Slings
- Synthetic Slings
- Structural Slings
- Lifting assemblies
- Shackles, Turnbuckles, Swivel Joints, Connecting Links, and other lifting hardware components
- Load Measuring Devices*
- MAPs including Attachments
- PITs including Fork Extensions and Attachments
- Jacks
- Shop cranes (Portable Automotive Lifting Devices)

***Load Measuring Devices are verified by RECERT for structural integrity in the load path. Calibration of these devices shall be the owner's responsibility.**

**** Mobile cranes used strictly for construction activities are exempt from meeting GSFC RECERT requirements but must meet OSHA requirements**.

2.1.2 Traceability to Original Equipment Manufacturer (OEM).

a. All LE hardware components shall be traceable to a credible source of information, such as OEM for certifiability.

b. Fork extensions and attachments to PITs that affect capacity and/or stability shall be OEM equipment; or approved by the OEM in writing for its design and fabrication. In all cases, a tag or notice shall be affixed to the equipment clearly showing the new CG and capacity restrictions.

c. All LDE shall be used consistent with their intended purpose per OEM recommendations. The use of LDE that is contrary to OEM instructions or recommendations is not permitted, unless approved by the RECERT manager and complies with the applicable ASME/ANSI B30 series documents.

2.2 LDE Certification and Safety Analyses

2.2.1 LDE Certification

a. LDE shall be certified, before first use, by the RECERT Manager based upon verification and acceptance of design safety factor, load testing, and nondestructive testing reports, if applicable, and by compliance with NASA-STD-8719.9 and this directive. It shall then be recertified thereafter in accordance with NASA-STD-8719.9 and this directive.

b. The RECERT Manager shall re-certify altered LDE assemblies as a system unless specifically exempted by a safety variance reviewed and approved in accordance with Section 4 of this directive. Alteration includes the extension, modification, addition, replacement, or deletion of components to the original certified configuration . All components comprising a critical LE assembly shall be uniquely identified and controlled, and should not be interchanged for use elsewhere. Replacement by identical, individually certified and tagged components of equal or greater load rating is permissible without having to recertify the LE assembly.

c. The RECERT Manger may authorize the applicable contractor organization to perform LDE test and inspections at Government Owned, Contractor Operated facilities by the applicable contractor organization provided the contractor has a test and inspection plan satisfactorily addressing GSFC requirements, including personnel qualifications, and the contractor's plan has been reviewed and approved by the RECERT Manager.

d. Owners and/or divisions responsible for LDE shall forward copies of all LDE test and inspection reports, including those for applicable off-site operations and applicable contractor installations, shall be forwarded to the RECERT Manager for annual re-certification and record keeping.

2.2.2 LDE Safety Analyses

a. A recognized Safety Analysis, such as a Fault Tree Analysis, a Failure Modes and Effects Analysis, or an Operating and Support Hazard Analysis shall be performed by the owning organization on critical LDE's (including jacks, as defined in NASA-STD-8719.9). The critical or non-critical category determination shall be performed in accordance with Appendix C of GPR 8834.1, Lifting Operations Requirements. The analysis shall, as a minimum, determine potential sources of danger, identify failure modes, and recommend resolutions and a system of risk acceptance for those conditions that could cause loss of life, personal injury, and loss of or damage to the equipment, facility, or load.

b. Safety Analyses shall be reviewed and approved by the RECERT Manager.

2.3 Operational Requirements

2.3.1 Criticality Determination. The owning organizations shall specify the category of operations to be performed by their LDE, i.e., critical or noncritical, so that the RECERT Manager may provide the requisite compliance requirements for the LDE. Appendix C of GPR 8834.1 must be completed, submitted, and approved by the RECERT Manager, for non-critical lifts that are non-institutional by nature.

2.3.2 LD (except MPJ) Inspection Requirements. Inspection requirements are based on the usage categories of LDs. "Daily" inspection requirements are generated by the LD owner. "Frequent" or "Periodic" inspections are defined in RECERT approved procedures.

2.3.2.1 Active LDs – These are devices that are available for unlimited daily use and:

- The Certified LDE Operator shall perform, prior to initial use, Daily Inspections and limit switch tests and record entry in the logbook in accordance with RECERT approved procedures.
- RECERT Frequent Inspections shall be performed at monthly intervals in accordance with NASA-STD 8719.9.
- RECERT Periodic Inspections for recertification shall be performed once a year in accordance with NASA-STD 8719.9.

2.3.2.2 Standby LDs – These devices are to be secured from use by using GSFC Administrative locking procedures as defined in GPR 1700.5 and operation shall be resumed only after an inspection by RECERT that allows unlimited use for a 1-month period as an Active LD. After that the LD shall be secured again. Additionally:

- RECERT Frequent Inspections shall be performed at 6-month intervals.
- RECERT Periodic Inspections shall be performed once a year in accordance with NASA-STD 8719.9.

2.3.2.3 Idle LDs: – These devices are to be secured from use by using GSFC Administrative locking procedures as defined in GPR 1700.5 and there is no planned use of the LD for the next 12 months. When LDs are idle more than 6 months, the LD shall be recertified prior to use. Additionally:

- RECERT tests and inspections are not required during an idle period.
- RECERT shall perform required tests and inspections prior to returning the LD to service.

2.3.3 Re-rating

Owner organizations may request that RECERT re-rate their LDs. Re-rating of LDs and the subsequent recertification shall be accomplished as follows:

a. Engineering analyses shall be performed in accordance with OSHA, NASA, and NCS requirements to validate that the LD can be used at the new re-rated load. Building structural support system(s) shall also be validated in terms of the new re-rated load. Re-rating resulting in higher equipment capacity shall require RECERT Manager's approval prior to modification.

b. Certify the LD and clearly display re-rated capacity with a tag or marking.

2.3.4 Transfer of LDE

a. LDE and associated certification documentation transferred to GSFC shall be reviewed for certification by the RECERT Manager.

b. Certification documentation shall accompany LDE permanently transferred from GSFC to other locations.

2.3.5 LDE (Re) Certification Tagging

Tags shall indicate the (re)certification and NDT, if applicable, status of all LDE. The tagging shall be done in accordance with a Work Instruction(s) describing the tags for each application. Unless indicated, all LDE tags shall expire on the last day of the month, one year from the month in which the tag was issued.

a. One load test tag (re)certification is applied to an assembly where the individual items are color-coded, tethered, or otherwise controlled as an assembly, and there are no plans to disassemble the assembly or to rearrange the configuration. The assembly is load tested as a unit with each item being individually NDT, if applicable, inspected and tagged as such.

b. Load test (re)certification tags are applied to each component for an assembly that will be disassembled and where the individual items are not color-coded, tethered, or otherwise controlled as an assembly. The assembly may be load tested as a unit or each component load tested individually with each item being individually NDT, if applicable, inspected and tagged as such.

c. One load test (re)certification tag per configuration is applied to an assembly where the configuration will be rearranged. The assembly is load tested in all applicable configurations with each item being individually NDT, if applicable, inspected and tagged as such. Note that there may be variations in the number of tags depending upon the similarities among the different configurations.

d. For loose, individual components, each component is load test (re)certification tagged and NDT, if applicable, inspected and tagged.

2.4 LDE Testing

2.4.1 Load Testing

New or modified LDs and MPJ shall be proof load tested in accordance with Table 1 and in accordance with NASA Standard 8719.9. For periodic recertification, LDs shall be tested to 100% of their rated load. New or modified LE shall be tested in accordance with NASA Standard 8719.9

Certified test weights or calibrated load cells and test equipment shall be used for all LDE load-testing activities.

2.4.2 Nondestructive Testing (NDT)

NDT shall be performed in accordance with NASA Standard 8719.9.

3. Personnel Qualification and Certification Requirements

3.1 Personnel Performing NDT

Personnel performing NDT shall meet the requirements of NASA Standard 8719.9.

3.2 Crane Operators

3.2.1 Crane Operator Certification Requirements

All Crane Operator candidates shall obtain formal training in LD operations and rigging as specified in NASA-STD-8719.9. Formal training may be available through the GSFC RECERT Program and other recognized sources and includes classroom instructions, written examination, and hands-on proficiency demonstration. The RECERT Manager shall evaluate and determine the acceptability of the syllabus of all training courses for which Operator candidates claim credit. In addition, all Crane Operator candidates shall pass the RECERT written examination and an applicable medical examination (in accordance with NASA-Standard 1800.1). The following training course topics shall be included as a minimum:

a. NASA-specific requirements
b. GSFC-specific requirements
c. Safe rigging procedures
d. Safe crane operations
e. Safety and emergency procedures
f. General performance standards
g. Pre-operational checks
h. Safety-related defects and symptoms
i. Specific hazards
j. Special procedures associated with critical lifts (critical lift operator training only)
k. Use of standard hand signals
l. Lessons learned

Upon successful completion of the required training, the certification records are updated and an individual license will be issued, or in some instances a roster of Certified Crane Operators, is prepared. The licenses or the Operator roster shall be signed by the RECERT Manager and issued to the Operator, or, in the case of the Operator roster, to the appropriate supervisory personnel. It is the crane Operator's responsibility to notify the RECERT Manager prior to expiration.

3.2.2 Categories of Crane Operator Licenses.

There are three categories of Crane Operator Permits and Licenses:

a. Apprentice Permit: Apprentice permits are typically issued with a required 40 hours of noncritical lift operation (minimum 20 hours Hands–On Crane Operation) and rigging to be attained under the direction of a licensed Crane Operator. Both the licensed operator and the candidate's supervisor shall attest to the attainment of these hours. On a case-by-case basis, for candidates with prior crane operation experience seeking GSFC Operator certification, the 40 hour apprenticeship requirement may be adjusted at the discretion of the RECERT Manager based on the recommendation of the trainer. The candidate shall complete the required hours of operation within 24 months from the Apprentice Permit issuance to prevent expiration of the Apprentice Permit. Upon completion of the required hours and attendance at a Noncritical Lift Crane Operator refresher class, the apprentice will be certified as a Noncritical Lift Crane Operator.

b. Noncritical Lift Crane Operator License: This license authorizes the Operator to use only the types of Cranes and Hoists listed thereon, and rigging for noncritical lifts only. Noncritical operators are not permitted to use Hydra-sets, unless permitted by the RECERT manager.

c. Critical Lift Crane Operator License: This license authorizes the operator to use Cranes and Hoists and rig for both noncritical and critical lifts, including Hydra-sets. The prerequisite for obtaining a Critical Lift Crane Operator License is that the candidate possesses a Noncritical Lift Crane Operator License and completes 40 hours of critical lift operation (minimum 20 hours Hands–On Crane Operation) and rigging under the direction of a licensed Critical Lift Crane Operator. Upon completion of the required 40 hours and attendance at a Critical Lift Crane Operator class, the Operator will be certified as a Critical Lift Crane Operator. Exceptions to the prerequisite may be reviewed and granted by the RECERT Manager on a case-by-case basis.

3.2.3 Crane Operator Recertification

All Certified Crane Operators shall be recertified and a new license issued based on providing evidence of completion of refresher training, including written examination and hands-on training. A new license will be issued to the Operator, or the Operator roster will be updated and sent to the appropriate supervisory personnel.

Critical and Noncritical Lift Crane Operators shall recertify every two years and provide evidence of successfully completing a medical examination in accordance with NASA Standard 1800.1.

3.3 Requirements for MAP and PIT Operator Certification and Jack Operator Authorization

3.3.1 MAP and PIT Operator Certification Requirements.

All MAP and PIT Operator candidates shall obtain formal training as specified in NASA-STD-8719.9. Formal training may be available through the GSFC RECERT Program or the RECERT Manager may evaluate and determine the acceptability of the syllabus of all training courses for which Operator candidates claim credit. In addition, all MAP and PIT Operator candidates shall pass a written exam, hands on proficiency demonstration, and the applicable medical examination per NASA-STD 1800.1. For MAP operator certification, the candidate must provide proof of successful completion of fall protection training in accordance with GPR 8715.8. A written RECERT exam shall be given to verify the adequacy of the commercial training that the operator candidate claims credit. The following training course topics shall be included as a minimum:

a. NASA-specific requirements
b. GSFC-specific requirements
c. Safe operations
d. Safety and emergency procedures
e. General performance standards
f. Pre-operational checks
g. Safety-related defects and symptoms
h. Specific hazards
i. Lessons learned

Upon successful completion of the required training, the certification records are updated and an individual license, or in some instances a roster of Certified MAP or PIT Operators is prepared. The licenses or the Operator roster shall be signed by the RECERT Manager and issued to the Operator, or, in the case of the Operator roster, to the appropriate supervisory personnel.

3.3.2 Jack Operator Authorization.

Operators of jacks shall be instructed in their proper use per NASA-STD-8719.9 and shall be designated and authorized to operate by their supervisor. The supervisor shall be responsible for retaining documentation of this training.

3.3.3 MAP and PIT Operator Recertification

All Certified MAP and PIT Operators shall be recertified every two years by providing evidence of completion of refresher training, including written examination and hands-on training. Evidence of completing a satisfactory medical examination shall be provided to the RECERT Manager every two years. For MAP operator certification, the candidate must provide proof of successful fall protection refresher training in accordance with GPR 8715.8. A new license will be issued to the Operator, or, in the case of the Operator roster update, to appropriate supervisory personnel.

3.4 Critical Lift Coordinators

3.4.1 CLC Certification Requirements

All CLC candidates shall attend a classroom training session equivalent to the training for critical lift crane operators (reference Section 3.2.1). All CLC candidates shall pass a written examination equivalent to that for critical lift operator certification but are excluded from hands-on proficiency demonstration and the medical examination requirement. Upon successful completion of CLC training and written examination requirements, the RECERT Manager shall certify CLC's by issuance of a signed license or a signed roster.

3.4.2 CLC Recertification

Recertification shall be granted upon successful completion of refresher training and applicable examinations every two years.

3.5 Reciprocity with Licensing Authorities.

At the RECERT Manager's discretion, a temporary Crane, MAP, or PIT Operator License may be issued to personnel on temporary assignment to GSFC provided that the candidate:

a. Possesses a valid Crane, MAP, or PIT operator license or equivalent issued by another Licensing Authority in compliance with requirements contained in NASA-STD-8719.9; and

b. The candidate's license or equivalent remains valid for the duration of the candidate's assignment at GSFC.

Temporary Crane, MAP, or PIT Operator Licenses will be valid for the duration of the candidate's assignment at GSFC, but shall not exceed 90 days. Thereafter, a GSFC Crane, MAP, or PIT Operator License will be required.

