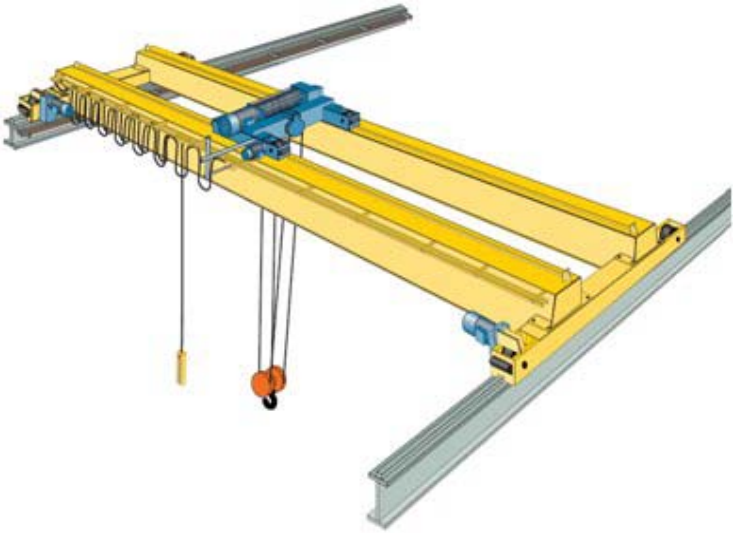
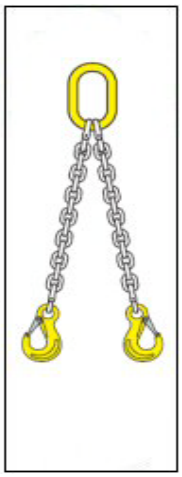
QinetiQ North America

NASA



OVERHEAD CRANE OPERATOR AND RIGGER TRAINING



Overhead Crane Operator Training Manual

1) Course Objectives
2) Common Overhead Crane Terminology
3) Do's and Don'ts
4) OSHA 1910.179 Overhead and Gantry Cranes
5) NASA STD.8719.9 excerpts (Section 4.6 through 4.8.2)
6) GPR 8834.1b (Entire document)
7) Hydra-sets
8) Dillon Scales
9) MSI Porta-Weigh + Crane Scale
10) GPR 8719.1a (Entire document)
11) Basic Overhead Crane Safety Video And Review
12) Arc Blast Information
13) Daily Inspection Procedure
14) Radio Remote Packet
15) Standard Hand Signal Chart
16) Emergency Operating Procedures
17) Riggers Worksheet
18) Rigging Safety Video and Review
19) Wire Rope Information Packet
20) Chain Sling Information Packet
21) Nylon Sling Information Packet
22) ASME B30.26 Rigging Hardware
23) Turnbuckle Policy for GSFC
24) Determining Weight Packet
25) Determining Center of Gravity Packet
26) The Crosby Users Guide
27) The Crosby Users Guide Q&A
28) Load Weight Estimation Exercise
29) Common Rigging Problems
30) The Rigging Plan
31) Recent Mishaps and Close Calls Packet (Contents to change as needed)

Overhead Crane 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 8834.1b, (GSFC) GPR 8719.1a, 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 8719.1a, 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 8834b, (GSFC) GPR 8719.1a, 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.