3.6 License Revocation

The RECERT Manager may revoke Crane Operator Licenses, CLC Licenses, MAP Operator Licenses, or PIT Operator Licenses for any of the following reasons:

a. Recommendations by an appointed panel of inquiry or Mishap Investigation Board.
b. Violations of, or noncompliance with, any of the safety requirements in the documented procedures.
c. Failure of supervisor providing annual documentation on reviewing of training per Section 1.4 of this document.
d. Failure to meet RECERT-required refresher training or medical examination requirements.

Revoked Operator Licenses shall be returned to the RECERT Manager within 3 business days, and may be reinstated upon satisfactory completion of applicable refresher training or other remedial action deemed appropriate by the RECERT Manager. License extensions may be granted up to but not exceeding 30 days to allow for project demands and class scheduling flexibility. To be eligible for a license extension the operator must request the extension prior to the expiration date of the license and have a current medical examination. Extensions will not be granted if the license or medical examination has expired.

4. Waivers

a. Waivers to the requirements of this directive shall be prepared and approved as outlined in NASA-STD 8709.20 and GPR 1400.1 prior to operation.

b. If a mandatory requirement of this directive cannot be met, a detailed waiver request package shall be prepared by the requesting organization in accordance with NASA-STD 8709.20 and GPR 1400.1. The waiver request package shall be reviewed and the risk accepted by the initiating Division Office and forwarded to the RECERT Manager for review and concurrence/non concurrence.

c. The RECERT Manager will submit the waiver request package to other authorities as stipulated in GPR 1400.1. Waiver requests approved by the Center shall be forwarded to NASA HQ within 14 days.

5. LDE Committee

5.1 A Center LDE Committee (LDEC) shall be established by the RECERT Manager via the Goddard Safety Committee (GSC) to ensure that LDE governing standards are understood and applied across all organizational elements at GSFC. In addition, the LDEC shall resolve LDE-related issues and provide a forum to exchange information. The RECERT Manager shall serve as the Chairperson of the Committee. The Deputy RECERT Manager/WFF shall serve as the Vice Chairperson of the Committee.

5.2 The LDEC Chairperson shall:

a. Accept appointees from the Directorates as Committee Members.
b. Include representatives from organizations conducting or having an interest in lifting operations.
c. Establish the Committee meeting schedule.
d. Conduct quarterly meetings, or more frequently as required.
e. Appoint an Executive Secretary for the Committee.
f. Report as required to the GSC regarding the activities of the Committee.

5.3 The Vice Chairperson shall:

a. Chair the Committee meeting in the absence of the Chairperson.
b. Report as required to the WFF Executive Safety Council regarding the activities of the Committee.

5.4 The Executive Secretary shall:

a. Assist the Chairperson in preparing and distributing meeting agenda, minutes, and related materials.
b. Assist the Chairperson in coordinating Committee-related activities.

c. Track action items and their status.
d. Maintain meeting minutes and make available for review by management and safety and health offices.

5.5 The Committee Members shall:

a. At least one member from each directorate, that have LDE, shall represent his/her Directorate in the Committee's scheduled meetings. Invite other interested personnel to the meeting, including supporting contractors, as appropriate. Membership will be on a 2-year renewable term.
b. Bring Directorate issues/concerns relating to LDE and LDE operations to the Committee.
c. Serve as the information conduit between the LDEC and his/her Directorate organizations.
d. Provide input/closure of the action items assigned by the Chairperson.
e. Review and provide input to the Chairperson on LDE variance requests as required.
f. Review close call and mishaps and provide recommendations for preventive measures.

TABLE 1
Load Test Requirements for New, Repaired, or Modified LDs

	Proof Load		Rated Load		Requirement
	Periodicity[1]	Percentage	Periodicity	Percentage	
Cranes					
Overhead (Non-Critical)	New, Altered	125% (+0%/-5%)	Every Four Years	100% (+5%/-0%)	NASA-STD-8719.9-4.3
Overhead (Critical)	New, Altered	125% (+0%/-5%)	Every Year	100% (+5%/-0%)	NASA-STD-8719.9-4.3
Mobile (Non-Critical)	New, Altered	110% (+0%/-5%)	Every Four Years	100% (+5%/-0%)	NASA-STD-8719.9-5.3
Mobile (Critical)	New, Altered	110% (+0%/-5%)	Every Year	100% (+5%/-0%)	NASA-STD-8719.9-5.3
MAPs (Non-Critical)	New, Altered	N/A[2]	Every Year	100% (+5%/-0%)	NASA-STD-8719.9-11.3
MAPs (Critical)	New, Altered	N/A[2]	Every Year	100% (+5%/-0%)	NASA-STD-8719.9-11.3
PITs (Non-Critical)	New, Altered	N/A[2]	Every Four Years	100% (+5%/-0%)	NASA-STD-8719.9-12.3
PITs (Critical)	New, Altered	N/A[2]	Every Year	100% (+5%/-0%)	NASA-STD-8719.9-12.3
Jacks (Flight Hardware)	New, Altered	120% (+0%/-5%)	Every Year	100% (+5%/-0%)	NASA-STD-8719.9-13.3

[1] "New, Altered" in the column entitled "Periodicity" means new, reinstalled, altered, repaired, rerated, reconditioned, and/or modified
[2] Load test shall be done in accordance with manufacturer's instructions and applicable ASME standard. In a case where both sources are silent, 100% of the rated capacity shall be used.

Appendix A – Definitions

Most of the terms used in this directive are defined in NASA-STD-8719.9 or NASA-STD-8709.22. Those that are critical and or unique to this directive are listed below.

A.1 Certification/Recertification – Written documentation that a set of requirements has been, and continues to be, met. As used in this GPR, certification and recertification is: 1) a process performed by the RECERT Manager that leads to the initial, or continuation of, certification that LDE is safe to use within specific certification parameters, and includes, but is not limited to LDE compliance and documentation reviews, tests, inspections, nondestructive testing, and analyses; 2) a license issued and renewed by the RECERT Manager for operation of LDE; and 3) a memo or license issued to perform the duties of a CLC.

A.2 Critical Hardware – Hardware whose loss would have serious programmatic or institutional impact and that has been identified by the installation, directorate, or project as being critical.

A.3 Critical Lift – A lift where failure/loss of control could result in loss of life, loss of or damage to critical hardware or other items such as spacecraft, one-of-a-kind articles, or major facility components whose loss or damage would have serious programmatic or institutional impact. Operations involving the lifting of personnel with a crane, and lifts where personnel are required to work under a suspended load, shall be defined as critical lifts (see NASA-STD-8719.9). Operations with special personnel and equipment safety concerns beyond normal lifting hazards shall also be designated as critical.

A.4 Critical Lift Coordinator (CLC) – An individual who is assigned or demonstrates a need to direct critical lift activities due to specific project requirements and who has obtained the necessary training and is certified by the RECERT Manager. The CLC is an optional position, used only when a project desires to have its own lifting expert. The role of the CLC shall be specified in the Critical Lift Procedure.

A.5. Daily Checklist – An inspection and/or test performed, prior to use, on a daily basis only for those days while in use.

A.6 Division Office – For the purposes of this GPR, use of the term "Division Office" includes Project Offices, Program Offices, Supervisors, and Owner of Equipment.

A.7 Flight Hardware – Hardware designed and fabricated for ultimate use in a vehicle intended to fly.

A.8 Institutional Lift – A lift performed as part of the day-to-day operations of the Center, such as lifting a section of pipe or moving a pallet of office supplies. It is not a manual lift, although a manual lift may be included as part of an institutional lift. NOTE: an Institutional Lift can also be classified as "critical," depending on the hardware involved.

A.9 Lifting Devices (LD) and Equipment (LE) collectively (LDE) – LDE comprises LD such as overhead and gantry cranes (including top running monorail, under-hung, and jib), mobile cranes, derricks, hoists, winches, special hoist supported personnel lifting devices, mobile aerial platforms (MAP), powered industrial trucks (PIT), and jacks; and LE such as Hydra-sets, load measuring devices, hooks, slings and rigging used for lifting and support of flight hardware or personnel..

A.10 LDE Operator Certification – The documented status of LDE operators (Crane Operator, MAP Operator, and PIT Operator) validating that they are trained and qualified in accordance with NASA-STD-8719.9 and certified by the RECERT Manager. For the purposes of the GSFC LDE RECERT Program, an individual certified as a Crane Operator is concurrently certified as a Rigger, and references to Crane Operators include Riggers. Jack Operators shall be designated and authorized by the equipment owning organization.

A.11 MPJ – For the purposes of this directive, the collective term "MPJ" refers to MAPs, PITs and Jacks as defined in NASA-STD-8719.9.

A.12 RECERT Documentation – Files that are maintained for LDE that may include, but are not limited to, manufacturer's/fabricator's documents, field test data, safety analyses, results of engineering analyses, repair history, facility descriptions, record of all safety variances, re-rating, and correspondence.

A.12 RECERT Approved Procedure – Owner generated, RECERT generated, or OEM-provided documentation that describes the specific steps needed to inspect, test, or operate LDE that is approved by the RECERT Manager.

A.14 RECERT Manager and Deputy RECERT Manager/WFF – Positions appointed by the Center Director to implement and enforce the Center's LDE Program meeting NASA-STD-8719.9 requirements.

A.15 Rigger – An individual who selects and attaches LE to an item to be lifted.

A.16 Support Services Contractors – Contract personnel who are based on-site and participate in on-going daily operations at GSFC.

Appendix B – Acronyms

Most of the acronyms used in this directive are defined in NASA-STD-8719.9 or NASA-STD-8709.22. Those that are critical and or unique to this directive are listed below.

CG	Center of Gravity
CLC	Critical Lift Coordinator
FMD	Facilities Management Division
GPR	Goddard Procedural Requirements
GSC	Goddard Safety Committee
GSFC	Goddard Space Flight Center
HQ	NASA Headquarters
IAW	In Accordance With
IDP	Individual Development Plan
LD	Lifting Device
LDE	Lifting Devices and Equipment
LDEC	LDE Committee
LDEM	LDE Manager
LE	Lifting Equipment
LOTO	Lockout Tagout
MAP	Mobile Aerial Platform
MPJ	Mobile Aerial Platform, Powered Industrial Truck, and Jack collectively (see Appendix A)
NDT	Nondestructive Testing
NRRS	NASA Records Retention Schedules
OEM	Original Equipment Manufacturer
OHCM	Office of Human Capital and Management
OSHA	Occupational Safety and Health Administration (29 CFR 1910, 29 CFR 1926)
PIT	Powered Industrial Truck
RECERT	Goddard Recertification Program
SATERN	System for Administration, Training and Educational Resources, for NASA
WFF	Wallops Flight Facility

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	11/23/04	Initial Release
Baseline	10/27/05	Administratively changed to reflect responsible office change from Code 540, Mechanical Systems Division, to Code 250, Safety and Environmental Division.
A	05/08/09	Responsible office was changed from Code 250, Safety and Environmental Division, to Code 540, Mechanical Systems Division. Revised nomenclature to be consistent with latest HQ requirements in Paragraph 4. Added Paragraph 5, LDE Committee. General editorial changes for consistency with GPR 8834.1.
B	5/29/12	Added GID changes; Under Section 1, changed Occupational Safety to Code 350; under P.1 reflected that this directive is implementing the NASA Standard; under P.2a added additional references; reworded Section 1.2 to reflect current contract; ; Section 1.4 added to reflect owners responsible to control LDE; Section 1.4 added to reflect NASA Standard; Section 1.8 added to give LDE operator authority; Section 2.1.2.3 wording added for ANSI requirements; Section 2.4.2 changed to optional; Section 3.2.3 period of recertification changed to reflect NASA Standard. A note was added to Section 3.6 License Revocation. All definitions and acronyms were moved to the end of the document.

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Overhead Crane Safe Operation Video & Quiz

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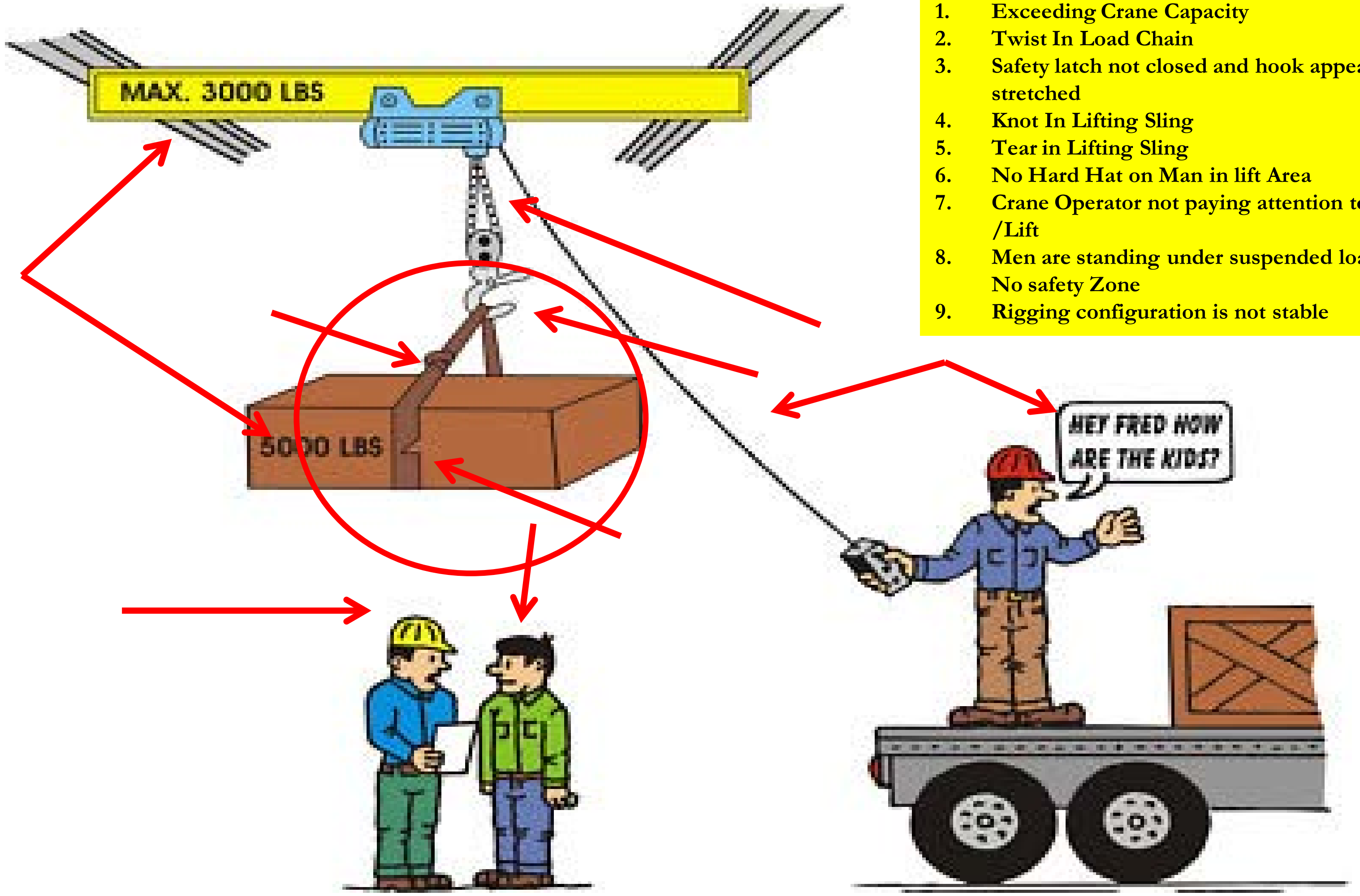
Violations - Let me count the Ways

Violations - Let me count the Ways

How Many Violations Can You Find?

1. Exceeding Crane Capacity
2. Twist In Load Chain
3. Safety latch not closed and hook appears stretched
4. Knot In Lifting Sling
5. Tear in Lifting Sling
6. No Hard Hat on Man in lift Area
7. Crane Operator not paying attention to load /Lift
8. Men are standing under suspended load - No safety Zone
9. Rigging configuration is not stable



Pre-Operational Inspection of Overhead Cranes

NOTE: OVERHEAD CRANE AND HOIST PRE-OPERATIONAL INSPECTION IS CURRENTLY A **DRAFT PENDING FINAL APPROVAL**

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Overhead Crane and Hoist Pre-Operational Inspection

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TABLE OF CONTENTS

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1.0 INTRODUCTION

This document defines the procedures for daily and limit switch inspection for cranes and hoists. These procedures are critical for safety as well as for the useful life of the equipment.

1.1 Definitions

1.1.1 **OSHA Frequent Inspections** are those inspections performed at daily to monthly intervals to insure compliance with OSHA 29CFR 1910.179 Section 1910.179 (j) and NASA Standard 8719.9 Sections 4.4.5 (a).

1.1.2 **Periodic inspections** are performed at a minimum of once per year, In accordance with OSHA 29 CFR 1910.179(j)(3); and NASA-STD-8719.9, Sections 4.4.5 and 6.4.5, as applicable.

1.1.3 **Pre Operational Inspections of all functional operating mechanisms** shall be performed before each lift or series of lifts by the certified operator, in compliance with OSHA 29CFR 1910.179 (j) (2); and NASA-STD-8719.9, Sections 4.4.4 and 6.4.4, as applicable. Daily inspections include the items listed in Sections 4.4.4 and 6.4.4 of NASA-STD-8719.9, as applicable.

1.1.4 **Limit Switch Test.** Before each lift or series of lifts, the operator shall functionally test proper operation of the upper limit switch with no load on the hook. Upper limit switches shall not be used as operating controls, in compliance with OSHA 29 CFR 1910.179(n)(4); and NASA-STD-8719.9,Sections 4.7k and 6.7h), as applicable.

1.1.5 **Discrepancy.** A term to describe any deviation from the normal operating processes; change from original design, or intended configuration of the crane and associated equipment.

1.1.6 **Out Of Service Warning tag.** A tag used to alert all concerned of a hazardous condition or defective equipment. "Out Of Service" or “Do Not Operate” warning tags shall be used until the hazard is eliminated.

1.1.7 **PPE.** Personal Protective Equipment

2.0 DESCRIPTION

This document specifically addresses the procedures for the pre-operational inspection of all cranes and hoists according to NASA, OSHA, and ANSI requirements. These procedures define pre-operational inspections and limit switch inspections. These inspections do not require detailed written reports, but do require log sheet entries to verify when inspections were performed and by whom they were performed. A log sheet example is included in Section 9 of this document. Consistent with the requirements defined in the applicable standards, the tasks shall be performed as outlined below.

3.0 REFERENCES

The following reference material is applicable to these procedures:

3.1 NASA-STD-8719.9, Standard For Lifting Devices and Equipment.

3.2 OCCUPATIONAL SAFETY AND HEALTH STANDARD, 29 CFR 1910.179, Overhead and Gantry Cranes.

3.3 American Society of Mechanical Engineers

- ASME B30.2, Overhead and Gantry Cranes
- ASME B30.7, Base Mounted Drum Hoists
- ASME B30.11, Monorails and Underhung Cranes
- ASME B30.16, Overhead Hoists
- ASME B30.17, Overhead and Gantry Cranes
- ASME HST-1, Performance Standard for Electric Chain Hoists
- ASME HST-2, Performance Standard for Hand Chain Manually Operated Chain Hoists
- ASME HST-4, Performance Standard for Overhead Electric Wire Rope Hoists
- ASME HST-5, Performance Standard for Air Chain Hoists

3.4 GPR 8719.1, Certification and Recertification of Lifting Devices and Equipment

3.5 GPR 8834.1, Lifting Operations Requirements

3.6 GPR 1700.5, Control of Hazardous Energy (Lockout/Tagout)

3.7 CMAA Crane Manufacturers Association of America, Crane Operators Manual

3.8 NFPA National Fire Protection Association, 70E Standard for Electrical Safety in the Workplace

4.0 Safety Requirements

4.1 The certified operator shall read and be familiar with these procedures prior to the start of operating a crane or hoist.

4.2 When operating the controls, the operator will refrain from conversation with other people and fix his/her attention on the movement of the crane or hoist.

4.3 A hard hat and safety shoes are required while operating overhead cranes and hoist or performing inspections. Proper Personal Protective Equipment (PPE) shall be worn when actuating an overhead crane mainline disconnect switch. PPE shall be determined by the category of the disconnect switch to be actuated and shall conform to NFPA 70E Article 130.

4.3.1 For a category “0” mainline disconnect switch, the PPE requirements are as follows:

Note: All Protective clothing must be made with a non-melting or untreated natural fiber (i.e. untreated cotton, wool, rayon, silk, or blends of these materials) with a fabric weight of at least 4.5 oz/square yard.

i.) Shirt (long sleeve)
ii.) Pants (long)
iii.) Safety glasses or safety goggles
iv.) Hearing Protection (ear canal inserts)
v.) Heavy duty leather gloves

4.3.2 For category 1 and above disconnects, consult NFPA 70E Article 130 and your safety representative for guidance and PPE requirements

4.3.3 In addition to the aforementioned PPE, the need for additional PPE and equipment may be required as follows:
Binoculars - (as needed)
Barrier Material (safety/lift zone)

Note: “Out Of Service” or “Do Not Operate” tags are available from the Shift Leader, LDE Inspectors or Maintenance groups, or through the safety offices at Greenbelt and Wallops. Reference GPR1700.5B

4.4 If a crane or hoist operator discovers a discrepancy in any item listed in this inspection procedure, the operator has the authority and is required to immediately remove the crane or hoist from service by administering an “Out Of Service” or “Do Not Operate” tag, securing the crane or hoist by using an administrative lock to lock out the disconnect or securing the operating control (i.e. Pendant, radio) as specified by the device owner and reporting his/her findings to the following personnel in the order noted:

i.) The owner of the lifting device

ii.) His/her Manger or Supervisor

iii.) The LDEM, Brian Montgomery, 6-4209 at GSFC or the Deputy LDEM, Prasad Hanagud, 1359 at WFF.

iv.) Others as appropriate or directed.

v.) All discrepancies shall be noted in the log book.

5.0 REQUIRED PERSONNEL

The pre-operational inspection and the limit switch test shall be performed by a certified crane or hoist operator (Critical or Noncritical) assigned to operate the crane or hoist before each lift or series of lifts. (Reference NASA- STD-8719.9, Section 4.6 through Section 4.7 and Section 6.6 through Section 6.7, as applicable)

6.0 PRE-OPERATIONAL INSPECTION PROCEDURE FOR ELECTRIC OVERHEAD CRANES AND HOISTS

This procedure shall be performed by the certified operator prior to each lift or series of lifts. The intent of this inspection is to verify operational readiness of the device, prior to use for lifting operations.

6.1 Check the log book, usually located near the crane disconnect switch to ascertain there are no outstanding deficiencies prior to proceeding with the pre-operational inspection.

6.2 Verify device is within certification intervals and that the device is certified for the type of lift for which the operator intends to use it (Critical or Non-Critical).

6.3 Verify there are no new or known hazards, obstructions or environmental conditions that would limit or obscure normal operation of the device for use or pre-operational inspection.

6.4 Prior to applying power to the device, operate pendant or radio buttons, switches and joysticks to ensure that all controls operate smoothly and efficiently without sticking or binding.

6.5 Visually inspect the condition of the pendant and cable for loose connections, cuts, chafing, abrasions, excessive wear, dirt, or grease.
If radio controlled, inspect the condition of the housing, battery, belts, fasteners, clips, buttons, joysticks and switches. Reference the manufacturer's manual for guidance of key components to inspect for the type of operating control you are inspecting.

6.6 Visually perform system checks to include:

6.6.1 Hoist, Trolley and Bridge as applicable.

i) Hoist to hanger connection or that hoist appears normal.

ii) Trolley to beam connection or general condition of trolley mounting

iii) Power feed system(s) general condition (including but not limited to Bus Bar conductors, belt systems and belt trolleys, hangers, visible fasteners) as applicable.

iv) Bridge runway beams, load beams, pedestals, supporting structure and visible fasteners for general condition as applicable.

Note: Any abnormal condition shall be logged and the pre-operational inspection discontinued until abnormality is addressed and resolved. Operator shall notify the personnel listed in section 4.4 of this document.

6.7 If no discrepancies were found during the visual inspection, it is permissible to supply power to crane controls.

6.7.1 If supplying power to the crane or hoist controls requires the actuation of a mainline disconnect switch, than the following methods shall be used to minimize potential injury in the event of an arc flash occurrence.

6.7.1.1 For mainline disconnect switches with the actuator mounted on the right side of the switch and hinged on the left you shall:

WARNING: Proper PPE as required by NFPA 70E "Standard for Electrical Safety in the Workplace" shall be worn. Operator should reference section 4.3 of this document for guidance.

i) Stand to the right side of the mainline disconnect switch, not in front of the box.

ii) Ensure that all personnel are clear of the area

iii) Grab the disconnect with your LEFT hand

iv) Turn your body and face away from the switch

v) Close your eyes.

vi) Take a deep breath and hold it.

vii) It is now permissible to actuate the electrical disconnect

6.7.1.2) If the above method is not feasible due to the location or construction of mainline disconnect switch, or physical limitations of the personnel actuating the mainline disconnect switch, follow at a minimum the following precautions.

WARNING: Proper PPE as required by NFPA 70E "Standard for Electrical Safety in the Workplace" shall be worn. Reference section 4.3 of this document for guidance

i) Position your body as far away as possible from the mainline disconnect switch, but within comfortable means to actuate the mainline disconnect switch with proper force.

ii) Ensure that all personnel are clear of the area

iii) Firmly grip the actuating lever/switch with Right or Left Hand (depending on location or construction of the mainline disconnect switch).

iv) Always turn your head away from the mainline disconnect switch.

v) Close your eyes.

vi) Take a deep breath and hold it.

vii) It is now permissible to actuate the mainline disconnect switch.

6.8 Functional Operation of Electric Crane/Hoist Mechanisms

6.8.1 Bridge operation.

6.8.1.1 Move the bridge at least 10 feet in each direction at a minimum, and through the entire working envelope as necessary. Listen and observe for erratic start and stop, smooth travel, braking action, and any unusual noises.

6.8.1.2 If equipped, and operating within the vicinity of the Bridge limit switches carefully move the bridge to the bridge limit switch to confirm bridge travel ceases.

6.8.2 Trolley Operation.

6.8.2.1 Move the trolley at least 10 feet in each direction at a minimum, and through the entire working envelope as necessary. Listen and observe for erratic start and stop, smooth travel, braking action, and any unusual noises.

6.8.2.2 If equipped, and operating within the vicinity of the trolley limit switches carefully move the trolley to the trolley limit switch to confirm trolley travel ceases.

6.8.3 Hoist Operation

6.8.3.1 Lower the hoist approximately 3 feet from its parked position (normally just below the upper limit switch). Perform the initial hoist limit switch test as follows:

i.) Carefully move the hoist block into the upper hoist limit switch to confirm hoist movement ceases. The initial upper hoist limit switch shall be tested under a no load condition (i.e. empty hook).

ii.) With extreme care, the block shall be "inched" into the limit switch at slow speed.

iii.) This test shall be performed before each lift or series of lifts per NASA Std. 8719.9 sec. 4.7 (k) and 6.6 (h) as applicable.

6.8.3 .2 If the limit switch fails to stop hoist motion the operator shall:

i) Secure the crane or hoist by locking out the disconnect, or securing the operating control (i.e. Pendant, radio) as specified by the device owner and reporting his/her findings to the personnel stated in section 4.4 of this document

ii) Attach a Yellow “Out Of Service" or “Do Not Operate” tag at the location of the administrative lockout lock.

6.8.3.3 After completing the initial upper limit switch test, move the hoist block to eye level. Listen and observe for erratic start and stop motion, smooth travel, braking action, unusual noise, or any loose parts or components. During lowering, check all speed functions that are available on the operating control. Always ensure there are no less than 2 full wraps of wire rope left on the drum with the hook in the extreme lower position.

6.9 Load Block Inspection

6.9.1 Examine the hook block side plate bolts and the sheave pin keepers for looseness.

6.9.2 Visually examine the load block sheaves or chain wheel(s) for excessive wear or broken flanges.

6.10 Hook Inspection

Check the Hook for the following:

i) Visual signs of wear, cracks, or deformation.

ii) Throat opening is normal.

iii) The tip of the hook and the shank of the hook are in the same plane.

iv) The safety latch is on the hook and that the latch operates properly.

v) The hook rotates freely and the hook bearing shows no signs of excessive wear.

6.11 Wire Rope /Load Chain Inspection

6.11.1 Visually inspect as much of the wire rope visible from floor level for twists, kinks, broken wires, excessive wear, and proper seating in the hook block sheaves and drum grooves.

CAUTION: If you grasp the wire rope for any reason, wear gloves to avoid a possible injury from a broken steel wire.

6.11.2 If the crane is equipped with a hoist load chain in lieu of a wire rope, visually inspect as much of the chain as possible from floor level. Check end connections for looseness or excessive wear. Make sure the chain links are not twisted, distorted, or stretched and that the chain tracks properly in the chain wheels.

Note: It is recommended that when the overhead height of the device is such that a visual inspection of the hoist wire rope or load chain is difficult, the operator should use a visual aid such as binoculars or monocular to thoroughly inspect wire rope or load chain.