Bridge

Hoist

Load Bock

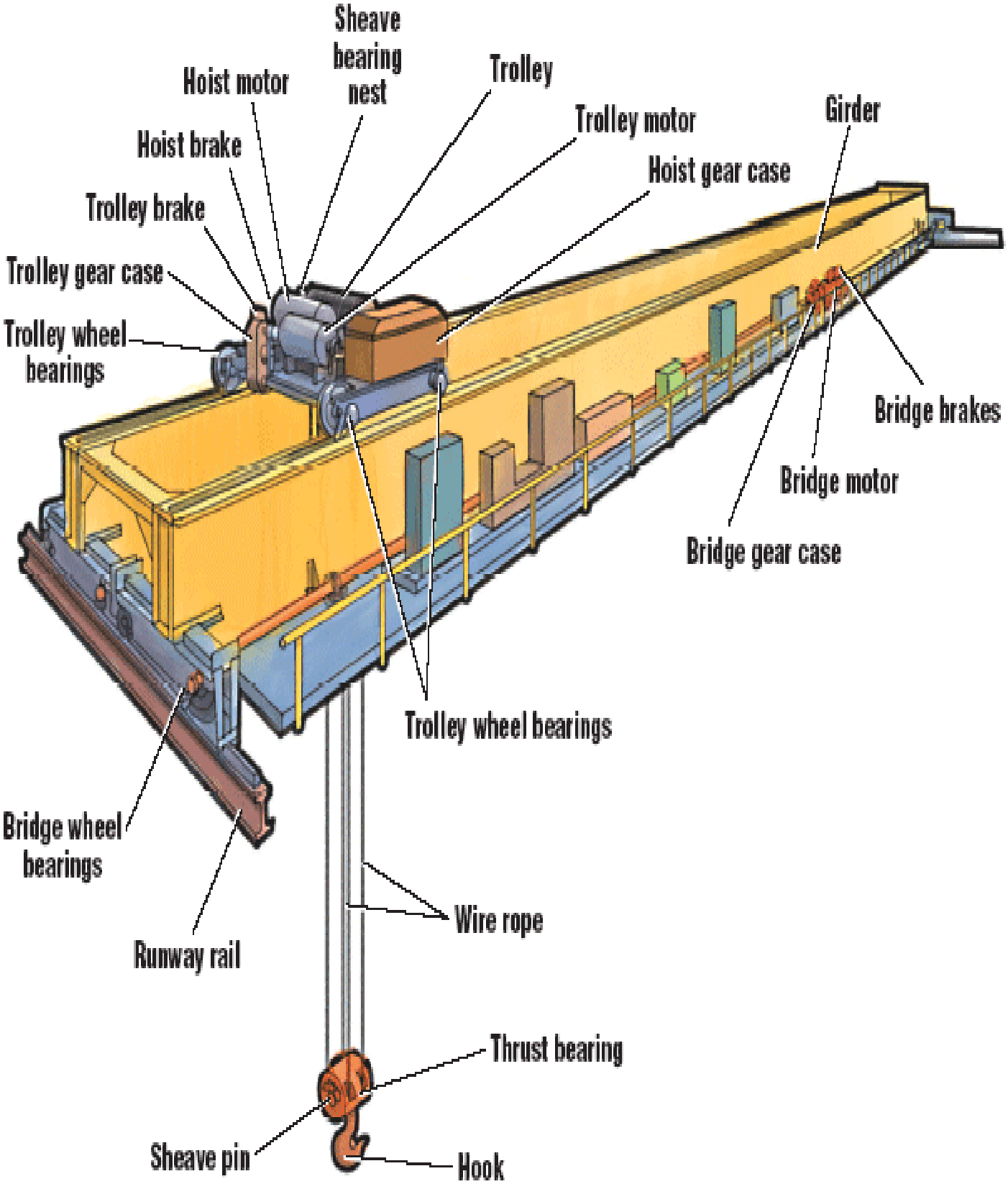
Common Overhead Crane Terminology

Reeving

Trolley

Hook

Common Overhead Crane Terminology



All overhead cranes consist of three basic units.

Bridge

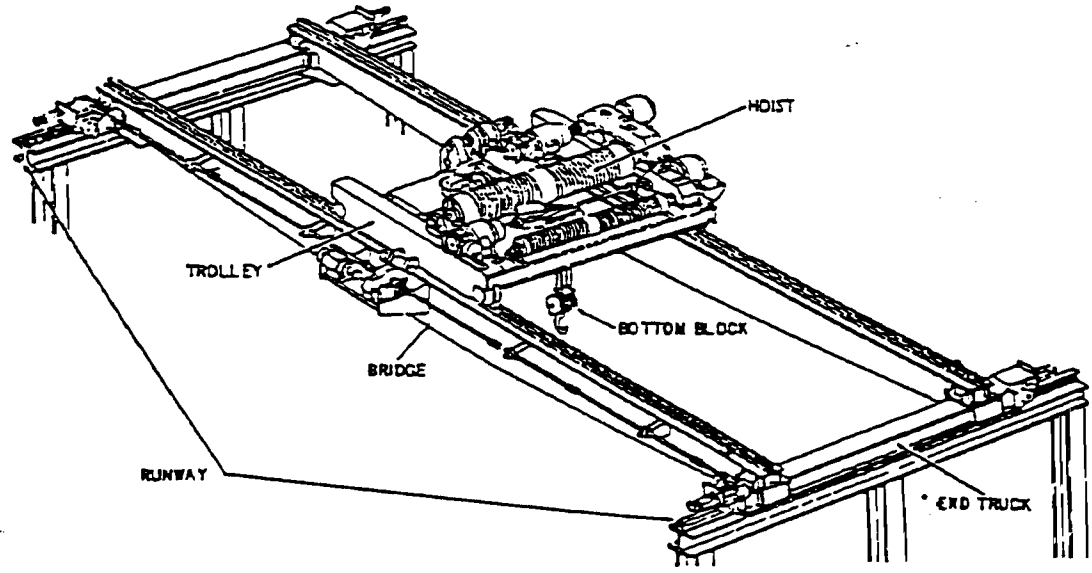
The bridge is the main structural member used to span the width of the runway area. It travels the length of the runway on rails fastened to the runway.