6.12 Operate the hoist in the up direction. While raising the block, check all speed functions available on the Operating control.

6.13 Emergency Stop Button Test

6.13.1 While hoisting, actuate the emergency stop/stop button on the operating control and ensure all functions are disabled at this time (Hoist, Trolley, and Bridge as applicable)

6.13.2 If any functions still operate with the emergency stop actuated, discontinue the preoperational inspection and perform lock out / tag out as outlined in sec 4.4 of this document.

6.13.3 If the device is equipped with a secondary emergency stop as required for some critical lift operations, than both emergency stop buttons must be tested independently.

6.14 Oil Leaks and visual check of condition

6.14.1 From the floor, look for any noticeable oil leaks on the underside of the crane.

6.14.2 Inspect the floor in the area where the crane is normally parked for oil, paying particular attention to the locations below the hoist, trolley and bridge drives.

6.14.3 Any oil leaks should be reported to the LDE inspectors and maintenance groups. If excessive, discontinue the preoperational inspection and perform lock out/tag out procedure as outlined in sec 4.4 of this document.

6.15 Hoist Wire Rope and Load Chain Travel

6.15.1 Wire Rope Hoist.

From the floor, look at the position of the hoist cable as it winds on and off the drum and through the upper sheaves. Ensure the wire rope travels smoothly and is seated properly in the sheave grooves. Look for twists, kinks, broken wires, excessive wear and signs of deterioration. Use binoculars to aid in this check if the hoist is high or difficult to see with the naked eye. If binoculars are required, ask your Shift Leader or Supervisor to provide binoculars.

6.15.2 Chain Hoist.
From the floor, look at the position of the load chain as it passes through the chain wheel(s) both at the hoist and at the load block. Make sure the chain links are not twisted, distorted, or stretched and that the chain tracks properly in the chain wheels. Note any binding or erratic movement while hoisting. If equipped with a chain container, visually inspect the chain container, chain guides and the fasteners as dead end of the chain is deposited into the chain container. Where visible, ensure the load chain dead end is fastened or equipped with a travel stop that prevents the chain from unspooling from the hoist. Use binoculars to aid in this check if the hoist is high or difficult to see with the naked eye. If binoculars are required, ask your shift leader or supervisor to provide binoculars.

6.16 In the Crane Inspection Log, the operator shall enter the date; print and sign their name (no initials); check off the results of the inspection items and note any departure from this procedure or discrepancies found during their inspection.

> Note: Any discrepancies discovered during the inspection shall be handled in accordance with Sections 4.4 of this document.

7.0 PRE-OPERATIONAL INSPECTION PROCEDURE FOR MANUALLY OPERATED CRANES AND HOISTS

This procedure shall be performed by the certified operator prior to each lift or series of lifts. The intent of this inspection is to verify the operational readiness of the device prior to use for lifting operations.

7.1 Check the log book located near the crane to ascertain there are no outstanding deficiencies prior to proceeding with the pre-operational inspection.

7.2 Verify the device is within certification intervals and that the device is certified for the type of lift for which the operator intends to use it (Critical or Non-Critical).

7.3 Verify there are no new or known hazards, obstructions or environmental conditions that would limit or obscure normal operation of the device while performing the pre-operational inspection or for normal use.

7.4 Operate the hand chain and ensure that all links operate smoothly and efficiently without binding prior to proceeding with the preoperational inspection.

7.5 Visually inspect the condition of the hand chain or other operating control device, all fasteners, clips, housings, warning labels and guides for the operating control.

7.6 Visually perform system checks to include:

7.6.1 Hoist, Trolley and Bridge as applicable.

i) Hoist to hanger connection or that hoist appears normal.

ii) Trolley to beam connection or general condition of trolley mounting

iii) Power feed system(s) general condition (including but not limited to Bus Bar Conductors, Belt systems and Belt Trolleys, Hangers, visible fasteners, and electrical connections) as applicable.

iv) Bridge runway beams, jib attachment, load beams, pedestals, supporting structure and visible fasteners for general condition as applicable.

Note: Any abnormal condition such as missing fasteners, evidence of structural degradation, or deterioration, should be noted and the pre-operational inspection shall be discontinued until the abnormality is addressed and resolved. Operator shall log findings and notify the personnel listed in section 4.4 of this document.

7.7 If the bridge or trolley is electrically operated reference and perform sections 6.7 through 6.9.2.

7.8 Functional Operation of Manual Crane/Hoist Mechanisms

7.8.1 Bridge operation.

7.8.1.1 Move the bridge at least 10 feet in each direction at a minimum, and through the entire working envelope as necessary. Listen and observe for erratic start and stop, smooth travel, braking action, and any unusual noises.

7.8.1.2 Carefully move the bridge into the bridge end stops to confirm bridge travel ceases. Move bridge in opposite direction and repeat.

7.8.2 Trolley Operation.

7.8.2.1 Move the trolley at least 10 feet in each direction at a minimum, and through the entire working envelope as necessary. Listen and observe for erratic start and stop, smooth travel, braking action, and any unusual noises.

7.8.2.2 Carefully move the trolley into the trolley end stops to confirm trolley travel ceases. Move the trolley in the opposite direction and repeat the procedure.

7.8.3 Hoist Operation

7.8.3.1 Move the hoist block to eye level. Listen and observe for smooth travel, unusual noise, or any loose parts or components.

7.8.3.2 If observable from floor level, check that the upper limit device is working properly. On a manual chain hoist, this may be a simple stop device to limit the travel of the chain beyond a designated point. Always ensure that the dead end of the chain is secured with a fastener or that a mechanical stop device is in place to prevent the chain from unspooling.

7.9 Load Block Inspection

7.9.1 Examine the Hook Block side plate bolts and the sheave pin keepers for looseness.

7.9.2 Visually examine the load block sheaves or chain wheel(s) for excessive wear or broken flanges.

7.10 Hook Inspection

Check the Hook for the following:

i) Visual signs of wear, cracks, or deformation.

ii) Throat opening is normal.

iii) The tip of the hook and the shank of the hook are in the same plane.

iv) The safety latch is on the hook and that the latch operates properly.

v) The hook rotates freely and the hook bearing shows no signs of excessive wear.

7.11 Wire Rope /Load Chain Inspection

7.11.1 Visually inspect the wire rope for twists, kinks, broken wires, excessive wear, and proper seating in the hook block sheaves.

CAUTION: If you grasp the wire rope for any reason, wear gloves to avoid a possible injury from a broken steel wire.

7.11.2 If the crane is equipped with a hoist chain in lieu of wire rope, visually inspect the chain. Check end connections for looseness or excessive wear. Make sure the chain links are not twisted, distorted, or stretched and that the chain tracks properly in the chain wheels.

7.12 Operate the hoist in the up direction. While raising the block, check to ensure smooth transfer of chain links through the upper and lower chain wheel(s). If operating a manual wire rope hoist, check to ensure smooth transfer of the wire rope through the upper and lower sheaves.

7.13 Oil Leaks and visual check of condition

7.13.1 From the floor, look for any noticeable oil leaks on the underside of the crane or hoist.

7.13.2 Inspect the floor in the area where the crane or hoist is normally parked for oil, paying particular attention to the locations below the hoist, trolley and bridge gear cases as applicable.

7.13.3 Any oil leaks should be reported to the LDE inspectors and maintenance groups. If excessive, discontinue the preoperational inspection and perform lock out / tag out as outlined in section 4.4 of this document.

7.14 Hoist Wire Rope and Load Chain Travel

7.14.1 Wire Rope Hoist.
From the floor, look at the position of the hoist cable as it winds on and off the drum and through the upper sheaves. Ensure the wire rope travels smoothly and is seated properly in the sheave grooves. Look for twists, kinks, broken wires, excessive wear and signs of deterioration. Use binoculars to aid in this check if the hoist is high or difficult to see with the naked eye. If binoculars are required, ask your Shift Leader or Supervisor to provide binoculars.

7.14.2 Chain Hoist.
From the floor, look at the position of the load chain as it passes through the chain wheel(s) both at the hoist and at the load block. Make sure the chain links are not twisted, distorted, or stretched and that the chain tracks properly in the chain wheel(s). Note any binding or erratic movement while hoisting. If equipped with a chain container, visually inspect the chain container, chain guides and the fasteners as the dead end of the chain is deposited into the chain container. Where visible, ensure the load chain dead end is fastened or equipped with a travel stop that prevents the chain from unspooling from the hoist. Use binoculars to aid in this check if the hoist is high or difficult to see with the naked eye. If binoculars are required, ask your shift leader or supervisor to provide binoculars.

7.15 In the Crane Inspection Log, the operator shall enter the date; print and sign their name (no initials); check off the results of the inspection items and note any departure from this procedure or discrepancies found during their inspection.

Note: Any discrepancies discovered during the inspection shall be handled in accordance with Sections 4.4 of this document.

8.0 DAILY OPERATOR INSPECTION CHECKLIST INSTRUCTIONS

Note1: The owner/user should ensure that whatever daily inspection form they use complies with the applicable codes and standards, and OEM manuals, as required by GPR 8719.1.

Note 2: Owner/users may review the sample forms provided herein, and request copies for their use as needed, or they may use an OSHA or ANSI approved checklist (ex. http://www.osha.gov/dte/library/pit/daily_pit_checklist.html), or a checklist from the OEM. When applicable, the owner of the LDE should have at a minimum, the sample fields located on the sample forms.

Note 3: LDE may provide owner/users with copies of the sample daily inspection forms for their use upon request.

8.1 After the daily inspection has been made, enter the following information in the Daily Operator Inspection Checklist.

AREA 1 Enter the date of inspection (e.g. 01/14/2013)

AREA 2 Enter the Crane or hoist Identification #. This ID can be found on the certification tag for each unit. Verify the crane or hoist is certified for the type of lifting operation you intend to use it for at this time.

AREA 3 Enter a check mark (√) in the appropriate column indicating either "Pass", "Fail" or "N/A" for each item listed. If any Item is indicated under the "Fail" column, the operator must notate the type of failure in the remarks column to the right of that item. Also use the remarks area to indicate anything that deviates from this procedure; (e.g. Trolley has no limit switch as trolley is stationary).

AREA 4 Enter any comments or conditions that in your judgment are unusual. Initial your comments,(i.e., Found radio not secured in lockbox). This section can also be used for additional comments to any discrepancies noted in AREA 3.

AREA 5 Print and sign your name to indicate you have completed the pre-operational inspection prior to operating or performing any lifting operations.

NOTE: If any discrepancy is encountered during the daily inspection, appropriate action shall be taken in accordance with section 4.4 of this document

SAMPLE

AREA-1 → **Date: <u>MM/DD/YYYY</u>**

AREA -2 → **Crane ID# ___________**

AREA 3

Operating Control	PASS	FAIL	N/A	Remarks
Pendant and Cable				
Radio				
Hand Chain				
Other				
Functional Operation	PASS	FAIL	N/A	Remarks
Trolley Operation(Start/ Stop, Smooth Operation)				
Trolley Limits or Stops				
Bridge Operation(Start/ Stop, Smooth Operation)				
Bridge Limits or Stops				
Hoist Operation(Start/ Stop, Smooth Operation)				
Hoist Upper Limit Switch				
Hoist Lower Limit Switch (If Applicable)				
Hoist Block, Sheaves, Pins & Fasteners				
Hoist Rope or Chain				
Grease or fluid leaks (Underside of hoist/crane and around drive gear cases)				

AREA 4

Comments/ Unusual Conditions, etc…

____

____

____

____

____

____

____

____

AREA 5

Printed Name of Inspector/ Operator ______________________________

Signature of Inspector / Operator ______________________________

NOTE: OVERHEAD CRANE AND HOIST PRE-OPERATIONAL INSPECTION IS CURRENTLY A **DRAFT PENDING FINAL APPROVAL**

SAMPLE

Date: ______/______/______

Crane ID# __________________

Operating Control	PASS	FAIL	N/A	Remarks
Pendant and Cable				
Radio				
Hand Chain				
Other				
Functional Operation	PASS	FAIL	N/A	Remarks
Trolley Operation (Start/ Stop, Smooth Operation)				
Trolley Limits or Stops				
Bridge Operation (Start/ Stop, Smooth Operation)				
Bridge Limits or Stops				
Hoist Operation (Start/ Stop, Smooth Operation)				
Hoist Upper Limit Switch				
Hoist Lower Limit Switch (If Applicable)				
Hoist Block, Sheaves, Pins & Fasteners				
Hoist Rope or Chain				
Grease or fluid leaks (Underside of hoist/crane and around drive gear cases)				

Comments/ Unusual Conditions, etc…

____
____
____
____
____
____
____

Printed Name of Inspector/ Operator __________________________________

Signature of Inspector / Operator _____________________________________

NOTE: OVERHEAD CRANE AND HOIST PRE-OPERATIONAL INSPECTION IS CURRENTLY A **DRAFT PENDING FINAL APPROVAL**

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Operating With A Radio Control

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SAFE OPERATING PROCEDURES

RADIO CONTROLLED CRANE OPERATION

Crane radio operators responsibilities and qualifications are the same as pendant operators. They must be capable of meeting all physical requirements, have a thorough knowledge of crane operations and rigging procedures, and always exercise safe operating practices and load control.

Radio controlled cranes operate basically the same as pendant or cab controlled cranes. The difference lies in the ability of the operator to move in areas not necessarily relative to the position of the crane, i.e., one has no fixed connection to the crane. Due to this freedom, it is imperative that a radio operator must always be aware of his position relative to load position and "pinch points."

The following are good, basic, operating practices that should be followed to help insure safe crane radio operation. They are, general, and one must remember that other practices may apply due to the individual facility requirements with respect to operation or physical lay out.

A. Verify that you have the correct transmitter for the crane you intend to operate before you turn the key or switch on.
B. Know the operation of the Radio Control box (position of relative controls).
C. Verify that all control levers are in the neutral or "off" position before turning the radio control box to the "on" position.
D. Walk to the Crane, do not bring the crane to you.
E. Do not operate the crane "blindly," the crane and load should be in clear sight and either to the side or in front of you.
F. The operator should maintain a position as close to the load as *safely* possible.
G. Do not wear gloves to operate the transmitter.
H. The transmitter should be secured to you, using straps or belts, before turning the controls to an "on" position.
I. Turn the transmitter to an "off" condition after use, or when transferring the control to another operator.
J. Never block the levers in an operating position.
K. If the crane does not operate correctly, or is operating intermittently, stop immediately, shut off transmitter, report the condition to your supervisor or RECERT, and write it in the log book immediately.
L. Radio transmitters should be kept in a designated area, and keys under the control of a designated person, with a routine established for charging new and spare batteries.

Bldg. 10 Known Hazards

Use of the ByPass Button

WARNING!