Trolley

The trolley is a motor driven vehicle, which travels along the rails fastened to the bridge girders, and supports the hoist and trolley mechanism.

Hoist

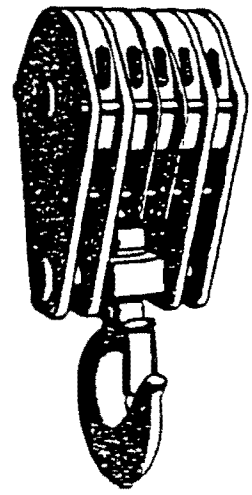
The hoist unit is an apparatus which exerts a force for lifting or lowering. It is power driven through a gear reducer and hoist drum. The bottom block is suspended from the hoist rope reeved between the upper block sheaves on the trolley structure, the bottom block sheaves, and dead ended at the hoist drum.



TYPICAL OVERHEAD CRANE

Blocks and Hooks

Blocks



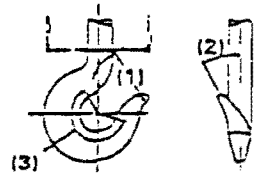
Crane blocks should be inspected regularly for sheave conditions and bent housing. Check the hook for excessive wear, gouging, or visible cracks.

Hooks

Check the hook nut, trunion and swivel. Make sure they are intact and operating freely.

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.

(1) Hook throat spread
  (a) Throat opening = ÷ 5%
  (b) Hook tram points = ÷5%
(2) Hook point twist = 0°
(3) Hook surface wear = 10%



WARNING

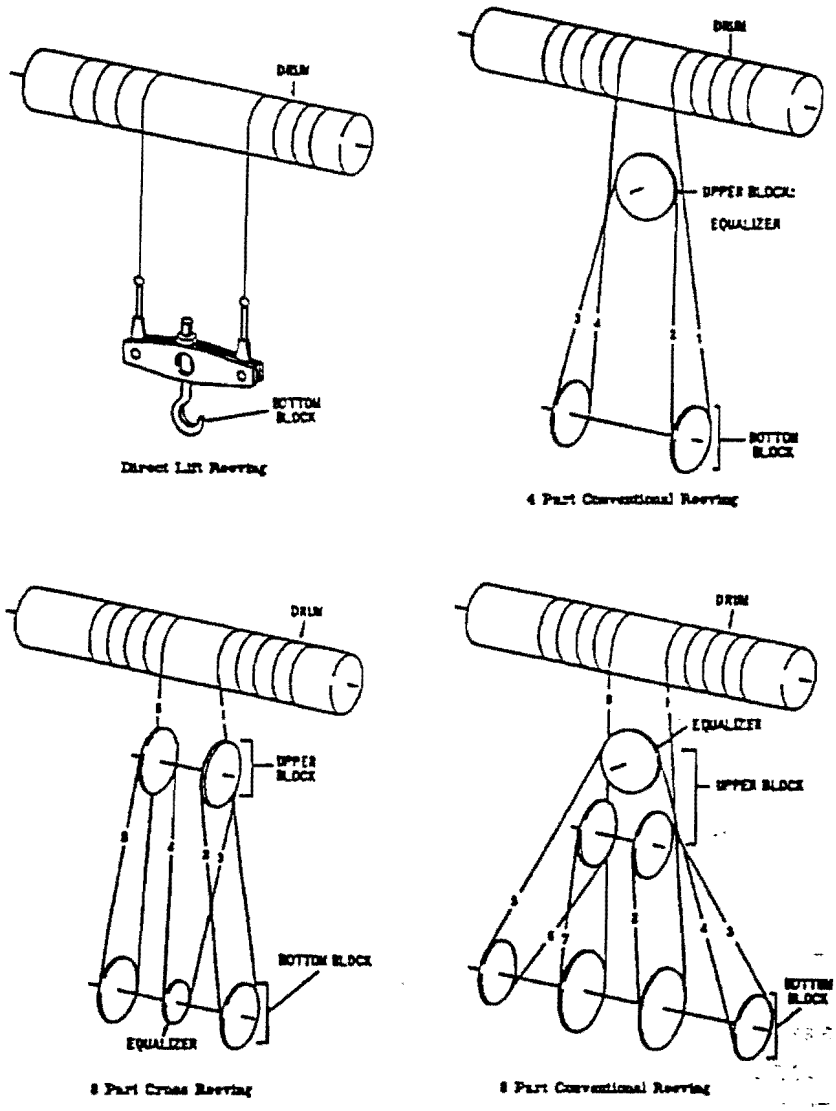
Do not weld on hooks or attempt to repair a damaged hook. Where one of the items above is found, the hook should be returned to the manufacturer for examination and possible reconditioning or replacement.