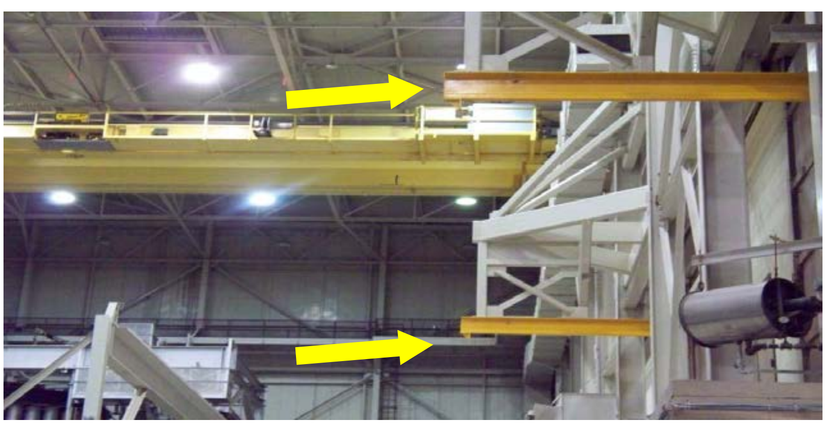
- When approaching the Clean Room #120 areas and actuating the proximity switch the operator must use extreme caution. Actuating the limit at even a moderate speed and having crane abruptly stop, can cause load swing, shock to crane and possible load control issues.
- Bring crane to a stop before entering the zone and actuate By-Pass button while controlling the crane with Joystick or Pushbutton control.
- While operating in the Clean Room #120 areas, always stop Bridge motion by using the Joystick or Pushbutton control

BEFORE RELEASING THE BY-PASS BUTTON

This will allow the bridge to decelerate slowly.
Once the Bridge has come to a complete stop, the operator can release the By-Pass button

Trolley

When traversing trolley in the "WEST" direction the primary limit switch will limit travel to allow clearance for the monorail spur extensions at the vibration test cells.



The operator can continue traveling "West" into the final Trolley limit by actuating the By-Pass button on either the Radio or Pendent control. This allows an envelope to transfer loads closer to the Vibration Cells with awareness of the monorail obstructions. **Extreme caution should be exercised when operating in the By-Pass mode.**

Bridge

When traversing "NORTH", the bridge will actuate a proximity limit just before reaching clean room 120 (a.k.a. the White House or the Robotics Lab) that will stop motion in the "NORTH" direction.

To continue travel in the "NORTH" direction the operator must actuate the By-Pass button on either the Radio or Pendent control.

Once the crane is in the envelope of clean room 120 the By-Pass button must be <u>maintained</u> to travel in the "NORTH" direction

For every Radio operated crane there is a pendant back-up in case of a problem with the the radio. The availibility of some functions may be limited in Pendant Mode.

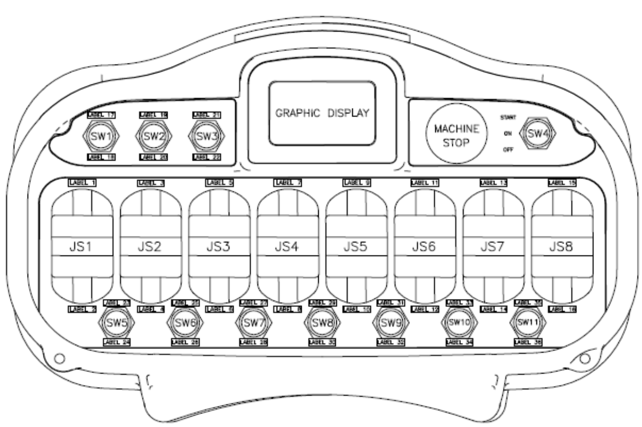
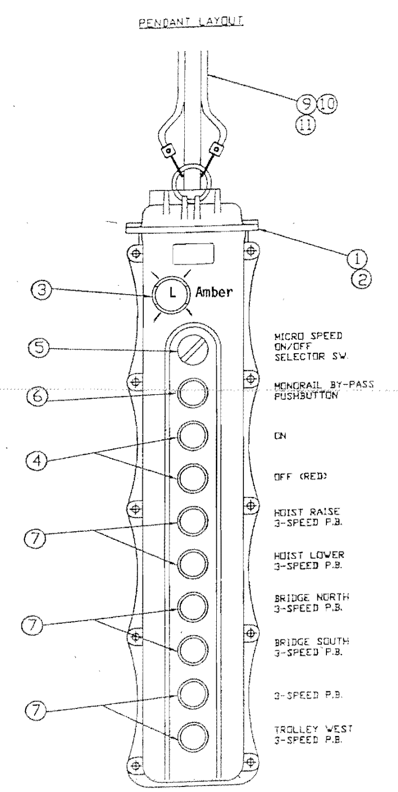


Figure 1: Typical XLTX with maximum number of Paddles and Auxiliary Switches



Some General Operating Procedures and Good Practices for all Radio Controlled /Pendant Operated Overhead Cranes

> The crane limit switch shall be checked before each lift or series of lifts. While checking the limit switches, the hoist be centered over an area free of personnel and equipment, so that if the limit switches fail and the hook and block assembly fall, no one will be injured and no equipment will be damaged.

> The limit switch shall never be used as a regular stopping device.They are intended to be protective devices only.

> When lifting maximum loads or loads near maximum, the operator shall test the hoist brakes by raising the load a few inches from the floor. If brakes do not hold, the load shall be immediately lowered to the floor and a report made to the supervisor, Crane owner or F.O.M., and the Lifting Device Equipment (LDE) Manager.

> Do not make lifts in excess of the rated capacity of the equipment.

> When making lifts, the bridge and trolley shall be centered directly over the load to prevent swinging when the load is raised.

> When raising or lowering a load, proceed slowly and make certain the load is under control. Tag lines shall be used for handling unusual lengths or bulky loads. Take the slack out of the chain or slings gradually. Make sure all persons are clear before making the lift.

> Crane operator shall keep all parts of his body away from the load and shall never position himself under the load.

> Do not make a lift or move the crane if anyone is in the loads path or at risk for injury from movement of the load or crane.

> If the Radio Control Crane Operator is being directed by a Rigger / Signal person, they shall not move the crane until they have received a signal from the Rigger/Signal Person that they are clear to move.

> Loads shall not be carried over personel . If anyone is in the path of travel, the Radio Control Crane Operator shall stop and clear the area before proceeding.

> Bumping into runway stops or into other cranes on the same runway is prohibited.

>The bridge and trolley brakes and limit switches if applicable shall be tested before each lift or series of lifts. They should be tested at low speed.

> The Radio Control Crane Operator shall stop operation and turn off the appropriate on/off switch on the radio control box if the crane fails to respond correctly. He should report the condition to his supervisor the crane owner or F.O.M. and the LDE Manager.

Some General Operating Procedures and Good Practices for all Radio Controlled /Pendant Operated Overhead Cranes

> Where gloves are not required for safety reasons, they should not be used when operating the radio control box. Cumbersome or large work gloves may cause inadverent actuation of control buttons or switches.

> The Radio Control Crane Operator shall not drag slings, chains, etc. along the floor. They could snag something causing damage to slings, Cranes or lifting equipment and could injure the operator or a fellow personel in the area.

> All loose material or parts shall be removed from the load before starting lift. Such material can fall, striking personel below that may result in injury or death.

> The Radio Control Crane Operator shall hoist lifts high enough to clear all apparatus and workman below the crane, but shall exercise good judgement to move loads as safely possible

> When moving the crane the Radio Control Crane Operator shall be sure that the hook, block, attachment or cables will not contact any nearby equipment

> The Radio Control Crane Operator shall never permit anyone to ride on the load or hook except when authorized by the supervisor.

>The Crane Operator shall have the final approval on the lift. If the Crane Operator is not comfortable or satisfied that all aspects are correct or complete prior to the lift, the Crane Operator does not have to perform the lift, and shall contact the LDE manager immediately

> When another crane on the same runway is stationary, with or without a load, the Radio Control Crane Operator shall maintain a safe distance. Pushing of cranes on the same runway to position them out of the way is forbidden.

> If the power goes off, the Radio Control Crane Operator shall position his switches in the OFF position and keep them OFF until power is restored.

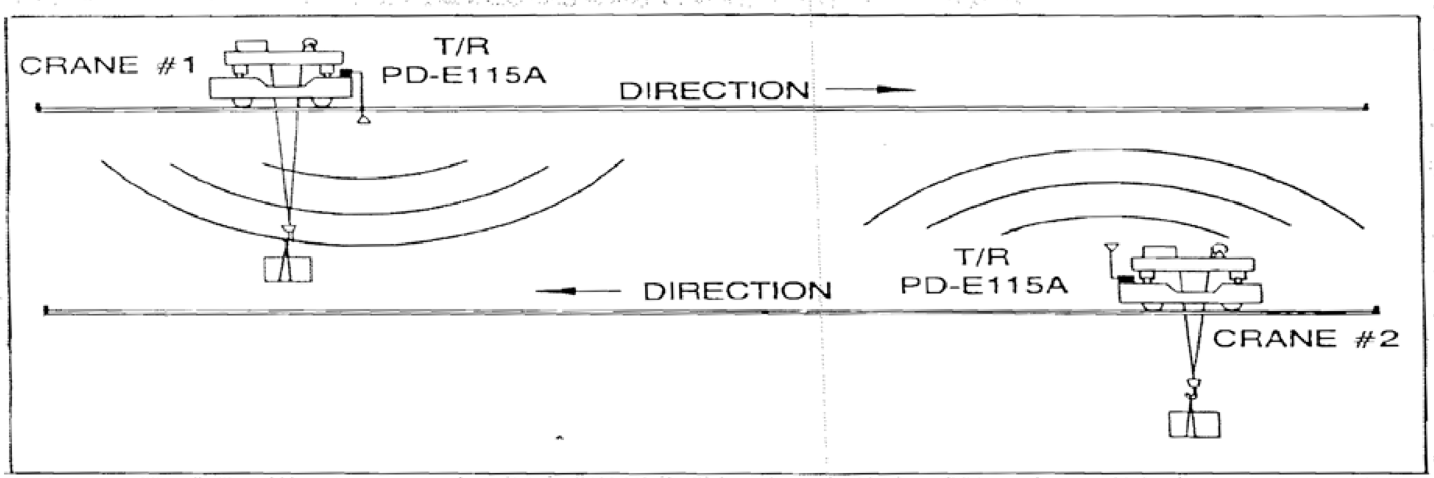
> Plugging shall not be used as a regular means of stopping the crane. Plugging is intended for emergency stops only, except when authorized by the crane manufacturer.

Caution should be used when plugging with the radio control box or any operating control.

> Outside cranes, subject to movement by winds, storms, etc. shall be anchored when left unattended. If crane is equipped with bridge brake, the parking brake should be set.

Anti-Collision Device

Zone Control – Collision Prevention Of Two Tiered Cranes



Anti Collision Components

A.)Two Transmitters

B.) Two Recievers

Transmitter #1 is on Crane #1(Upper Crane) while Reciever #1 Is on Crane #2(Lower Crane)
Transmitter #2 is on Crane # 2 (Lower Crane) while Reciever #2 is on Crane #1 (Upper Crane)

Anti-Collision Device Operation

A.) Both Cranes must be energized at the mainline disconnect for the system tooperate properly

B.) System is activated by loweing the the load block/hook of the upper Crane (Crane #1) approxemately 6 inches from the limit actuated position. This action applies power to both Transmitter# 1 and reciever #2 located on Crane #1 sevice platform.

C.) Sytem has three stages of operation dependant on distance as follow:

Stage 1 > At approxematly 30 feet both cranes go into low speed and constant audible bell alarm is actuated.

Stage 2 > At approxematly 25 feet both cranes go into creep speed and constant audible bell alarm continues to sound.

Stage 3 > At approxematly 10 feet both cranes stop and travel in direction of opposing crane is disabled. The constant audible bell alarm continues to sound.

Distances are not always the same as stated as they are dependent on positioning of cranes, Amplifier gain and sensitivity settings of the transmitters and recievers, and interferences of the radio frequencies for the system.

D.) To Reset The Anti-Collision Sytem

1.) Cranes can be moved in reverse direction until they are out of the approxemate 30 foot approach zone in relation to each other.

2.) The By-pass button on either crane operating control (Radio) can be mannually actuated by the operator to allow brigde funtion in the direction of the opposing crane.

(Extreme caution shall be used when operating the upper or lower crane at distances of less than 10 foot of approach with the upper cranes (Crane #1) load block/hook is lowered into the path of the lower cranes (Crane#2) Brige or trolley path.

3.) Opening the disconnect of eiter the upper or lower crane will disable the anti-collision system

(AGAIN >>Extreme caution shall be used when operating the upper or lower crane at distances of less than 10 foot of approach with the upper cranes (Crane #1) load block/hook is lowered into the path of the lower cranes (Crane#2) Brige or trolley path.

Generally most Radio transmitters will consist of the following:

- ON-OFF Switch - turn the switch "ON" - a green flashing light indicates that the transmitter is in operation. Be sure to turn this switch "OFF" at the completion of your job.

- Reset Button - pushing this button resets the crane control and sounds a horn. A light on the bridge indicates the crane control is reset. (NOTE: Allow at least 2 minute between crane resets.)

- Micro Speed selector - sets up the hoist micro speed selection. May also apply to Bridge or trolley

- Ultra Lift Selector Switch - provides a slightly faster than normal speed for the hoist May also apply to Bridge or trolley

- Normal Speed Selector - normal hoist speed. May also apply to Bridge or trolley

- Joy Sticks - bridge, trolley, and hoist. Provides infinitely variable speed control for the hoist and five-step speed control for the bridge and trolley.

- Read-out Console - provides the percent of full load amps for the hoist and hoist speed. (Inches per minute when in micro speed and feet per minute when in normal or ultra lift.)

- Back-up Pendant - a pendant exists on the crane bridge that can be lowered and put in service by the crane RECERT Group, when required.

- Emergency Stop Button - this is a red push/pull button. The button must be pulled "up" to permit a crane reset. Pushing the button down drops out the crane reset and sets all brakes. (Use this button to shut down the crane at the completion of your job.)

The Flux Vector Drive provides the means for precise positioning of the hoist to enhance integration work and smooth handling.

The following terms describe some of the benefit of the system.

- Vector duty motor - specially designed motor to be used with Flux Vector Drive systems. Permits slow speeds for long periods of time without overheating - will hold the load at zero speed.

- Encoders - motor feedback system providing a closed loop control - has a resolution 1040:1.

- Load Float - the motor holds the load in a float or zero speed condition for a period of time before the brakes are set. (The time period for this drive system is 10 seconds.)

  Except for an "E" stop or fault condition, the brakes do not stop the load. The motors stop the load; and after 10 seconds, the brakes set to hold the load in position. The timing restarts after each command.

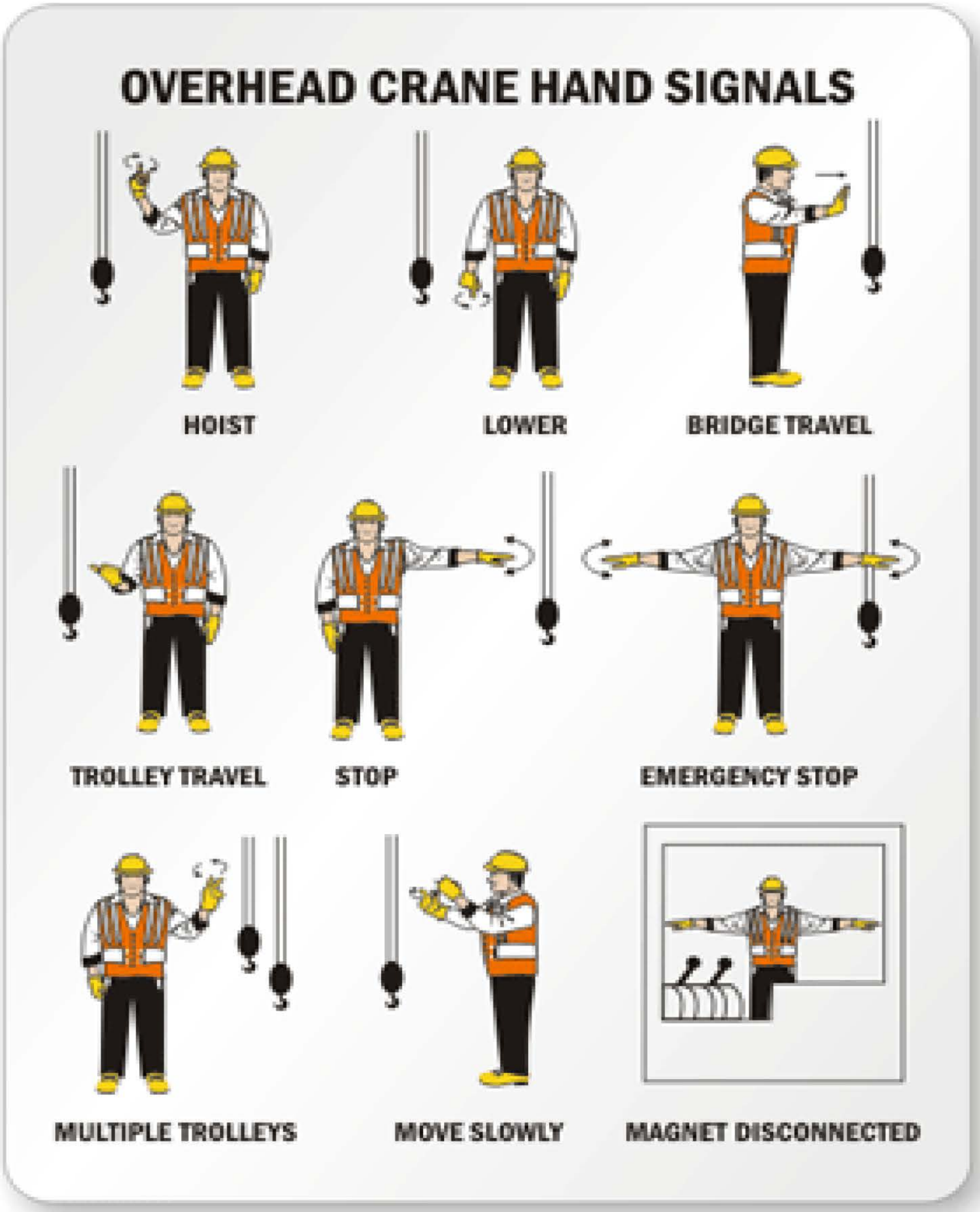
- Micro Speed - sets the speed range to 10% of the normal speed. A minimum speed of 7/16" per minute can be achieved. The load can be bumped or jogged at .005 inch.

- The bridge and trolley drive systems were not changed. They still have five-step speed control but are operated from the radio instead of the pendant.

- The radio control system consists of two transmitters - an Emergency Stop transmitter and the operator's transmitter. Both must be ON to obtain a reset.

- The Emergency Stop transmitter has one function - an E Stop button that drops out the crane reset and sets all brakes. (This is the remote E Stop for critical lifts.) To activate, the green start button must pushed ON. A red light will come "ON" and change to flashing green light indicating that the transmitter is operating. To stop the crane, press the red stop button. This button also turns the transmitter "off" at the completion of your job.

Communication
Standard Hand Signals


OVERHEAD CRANE HAND SIGNALS
HOIST
LOWER
BRIDGE TRAVEL
TROLLEY TRAVEL
STOP
EMERGENCY STOP
MULTIPLE TROLLEYS
MOVE SLOWLY
MAGNET DISCONNECTED

Signal Person Requirements in OSHA's New Crane Rule

September 22, 2010

1. PURPOSE

The safety of equipment operations depends in many situations on signals given to the operator. It is critical that the operator understand the signals given, and the signals person must therefore be able to give clear, accurate and appropriate signals that clearly convey the needed information.

2. DEFINITIONS (1926.1401)

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 whistle.

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.

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).

Directly under the load means a part or all of an employee is directly beneath the load.

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 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 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.

Standard Method means the protocol in Appendix A for hand signals.

3. GENERAL REQUIREMENTS (1926.1419)

(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). 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 (i) of this section.

(i) 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, irrespective of who gives it.)

(j) All directions given to the operator by the signal person must be given from the operator's direction perspective.

(k) 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.

4. RADIO, TELEPHONE, OR OTHER ELECTRONIC TRANSMISSION OF SIGNALS (1926.1420)

(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.

5. VOICE SIGNALS – ADDITIONAL REQUIREMENTS (1926.1421)

(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.

6. HAND SIGNAL CHART (1926.1422)

Hand signal charts must be either posted on the equipment or conspicuously posted in the vicinity of the hoisting operations.

7. SIGNAL PERSON QUALIFICATIONS (1926.1428)

(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 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 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 (paper or electronically) 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 boom deflection from hoisting loads.

(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.

8. TRAINING (1926.1430)

The employer must provide training as follows:

(a) Signal persons. The employer must train each employee who will be assigned to work as a signal persons who does not meet the requirements of § 1926.1428(c) in the areas addressed in that paragraph.

(b) Competent persons and qualified persons. The employer must train each competent person and each qualified person regarding the requirements of this subpart applicable to their respective roles.

(c) Training administration.

(1) The employer must evaluate each employee required to be trained under this subpart to confirm that the employee understands the information provided in the training.

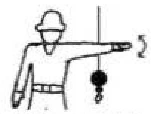
(2) The employer must provide refresher training in relevant topics for each employee when, based on the conduct of the employee or an evaluation of the employee's knowledge, there is an indication that retraining is necessary.

(3) Whenever training is required under this standard, the employer must provide the training at no cost to the employee.

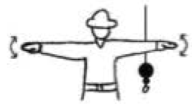
9. APPENDIX

(a) Appendix A – Standard Hand Signals

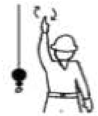
Appendix A – Standard Hand Signals



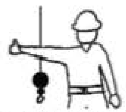
STOP – With arm extended horizontally to the side, palm down, arm is swung back and forth.



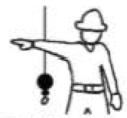
EMERGENCY STOP – With both arms extended horizontally to the side, palms down, arms are swung back and forth.



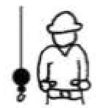
HOIST – With upper arm extended to the side, forearm and index finger pointing straight up, hand and finger make small circles.



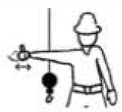
RAISE BOOM – With arm extended horizontally to the side, thumb points up with other fingers closed.



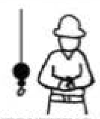
SWING – With arm extended horizontally, index finger points in direction that boom is to swing.



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

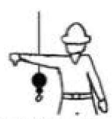


RAISE THE BOOM AND LOWER THE LOAD – With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.

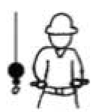


DOG EVERYTHING – Hands held together at waist level.

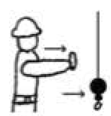
LOWER – With arm and index finger pointing down, hand and finger make small circles.



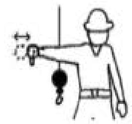
LOWER BOOM – With arm extended horizontally to the side, thumb points down with other fingers closed.



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

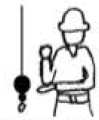


TRAVEL/TOWER TRAVEL – With all fingers pointing up, arm is extended horizontally out and back to make a pushing motion in the direction of travel.

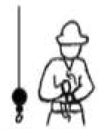


LOWER THE BOOM AND RAISE THE LOAD – With arm extended horizontally to the side and thumb pointing down, fingers open and close while load movement is desired.

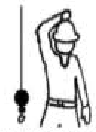
MOVE SLOWLY – A hand is placed in front of the hand that is giving the action signal.



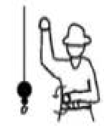
USE AUXILIARY HOIST (whipline) – With arm bent at elbow and forearm vertical, elbow is tapped with other hand. Then regular signal is used to indicate desired action.



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



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



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

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

Additional

Emergency Operating Procedures

For Crane Operators andCrane Operations Operations

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CRANE OPERATION EMERGENCY OPERATING PROCEDURES

1.0 GENERAL

For the purpose of this document, an emergency is any abnormal situation that endangers personnel, flight or critical hardware or the crane load during the course of a crane operation. If in doubt about the seriousness of a problem, treat it as an emergency first, and analyze it later. All Certified Operators shall know the following in advance of performing a lifting operation to assist in response to an emergency situation:

1.1 How to contact emergency personnel:
Dial 911 when calling from in-house phone (GSCF Center Extension)
Dial 301-286-9111 from outside phone (I.e. Cell Phone)

1.2 The location of emergency equipment in the vicinity of the operational area.
(I.e. **fire alarms, telephones, fire extinguishers, etc.)**
Note: It is not the responsibility of the operator or any personnel involved in the lifting operation to administer first aid or fight a fire. However it is everyone's responsibility to report an emergency and to warn other personnel in the area of any hazard or dangerous situation that may affect their safety.

1.3 The Building Emergency Action Plan.
THE EMERGENCY ACTION PLAN FOR ALL BUILDINGS ON THE GSFC COMPLEX CAN BE FOUND BY GOING TO THE FOLLOWING LINK:
http://protectiveservicesdivision.gsfc.nasa.gov/emergencyBuildingPlans.html

1.4 The instructions given in this document for crane emergency cases.

2.0 Standard Emergency Procedures

When an emergency happens, (unless directed otherwise by specific case instructions) perform the following standard steps:

2.1 For Emergencies involving fire, injury, etc. Dial 911 and request HELP.
Answer all questions/ let the other person hang up first.

2.2 If emergency situation permits
- a.) Actuate the Stop Button on the crane controller.
- b.) Using the proper method and PPE, open the mainline disconnect and perform proper Lock Out/Tag Out procedures.
- c.) If Lock Out/ Tag Out cannot be performed, personnel must remain with the crane and or at the mainline disconnect until proper authorities are informed and have placed proper Lock Out/ Tag Out on disconnect.
- d.) Insure all proper authorities are notified of the incident (see section 2.4)
- e.) **ALL** Personnel involved in the lifting operation shall remain on site until dismissed by the proper authorities.

2.3 If the area is not already secured, rope off the area around the load and or crane

2.4 As soon as you are clear of emergency situation you shall notify in no specific order:

a) The supervisor in charge

b) The LDE MANAGER and LDE RECERT Technicians.

c) Appropriate Safety Personnel and Technical Monitor for that area.

d) The Facility Operations Manager (FOM).

Note: These four parties will hereafter be referred to as "the proper authorities". Report in detail the nature of the problem and communicate all pertinent information requested by the RECERT department to expedite repairs and the preparation of the incident report.

Contact	Title	Phone Extension
Brian Montgomery	**Lifting Device Equipment Manager (LDEM)**	**6-4209**
Richard Clough	**QinetiQ Recert Manager**	**6-3653**
Dave Burtis	**QinetiQ Recert Lead Technician**	**6-2583**
Emergency Console	**From internal Phone Ext.**	**911**
Emergency Console	**From External Phone**	**301-286-9111**
Area Technical Monitor	**Dependent on Work Location**	

Consult NASA Directory for Building F.O.M. , Area Technical Monitor and Supervisor Contact Numbers @ https://internal.gsfc.nasa.gov/web/phonebook/home

3.0 SPECIFIC EMERGENCY CASES

3.1 Case 1 - Brakes Slip, Load Falls Gradually

a. Push the UP button repeatedly and as often as necessary to attempt to keep the load from accelerating down until a safe area is established to allow the load to be safely landed.

b. Using the above technique to control the load, lower the load to the established area.

c. Perform standard emergency steps to secure the load and crane as stated in Section 2.0 through 2.4 of this document.

3.2 Case 2 - Load Falls Suddenly, Collision, Crane Stuck with Elevated Load or Crane Damage During Lift

a. Move as quickly as possible away from the load. Do not try to intervene and save the load.

b. Perform standard emergency steps to secure the load and crane as stated in Section 2.0 through 2.4 of this document.

c. If the incident results in a minor fire, refer to (Section 3.6)

d. If the incident causes an explosion, major fire or release of radiation or toxic material, warn surrounding personnel , activate fire alarm and evacuate the building as quickly as possible.

3.3 Case 3 - Runaway Crane

a. If crane motion continues after a button is released, push the emergency STOP button and warn surrounding personnel.

b. If motion still continues, go to the main disconnect. Using the proper method and PPE, open the mainline disconnect and perform proper Lock Out/Tag Out procedures.
Danger of Arc Flash is greatest at this time.

c. If the runaway condition causes any other problems (collision, fire, etc.), follow the instructions for the appropriate emergency case at this time.

d. Perform standard emergency steps to secure the load and crane as stated in Section 2.0 through 2.4 of this document.

3.4 Case 4 - Power Outage

a. Perform standard emergency steps to secure the load and crane as stated in Section 2.0 through 2.4 of this document.

b. When power is restored and it is safe to do so, restart the operation.

3.5 Case 5 - Storm Warnings

a. If operation is underway and there is not an applicable Storm Code Waiver, when and if the storm code warning changes to a "Condition 3" or "Condition 5", lower the load to the nearest safe location.

b. Perform the standard emergency steps to secure the load and crane as stated in section 2.0 through 2.4 of this document.

c. When conditions return to Storm Code conditions 1, 2 or 4, restart the operation.