Hooks should be checked for cracks using magnetic particle or some other acceptable means on a annual basis. More frequent checks should be considered for severe duty service cranes.

Reeving

The following reeving methods are commonly used on overhead cranes. 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 ON EACH REEVING SYSTEM AT RIGHT



DO'S and DON'TS

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.

OSHA 1910.179
Overhead and Gantry Cranes

- **Part Number:**

  1910

- **Part Title:**

  Occupational Safety and Health Standards

- **Subpart:**

  N

- **Subpart Title:**

  Materials Handling and Storage

- **Standard Number:**

  1910.179

- **Title:**

  Overhead and gantry cranes.

1910.179(a)

Definitions applicable to this section.

1910.179(a)(1)

A "crane" is a machine for lifting and lowering a load and moving it horizontally, with the hoisting mechanism an integral part of the machine. Cranes whether fixed or mobile are driven manually or by power.

1910.179(a)(2)

An "automatic crane" is a crane which when activated operates through a preset cycle or cycles.

1910.179(a)(3)

A "cab-operated crane" is a crane controlled by an operator in a cab located on the bridge or trolley.

1910.179(a)(4)

"Cantilever gantry crane" means a gantry or semi-gantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.

1910.179(a)(5)

"Floor-operated crane" means a crane which is pendant or nonconductive rope controlled by an operator on the floor or an independent platform.

1910.179(a)(6)

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

1910.179(a)(7)

"Hot metal handling crane" means an overhead crane used for transporting or pouring molten material.

1910.179(a)(8)

"Overhead crane" means a crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed runway structure.

1910.179(a)(9)

"Power-operated crane" means a crane whose mechanism is driven by electric, air, hydraulic, or internal combustion means.

1910.179(a)(10)

A "pulpit-operated crane" is a crane operated from a fixed operator station not attached to the crane.

1910.179(a)(11)

A "remote-operated crane" is a crane controlled by an operator not in a pulpit or in the cab attached to the crane, by any method other than pendant or rope control.

1910.179(a)(12)

A "semi-gantry crane" is a gantry crane with one end of the bridge rigidly supported on one or more legs that run on a fixed rail or runway, the other end of the bridge being supported by a truck running on an elevated rail or runway.

1910.179(a)(13)

"Storage bridge crane" means a gantry type crane of long span usually used for bulk storage of material; the bridge girders or trusses are rigidly or non-rigidly supported on one or more legs. It may have one or more fixed or hinged cantilever ends.

1910.179(a)(14)

"Wall crane" means a crane having a jib with or without trolley and supported from a side wall or line of columns of a building. It is a traveling type and operates on a runway attached to the side wall or columns.

1910.179(a)(15)

"Appointed" means assigned specific responsibilities by the employer or the employer's representative.

1910.179(a)(16)

"ANSI" means the American National Standards Institute.