3.6 Case 6 - Fire in Crane

a. Activate the fire alarm.
b. Perform the standard emergency steps to secure the load and crane as stated in section 2.0 through 2.4 of this document.
c. If the fire is minor, attempt to extinguish the fire only if there are no personnel risk and you possess proper and current fire extinguisher training. **(See section 1.2)**
d. If the fire is major, evacuate the building.

3.7 Case 7-Fire Alarm Sounds in Building

a. If time permits, lower the load to the floor (or handling fixture) as quickly as possible without damage.
b. If time permits, perform the standard emergency steps to secure the load and crane as stated in section 2.0 through 2.4 of this document.
c. Vacate building through the closest designated emergency exit.

Operation may resume only after receiving an "OK to proceed" from either SAFETY or the Incident Commander.

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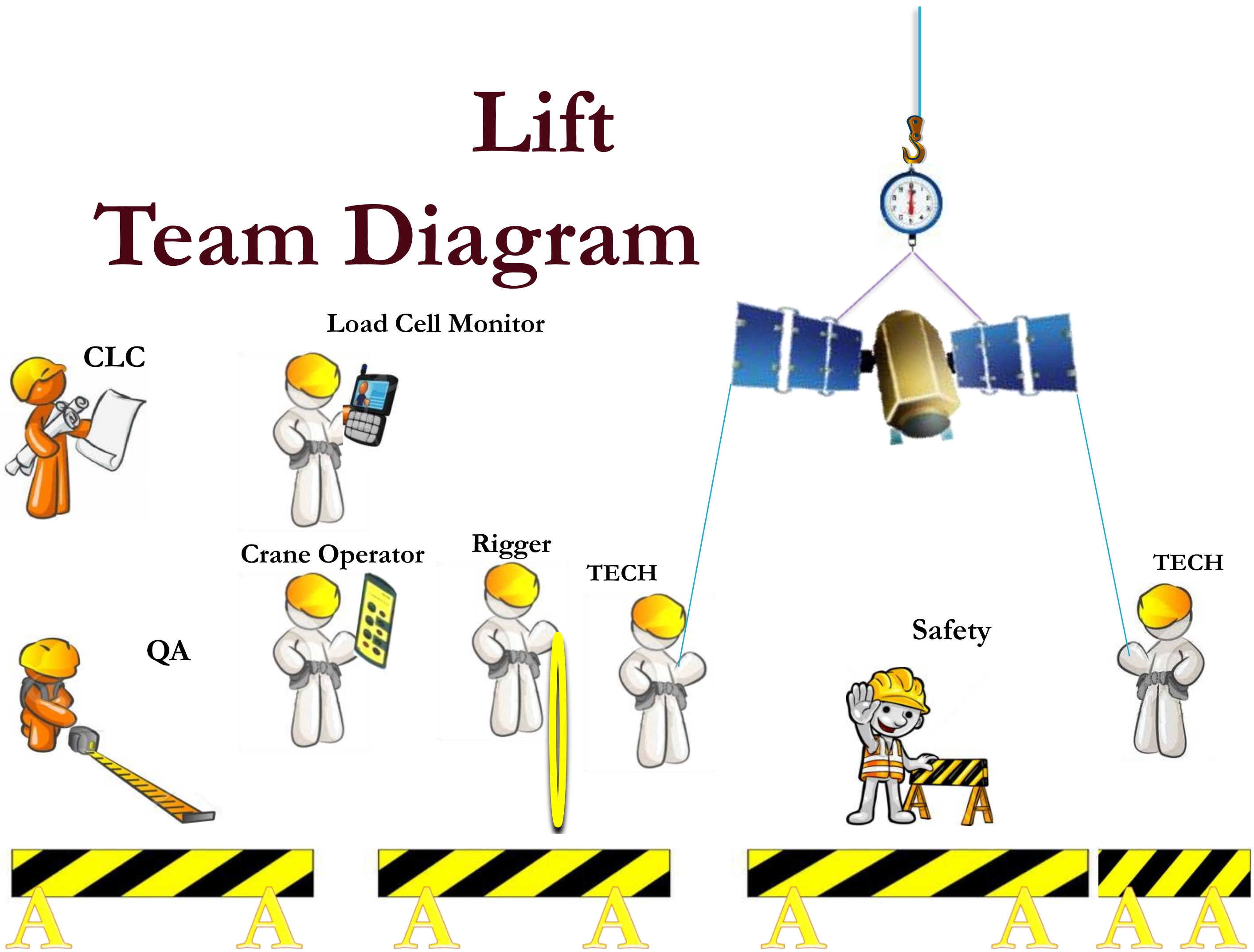
Lift Team Diagram



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Mishaps and Close Calls

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Code 549 INCIDENT REPORT				**No. TA-IR-05-005**
(1) Title: GPM Lift Adapter Proof Test Imbalanced Rotation				
(2) Incident Date: 12/7/2010	**(3) Time**: 2:15pm		**(4) Location**: B29 HighBay	
(5) Project/Activity GPM Lift Adapter/Proof Test	**(6) WOA** In-dispute	**(7) Procedure** 11-02-3170	**(8) NCR**	**(9) NASA Mishap Report** 2010-341-00004
(10) Personnel Involved: Eb Akinpetide, Kevin Hagerich, Eric Norris	**(11) Affiliation** Qinetiq-NA	**(12) Injury** Personnel: None, Hardware: None		
(13) Equipment: Module Interface Tool (Counter balance Lifting Device) also known as a pickle fork				
(14a) Problem Description: Under Project direction, the test configuration was changed, just prior to starting the lift, to remove 100lb attached with straps. Without the 100lb, the test set-up rotated when lifted due to the large imbalance.				
(14b) Root Cause:				
(15) Immediate Corrective Action: The test set-up was lowered to the ground and reconfigured with the proper weight and a lockout pin. The test was completed without further unexpected reactions.				
(16) Task Leader Approval:				
(17) Corrective Action:. INVESTIGATION UNDERWAY				
(18) Follow Up:				
(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg		**Eye Witness:** Tim Schwartz Code 549	**Responsible Manager/Supervisor:** Nick Hovaker	
Verified Effective:		**Originator:** Mark Ramsey		

Code 549 INCIDENT REPORT				No. TA-IR-05-008
(1) Title: Restricted area (Crane) entrance				
(2) Incident Date: 01/10/2011	**(3) Time**: 8:45 a.m.		**(4) Location**: Building 10 High Bay	
(5) Project/Activity Crane Operation	**(6) WOA**	**(7) Procedure**	**(8) NCR**	**(9) NASA Mishap Report**
(10) Personnel Involved: Chuck Keeney, Brian Gambina, Gary Sheridan (QNA), William Kaline et al (CTSI)	**(11) Affiliation** Code 540 Code 227	**(12) Injury** NONE; Close Call		

(13) Equipment:
Overhead Crane 10-1

(14a) Problem Description:
Code 227 entered onto the Crane without notification to FOM, Code 549, Code 540, or QNA personnel. Entry was also conducted without performing LOTO, and these failures resulted in placing themselves into imminent danger.

(14b) Root Cause: Failure to follow directions and required procedures.

(15) Immediate Corrective Action:
The Crane operator stopped the Crane check-out procedure. The QNA safety representative immediately contacted the FOM and the Code 227 personnel to address the violation.

(16) Task Leader Approval:

(17) Corrective Action:
This effort should be a coordinated effort between Code 549 and Code 540 direction should include update of signage and possibly an inhibiting barricade of ladder entrance.

(18) Follow Up:
Ladder guards were installed in selected cranes (Bldg 10, 15) and keys are now with the FOM

(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg	**Eye Witness:** None	**Responsible Manager/Supervisor:**
Verified Effective:	**Originator:** Bob Hackley	

Code 549 INCIDENT REPORT	No. TA-IR-05-013

(1) Title: Vibration Cell Crane. "North Cell"

(2) Incident Date: 3/18/2011	**(3) Time**: 1300 – 1600 hours	**(4) Location**: North Vibration Cell

(5) Project/Activity TIRS	**(6) WOA**	**(7) Procedure**	**(8) NCR**	**(9) NASA Mishap Report**

(10) Personnel Involved: Barry F. Smith "Crane Operator"	**(11) Affiliation** Qinetiq	**(12) Injury** None.

(13) Equipment:
Vibration Cell Crane

(14a) Problem Description: Crane would respond to east and west commands, but would not respond to raise or lower commands. After shutting down the crane and waiting about 20 minutes the crane responded and the lift was continued.

(14b) Root Cause: Internal logic controls of the crane were faulty.

(15) Immediate Corrective Action: I contacted my supervisor Wyatt Rinker and informed Onur Atabac, and Brain Ross of what was going on. After 20 minutes of letting the crane sit and reset of power the crane responded to pendent controls.

(16) Task Leader Approval:

(17) Corrective Action:
The crane controls have been repaired by RECERT personnel and the crane has been monitored and tested. The crane is deemed repaired and back in service.

(18) Follow Up: Working the problem.
This crane's operation will continue to be monitored and the Vibration Lab personnel have been instructed to contact RECERT if an anomaly occurs.

(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg	**Eye Witness:** B.F.Smith Chris Kolos, Karl Shuler, Mike Golob, Synthia Tonn, Robin Knight, Jamil Smart, Dave Robinson.	**Responsible Manager/Supervisor:** Wyatt Rinker

Verified Effective:	**Originator:** Barry Smith

Code 549 INCIDENT REPORT				No. TA-IR-05-020
(1) Title: JWST GSE Lift out of Vibration Test Cell				
(2) Incident Date: 5/9/2011	**(3) Time**: 9:15am		**(4) Location**: B7, N Vibration Cell	
(5) Project/Activity JWST/ Crane lift	**(6) WOA** JWST-WOA-003989	**(7) Procedure** JWST-PROC-005468	**(8) NCR**	**(9) NASA Mishap Report**
(10) Personnel Involved: D. Burkart B. Gauss K. Budden T. Huber S. Hopson G. Mooney	**(11) Affiliation**	**(12) Injury** NONE		

(13) Equipment: JWST GSE (Aronson Plate and NIRSpec mass dummy), Crane 7-6, Vibration Shaker Table, Various OEM Lifting Hardware (Lifting straps, Shackles, Hoist Rings)

(14a) Problem Description:

During a lifting operation with an expected total load of 1500# to remove an adapter plate (which had the JWST NIRSpec mass dummy integrated) from the Vibration Shaker Table, one bolt was inadvertently left in preventing the adapter plate from lifting freely from the shaker table. The insert in the shaker table interface plate pulled out during the lift causing the payload to spring vertically ~12+”. The payload was then placed on sawhorses and the crane disconnected and locked out.

(14b) Root Cause:

(15) Immediate Corrective Action:

- **Set the payload on sawhorses and disconnect all lifting hardware**
- **Contact Recert for crane inspection and recertification**
- **Contact 549 Facility management and Safety department**
- **Record and quarantine all lifting hardware involved for inspection and recertification**
- **Perform analysis to determine approximate applied load**

(16) Task Leader Approval:

(17) Corrective Action:

-

(18) Follow Up:

(19) Approval: **Code 549 Branch Head:** **Other Approvals:**	**Eye Witness:**	**Responsible Manager/Supervisor:** Greg Miller
Verified Effective:	**Originator:** Delaney Burkart	

Code 549 INCIDENT REPORT				No. TA-IR-05-026
(1) Title: SSDIF Lower Crane Control Issue				
(2) Incident Date: 6/20/2011	**(3) Time**: Approx 9:30 AM		**(4) Location**: Bldg 29, SSDIF	
(5) Project/Activity JWST/ISIM	**(6) WOA** JWST-WOA-004041	**(7) Procedure** JWSR-PROC--017077	**(8) NCR**	**(9) NASA Mishap Report**
(10) Personnel Involved: N. Becker T. Huber D. Burkart G. Mooney B. Gauss E. Hemminger M. Lenz A. Nwagu T. Keim J. Pontius	**(11) Affiliation** - Mooney – Sigma - Hemminger and Nwagu – ManTech - Lenz – 543 - Pontius – 542 - All others - QNA	**(12) Injury** None		

(13) Equipment: SSDIF Lower Crane (29-1), JWST GSE (Horizontal Integration Tool, NIRSpec HIT adapter), OEM Lift Hardware (Ring, shackles, load cells, hydraset)

(14a) Problem Description:

During lift operations to remove the NIRSpec Mass Dummy from the ISIM structure, the crane was not properly responding to the remote control. As the crane was being moved into position to attach to the simulator, the crane operator was directed by the rigger to move the bridge north as slowly as possible. When the operator moved the joystick to bring the crane bridge north, the crane moved south. The direction was given again with an onlooker verifying that the operator was moving the joystick in the correct direction. Again, the operator actuated the joystick to move the crane north and the crane moved south.

(14b) Root Cause:

(15) Immediate Corrective Action:
The planned lift operation was discontinued and the HIT was returned to its stand. All other lift hardware was removed from the crane. The crane operator was then successfully able to duplicate the anomalous behavior. It was noted that the problem only occurred when trying to move the crane north at the slowest possible speed. The crane RECERT group was contacted.

(16) Task Leader Approval:

(17) Corrective Action:

(18) Follow Up:

(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg	**Eye Witness:** All personnel listed in block #10.	**Responsible Manager/Supervisor:** Greg Miller
Verified Effective:	**Originator:** Neil Becker	

Code 549 INCIDENT REPORT				No. TA-IR-05-027
(1) Title: GPM HGAS Vibration Fixture Lift				
(2) Incident Date: 6/30/2011	**(3) Time**: 3:45		**(4) Location**: B7, S Vibration Cell	
(5) Project/Activity GPM/ Crane lift	**(6) WOA**	**(7) Procedure**	**(8) NCR**	**(9) NASA Mishap Report**
(10) Personnel Involved: Walt Plesniak John Penderghast	**(11) Affiliation** QNA	**(12) Injury** NONE		

(13) Equipment: Vibration Mounting Plate Crane 7-4, Vibration Shaker Head Expander, Various OEM Lifting Hardware (Lifting straps, Shackles, Hoist Rings)

(14a) Problem Description:

During a lifting operation, from the Vibration Shaker Head Expander, one bolt was inadvertently left or partially re-engaged preventing the adapter plate from lifting freely from the shaker table. The insert in the shaker head expander pulled out during the lift.