1910.179(a)(17)

An "auxiliary hoist" is a supplemental hoisting unit of lighter capacity and usually higher speed than provided for the main hoist.

1910.179(a)(18)

A "brake" is a device used for retarding or stopping motion by friction or power means.

1910.179(a)(19)

A "drag brake" is a brake which provides retarding force without external control.

1910.179(a)(20)

A "holding brake" is a brake that automatically prevents motion when power is off.

1910.179(a)(21)

"Bridge" means that part of a crane consisting of girders, trucks, end ties, footwalks, and drive mechanism which carries the trolley or trolleys.

1910.179(a)(22)

"Bridge travel" means the crane movement in a direction parallel to the crane runway.

1910.179(a)(23)

A "bumper" [buffer] is an energy absorbing device for reducing impact when a moving crane or trolley reaches the end of its permitted travel; or when two moving cranes or trolleys come in contact.

1910.179(a)(24)

The "cab" is the operator's compartment on a crane.

1910.179(a)(25)

"Clearance" means the distance from any part of the crane to a point of the nearest obstruction.

1910.179(a)(26)

"Collectors current" are contacting devices for collecting current from runway or bridge conductors.

1910.179(a)(27)

"Conductors, bridge" are the electrical conductors located along the bridge structure of a crane to provide power to the trolley.

1910.179(a)(28)

"Conductors, runway" [main] are the electrical conductors located along a crane runway to provide power to the crane.

1910.179(a)(29)

The "control braking means" is a method of controlling crane motor speed when in an overhauling condition.

1910.179(a)(30)

"Counter torque" means a method of control by which the power to the motor is reversed to develop torque in the opposite direction.

1910.179(a)(31)

"Dynamic" means a method of controlling crane motor speeds when in the overhauling condition to provide a retarding force.

1910.179(a)(32)

"Regenerative" means a form of dynamic braking in which the electrical energy generated is fed back into the power system.

1910.179(a)(33)

"Mechanical" means a method of control by friction.

1910.179(a)(34)

"Controller, spring return" means a controller which when released will return automatically to a neutral position.

1910.179(a)(35)

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

1910.179(a)(36)

A "drift point" means a point on a travel motion controller which releases the brake while the motor is not energized. This allows for coasting before the brake is set.

1910.179(a)(37)

The "drum" is the cylindrical member around which the ropes are wound for raising or lowering the load.

1910.179(a)(38)

An "equalizer" is a device which compensates for unequal length or stretch of a rope.

1910.179(a)(39)

"Exposed" means capable of being contacted inadvertently. Applied to hazardous objects not adequately guarded or isolated.

1910.179(a)(40)

"Fail-safe" means a provision designed to automatically stop or safely control any motion in which a malfunction occurs.

1910.179(a)(41)

"Foot walk" means the walkway with handrail, attached to the bridge or trolley for access purposes.

1910.179(a)(42)

A "hoist" is an apparatus which may be a part of a crane, exerting a force for lifting or lowering.

1910.179(a)(43)

"Hoist chain" means the load bearing chain in a hoist.

NOTE: Chain properties do not conform to those shown in ANSI B30.9-1971, Safety Code for Slings.

1910.179(a)(44)

"Hoist motion" means that motion of a crane which raises and lowers a load.

1910.179(a)(45)

"Load" means the total superimposed weight on the load block or hook.

1910.179(a)(46)

The "load block" is the assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoisting rope.

1910.179(a)(47)

"Magnet" means an electromagnetic device carried on a crane hook to pick up loads

magnetically.

1910.179(a)(48)

"Main hoist" means the hoist mechanism provided for lifting the maximum rated load.

1910.179(a)(49)

A "man trolley" is a trolley having an operator's cab attached thereto.

1910.179(a)(50)

"Rated load" means the maximum load for which a crane or individual hoist is designed and built by the manufacturer and shown on the equipment nameplate(s).

1910.179(a)(51)

"Rope" refers to wire rope, unless otherwise specified.

1910.179(a)(52)

"Running sheave" means a sheave which rotates as the load block is raised or lowered.

1910.179(a)(53)

"Runway" means an assembly of rails, beams, girders, brackets, and framework on which the crane or trolley travels.