(14b) Root Cause:

(15) Immediate Corrective Action:

- **Set the fixture plate on dollies**
- **Contact Recert for crane inspection and recertification**
- **Contact 549 Facility management and Safety department**
- **Record and quarantine all lifting hardware involved for inspection and recertification**
- **Released an emergency procedure change to all lifts from Structural Dynamics Facilities**

(16) Task Leader Approval:

(17) Corrective Action:

-

(18) Follow Up:

(19) Approval: **Code 549 Branch Head:** **Other Approvals:**	**Eye Witness:**	**Responsible Manager/Supervisor:** Mark Ramsey
Verified Effective:	**Originator:** Mark Ramsey	

Code 549 INCIDENT REPORT	No. TA-IR-05-028

(1) Title: Bldg-29, Crane 29-3 trolley Limit Switch

(2) Incident Date: 7/5/11	**(3) Time**: 4:40pm	**(4) Location**: 29

(5) Project/Activity Bldg-29, overhead lighting replacement	**(6) WOA**	**(7) Procedure**	**(8) NCR**	**(9) NASA Mishap Report**

(10) Personnel Involved: Greg Francisco	**(11) Affiliation** QinetiQ	**(12) Injury** None

(13) Equipment: Crane 29-3

(14a) Problem Description:
During the Daily Crane Inspection on 7/5/2011 the crane operator discovered that the trolley north limit switch was inoperable. After visual inspection of the trolley limit switch the rollers appeared to have cracked and separated.

(14b) Root Cause: Under investigation

(15) Immediate Corrective Action:
The crane was locked out and tagged. And the remaining work schedule was halted

(16) Task Leader Approval:

(17) Corrective Action: TBD

(18) Follow Up:

(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg	**Eye Witness:**	**Responsible Manager/Supervisor:** Robert Hackley
Verified Effective:	**Originator:**	

Code 549 INCIDENT REPORT				No. TA-IR-05-029
(1) Title: IEC Modal Incident				
(2) Incident Date: 07/06/11	**(3) Time**: 9:00am		**(4) Location**:Modal Facility Bldg 15	
(5) Project/Activity JWST/IEC	**(6) WOA** JWST-WOA-004048	**(7) Procedure** JWST-PROC-017435	**(8) NCR**	**(9) NASA Mishap Report**
(10) Personnel Involved: D. Holliday B. Gauss T. Keim G. Mooney C. Tolman A. Nwagu D. Dassoulas M. Pilecki	**(11) Affiliation** - Mooney – Sigma - Nwagu – ManTech - Pilecki – Honeywell - Tolman, Dassoulas - Genesis - All others - QNA	**(12) Injury** None		

(13) Equipment:
Bldg 15 Crane. JWST IEC Lift Sling (GE2160320). OEM Lift Hardware (Lift Ring, Shackles, Load Cell, Hydraset)

(14a) Problem Description:
During the lifting operations to remove the IEC from the Modal Facility floor, the load cells were not reset to zero after picking up the weight of the lifting hardware and sling. The lifting crew assumed the load cells had been zeroed for the OLOC which meant only a percentage of the weight was offloaded onto the crane before the removal operation began.

The IEC is held by three mounting locations that secure it to GSE that is then mounted to the modal facility floor. Upon removing two fasteners from one mounting location and breaking the torque on the other two, it was noted that the weight on the crane had increased slightly and a bracing bar of the IEC was now contacting the GSE. It was then realized that the load cell had not been zeroed as assumed, and that the full weight of the IEC was not being offloaded by the crane.

(14b) Root Cause: TapRoot analysis
Human Performance Difficulty>>Mistake in Procedure>>Procedure>>Procedure followed incorrectly>>no checkoff

(15) Immediate Corrective Action:
The offloaded weight on the crane was corrected to include the weight of the lifting hardware and sling.

(16) Task Leader Approval:

(17) Corrective Action:.
- Re-training of all department personnel: emphasize procedure step, avoid complacency
- Disciplinary action of involved personnel
- Attend stand down on 7/29/11

(18) Follow Up:
- Project personnel were made aware of the fact that a bracing beam had come into contact with the GSE and that approximately 70lb was placed on this beam. An analysis is being performed by the project to determine the result of this contact.
- Re-training completed on 7/13/11.

(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg	**Eye Witness:** All personnel listed in block #10.	**Responsible Manager/Supervisor:** Greg Miller
Verified Effective:	**Originator:** David Holliday	

Code 549 INCIDENT REPORT				**No. TA-IR-05-032**
(1) Title: Crane 29-4 malfunction				
(2) Incident Date: 9-29-2011	**(3) Time**: 1:00 PM		**(4) Location**: Bldg 29 High bay	
(5) Project/Activity Static Test	**(6) WOA**	**(7) Procedure**	**(8) NCR**	**(9) NASA Mishap Report**
(10) Personnel Involved: Kevin Hagerich – Static Load Dave Burtis - RECERT Gary Bell - RECERT Walt Leary _ RECERT	**(11) Affiliation** All QNA	**(12) Injury** None		
(13) Equipment: Crane 29-4 (south crane)				

(14a) Problem Description:
Kevin Hagerich was performing an initial start-up and checkout of Crane 29-4 and he observed that the Trolley would not travel in either direction. RECERT personnel were contacted to resolve the problem. Upon boarding Crane 29-4, a preliminary inspection by Dave Burtis and Gary Bell revealed that the Trolley travel limit switches had been circumvented. That is, it appears that someone had manually flipped them in the opposite direction to which they were intended to work. These limit switches are intended to prevent the trolley from impacting the mechanical stops at hi-speed.

(14b) Root Cause: The Trolley limit switches appear to have been circumvented by person or persons on the crane bridge. The lighting contractors had been on the bridge the evening before and the crane had undergone an initial start-up and checkout before they had gone up on the crane.

(15) Immediate Corrective Action:
The limit positions were properly positioned, and Crane 29-4 checked out OK and returned to service.

(16) Task Leader Approval:

(17) Corrective Action:

- After a task during which non-QNA personnel are using the bridge of an overhead crane in the Bldg 7-10-15-29 I&T complex to perform tasks such as lighting repairs, the QNA crane operator shall perform a post-task operational check of all of the crane functions.
- Additionally QNA RECERT personnel will visually inspect the bridge to ensure foreign materials have not been left behind. These actions will be recorded in the crane logbook and will be done before the crane is placed back in-service for the next task.

(18) Follow Up:
QNA Group Leaders and/or Supervisors will discuss this Incident and Corrective Action with their crane operators by the end of October, 2011 and report as such to the QNA Safety Manager.

(19) Approval: **Code 549 Branch Head:** Carmine Mattiello **Other Approvals:** Barry Greenberg	**Eye Witness:**	**Responsible Manager/Supervisor:**

<table>
<tr><td colspan="5">Code 549 INCIDENT REPORT</td><td>No. TA-IR-05-032</td></tr>
<tr><td colspan="6">(1) Title: Crane 29-4 malfunction</td></tr>
<tr><td>(2) Incident Date: 9-29-2011</td><td colspan="2">(3) Time: 1:00 PM</td><td colspan="3">(4) Location: Bldg 29 High bay</td></tr>
<tr><td>(5) Project/Activity
Static Test</td><td>(6) WOA</td><td>(7) Procedure</td><td>(8) NCR</td><td colspan="2">(9) NASA Mishap Report</td></tr>
<tr><td>(10) Personnel Involved:
Kevin Hagerich – Static Load
Dave Burtis - RECERT
Gary Bell - RECERT
Walt Leary _ RECERT</td><td>(11) Affiliation
All QNA</td><td colspan="4">(12) Injury
None</td></tr>
<tr><td colspan="6">(13) Equipment: Crane 29-4 (south crane)</td></tr>
<tr><td colspan="2">Verified Effective:</td><td colspan="4">Originator:
Phil Matthews
RECERT Supervisor</td></tr>
</table>

KSC NASA Advisory

GOVERNMENT INDUSTRY DATA EXCHANGE PROGRAM

3. Page 1 of 2

1. Nomenclature of Part	2. Manufacturer/Manufacturer Address
Swivel Hoist Ring	ALL

4. Subject	5. Cage Code	6. Lot/Date Code
Swivel Hoist Ring Side-Loading — Rigging Practices and Inspection	N/A	N/A

7. Manufacture Part/Material Number	8. Serial Number	9. References
N/A	N/A	N/A

GENERAL INFORMATION

11. Problem Description (continued in Block 24)

Recently, NASA experienced a swivel hoist ring failure during pre-lift tensioning operations that preceded a planned lift of an Orbiter Maneuvering System (OMS) Pod Cover at White Sands Test Facility (WSTF). The swivel hoist ring, with a rated load of 1000 lbs., failed under a calculated load of no more than 813 lbs. This swivel hoist ring had been used successfully to lift the OMS Pod Cover several times at Kennedy Space Center (KSC) prior to this event.

While an initial NASA investigation "concluded that the procedure used during the lifting operation did not contribute to the failure," and implied a potential manufacturing defect; further analysis pointed to evidence of side-loading of the swivel hoist ring and deformation of the bail. This side-loading may have occurred during any of the previous lifts at KSC and / or during the pre-lift tensioning operations at WSTF.

Given the manufacturer's quality control, inspection, and functionality test processes; and evidence such as the spread legs of the bail and a red paint mark from the shackle pin indicating loads applied at approximately 45 degrees off-center; side-loading is the most probable cause of the WSTF swivel hoist ring failure.

See Block 24 for graphic depicting correct loading of a swivel hoist ring and advisory against side-loading. (Note: Red paint mark on the inside of the bail of the failed swivel hoist ring was in the same approximate position as the base of the red arrow pointing up and to the right.)

12. Action Taken (continued in Block 25)

Following issuance of the initial NASA investigation, KSC Lifting Devices and Equipment Manager (LDEM) notified all other NASA Center LDEMs of the failure and instructed all KSC organizations to survey their equipment and stocks for the suspect swivel hoist rings and remove them from service pending final disposition of this issue. KSC LDEM drafted a GIDEP Safety Alert based on the information contained in the initial NASA investigation and contacted the swivel hoist ring manufacturer to begin the GIDEP process.

The KSC LDEM and manufacturer's representative met at KSC to discuss the issue, review the initial NASA investigation report, and inspect the remaining parts of the swivel hoist ring. The manufacturer's representative took temporary custody of the swivel hoist ring parts to conduct further inspection and analysis of the root cause of the failure. *(cont'd in Block 25)*

13. Name/Title of Originator	14. Originator Phone Number	15. Originator Advisory Number	16. Date Prepared
Joe Torsani, KSC LDEM	(321) 861-3806	N/A	25 August 2011

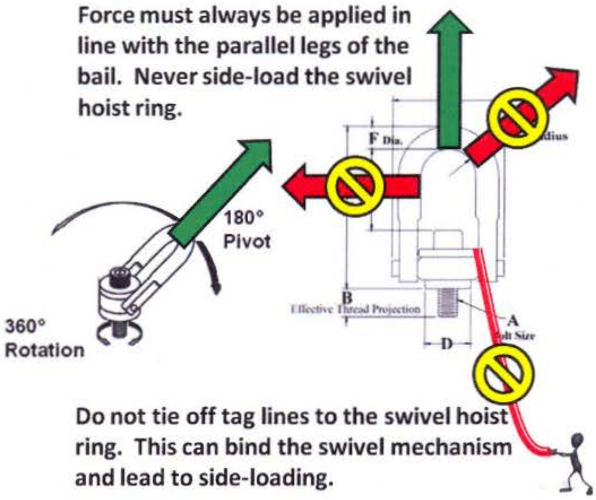
17. Date Released:	18. KSC GIDEP Alert Coordinator:	19. NASA/KSC Advisory Number:
25 August 2011	Dr. Chi Yeh, SA-G2	
RELEASED BY: (SIGNATURE)	Phone: (321) 867-1887 Fax: (321) 867-9504	NA-KSC- 2011 - 004
	E-mail: Chi.Yeh-2@nasa.gov	

KSC FORM 20-196 NS (REV. 05/07) PREVIOUS EDITIONS ARE OBSOLETE

20. Nomenclature of Part	21. NASA/KSC Advisory Number	22. Date Prepared	23.
Swivel Hoist Ring	NA-KSC- 2011 - 004	25 August 2011	Page 2 of 2

GENERAL INFORMATION

24. Problem Description (continued)



Never use a swivel hoist ring for other than its intended purpose—lifting. Do not tie loads down using swivel hoist rings as tie-down points.

25. Action Taken (continued)

In response to the draft GIDEP Safety Alert, the manufacturer provided a point-by-point response to assertions in the draft GIDEP Safety Alert. This response provided proof the swivel hoist ring had been side-loaded and offered a more plausible explanation (vice manufacturing defect) for the failure. Subsequent testing conducted by the swivel hoist ring manufacturer proved that this type of failure can occur at side-loads significantly less than the rated load of the swivel hoist ring. During one test, a similar swivel hoist ring with a rated load of 1000 lbs. failed under a side-load of 795 lbs. The post-test state of the swivel hoist ring components from this side-load test mirrored the condition of the hardware from the WSTF failure including the complete absence of one of the shoulder pins in the swivel body.

Given the facts above, and based on subsequent discussions with the manufacturer, KSC LDEM recommends KSC and all NASA Centers comply with the following:

1) Distribute this KSC NASA Advisory to all organizations involved in rigging loads for lifting, and to all design engineering organizations utilizing swivel hoist rings as lifting points in their designs.
2) Ensure all swivel hoist rings are proof load tested in accordance with NASA-STD-8719.9, NASA Standard for Lifting Devices and Equipment, prior to first use regardless of their application.
3) Pending a visual examination per inspection and removal criteria in ASME B30.26-2010, Rigging Hardware, Section 26-2.8, return previously suspect swivel hoist rings to service.
4) Ensure swivel hoist rings and all rigging hardware are inspected daily and operated in accordance with rigging practices contained in ASME B30.26.
5) During the lift, ensure the load is applied slowly, gradually, and in line with the center of the bail of the swivel hoist ring to prevent side-loading.
6) Ensure tag lines are not tied to any part of the swivel hoist ring. This can inhibit the free swivel / alignment of the swivel hoist ring and lead to side-loading. (Note: Always ensure swivel hoist rings are free to swivel 360 degrees and the bails are free to pivot 180 degrees.)
7) While ASME B30.26, paragraph 26-2.9.4.4 (h) states, "Any attached load-handling component shall be narrower than the inside width of the bail to avoid spreading," (which was the case in the failure at WSTF), consider using a shackle or other load-handling component with a diameter significantly less than the inside width of the bail. This may allow more freedom of movement and permit the swivel hoist ring to more easily align itself during the lift. One swivel hoist ring manufacturer recommends using the following rule of thumb: *Shackle pin diameter should be equal to or less than 2/3 of the inside width of the swivel hoist ring's bail.* (Note: Always ensure that the swivel hoist ring and other load-handling components' Working Load Limits (WLL) meet or exceed the anticipated angular rigging tension.)