1910.179(a)(54)

"Side pull" means that portion of the hoist pull acting horizontally when the hoist lines are not operated vertically.

1910.179(a)(55)

"Span" means the horizontal distance center to center of runway rails.

1910.179(a)(56)

"Standby crane" means a crane which is not in regular service but which is used occasionally or intermittently as required.

1910.179(a)(57)

A "stop" is a device to limit travel of a trolley or crane bridge. This device normally is attached to a fixed structure and normally does not have energy absorbing ability.

1910.179(a)(58)

A "switch" is a device for making, breaking, or for changing the connections in an electric circuit.

1910.179(a)(59)

An "emergency stop switch" is a manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

1910.179(a)(60)

A "limit switch" is a switch which is operated by some part or motion of a power-driven machine or equipment to alter the electric circuit associated with the machine or equipment.

1910.179(a)(61)

A "main switch" is a switch controlling the entire power supply to the crane.

1910.179(a)(62)

A "master switch" is a switch which dominates the operation of contactors, relays, or other remotely operated devices.

1910.179(a)(63)

The "trolley" is the unit which travels on the bridge rails and carries the hoisting mechanism.

1910.179(a)(64)

"Trolley travel" means the trolley movement at right angles to the crane runway.

1910.179(a)(65)

"Truck" means the unit consisting of a frame, wheels, bearings, and axles which supports the bridge girders or trolleys.

1910.179(b)

General requirements -

1910.179(b)(1)

Application. This section applies to overhead and gantry cranes, including semi-gantry, cantilever gantry, wall cranes, storage bridge cranes, and others having the same fundamental characteristics. These cranes are grouped because they all have trolleys and

similar travel characteristics.

1910.179(b)(2)

New and existing equipment. All new overhead and gantry cranes constructed and installed on or after August 31, 1971, shall meet the design specifications of the American National Standard Safety Code for Overhead and Gantry Cranes, ANSI B30.2.0-1967, which is incorporated by reference as specified in Sec. 1910.6.

1910.179(b)(3)

Modifications. Cranes may be modified and rerated provided such modifications and the supporting structure are checked thoroughly for the new rated load by a qualified engineer or the equipment manufacturer. The crane shall be tested in accordance with paragraph (k)(2) of this section. New rated load shall be displayed in accordance with subparagraph (5) of this paragraph.

1910.179(b)(4)

Wind indicators and rail clamps. Outdoor storage bridges shall be provided with automatic rail clamps. A wind-indicating device shall be provided which will give a visible or audible alarm to the bridge operator at a predetermined wind velocity. If the clamps act on the rail heads, any beads or weld flash on the rail heads shall be ground off.

1910.179(b)(5)

Rated load marking. The rated load of the crane shall be plainly marked on each side of the crane, and if the crane has more than one hoisting unit, each hoist shall have its rated load marked on it or its load block and this marking shall be clearly legible from the ground or floor.

1910.179(b)(6)

Clearance from obstruction.

1910.179(b)(6)(i)

Minimum clearance of 3 inches overhead and 2 inches laterally shall be provided and maintained between crane and obstructions in conformity with Crane Manufacturers Association of America, Inc, Specification No. 61, which is incorporated by reference as specified in Sec. 1910.6, (formerly the Electric Overhead Crane Institute, Inc).

1910.179(b)(6)(ii)

Where passageways or walkways are provided obstructions shall not be placed so that safety of personnel will be jeopardized by movements of the crane.

1910.179(b)(7)

Clearance between parallel cranes. If the runways of two cranes are parallel, and there are no intervening walls or structure, there shall be adequate clearance provided and maintained between the two bridges.

1910.179(b)(8)

Designated personnel - Only designated personnel shall be permitted to operate a crane covered by this section.

1910.179(c)

Cabs -

1910.179(c)(1)

Cab location.

1910.179(c)(1)(i)

The general arrangement of the cab and the location of control and protective equipment shall be such that all operating handles are within convenient reach of the operator when facing the area to be served by the load hook, or while facing the direction of travel of the cab. The arrangement shall allow the operator a full view of the load hook in all positions.

1910.179(c)(1)(ii)

The cab shall be located to afford a minimum of 3 inches clearance from all fixed structures within its area of possible movement.

1910.179(c)(2)

Access to crane. Access to the cab and/or bridge walkway shall be by a conveniently placed fixed ladder, stairs, or platform requiring no step over any gap exceeding 12 inches. Fixed ladders shall be in conformance with the American National Standard Safety Code for Fixed Ladders, ANSI A14.3-1956, which is incorporated by reference as specified in Sec. 1910.6.

1910.179(c)(3)

Fire extinguisher. Carbon tetrachloride extinguishers shall not be used.

1910.179(c)(4)

Lighting. Light in the cab shall be sufficient to enable the operator to see clearly enough to perform his work.

1910.179(d)

Foot walks and ladders -

1910.179(d)(1)

Location of foot walks.

1910.179(d)(1)(i)

If sufficient headroom is available on cab-operated cranes, a foot walk shall be provided on the drive side along the entire length of the bridge of all cranes having the trolley running on the top of the girders.

1910.179(d)(1)(ii)

Where foot walks are located in no case shall less than 48 inches of headroom be provided.

1910.179(d)(2)

Construction of foot walks.

1910.179(d)(2)(i)

Foot walks shall be of rigid construction and designed to sustain a distributed load of at least 50 pounds per square foot.

1910.179(d)(2)(ii)

Foot walks shall have a walking surface of anti-slip type.

NOTE: Wood will meet this requirement.

1910.179(d)(2)(iii)

[Reserved]

1910.179(d)(2)(iv)

The inner edge shall extend at least to the line of the outside edge of the lower cover plate or flange of the girder.

1910.179(d)(3)

Toe boards and handrails for foot walks. Toe boards and handrails shall be in compliance with section 1910.23 of this part.

1910.179(d)(4)

Ladders and stairways.

1910.179(d)(4)(i)

Gantry cranes shall be provided with ladders or stairways extending from the ground to the foot walk or cab platform.

1910.179(d)(4)(ii)

Stairways shall be equipped with rigid and substantial metal handrails. Walking surfaces shall be of an anti-slip type.

1910.179(d)(4)(iii)

Ladders shall be permanently and securely fastened in place and shall be constructed in compliance with 1910.27.

1910.179(e)

Stops, bumpers, rail sweeps, and guards -

1910.179(e)(1)

Trolley stops.

1910.179(e)(1)(i)

Stops shall be provided at the limits of travel of the trolley.

1910.179(e)(1)(ii)

Stops shall be fastened to resist forces applied when contacted.

1910.179(e)(1)(iii)

A stop engaging the tread of the wheel shall be of a height at least equal to the radius of the wheel.

1910.179(e)(2)

Bridge bumpers -

1910.179(e)(2)(i)

A crane shall be provided with bumpers or other automatic means providing equivalent effect, unless the crane travels at a slow rate of speed and has a faster deceleration rate

due to the use of sleeve bearings, or is not operated near the ends of bridge and trolley travel, or is restricted to a limited distance by the nature of the crane operation and there is no hazard of striking any object in this limited distance, or is used in similar operating conditions. The bumpers shall be capable of stopping the crane (not including the lifted load) at an average rate of deceleration not to exceed 3 ft/s/s when traveling in either direction at 20 percent of the rated load speed.

1910.179(e)(2)(i)(a)

The bumpers shall have sufficient energy absorbing capacity to stop the crane when traveling at a speed of at least 40 percent of rated load speed.

1910.179(e)(2)(i)(b)

The bumper shall be so mounted that there is no direct shear on bolts.

1910.179(e)(2)(ii)

Bumpers shall be so designed and installed as to minimize parts falling from the crane in case of breakage.

1910.179(e)(3)

Trolley bumpers -

1910.179(e)(3)(i)

A trolley shall be provided with bumpers or other automatic means of equivalent effect, unless the trolley travels at a slow rate of speed, or is not operated near the ends of bridge and trolley travel, or is restricted to a limited distance of the runway and there is no hazard of striking any object in this limited distance, or is used in similar operating conditions. The bumpers shall be capable of stopping the trolley (not including the lifted load) at an average rate of deceleration not to exceed 4.7 ft/s/s when traveling in either direction at one-third of the rated load speed.

1910.179(e)(3)(ii)

When more than one trolley is operated on the same bridge, each shall be equipped with bumpers or equivalent on their adjacent ends.

1910.179(e)(3)(iii)

Bumpers or equivalent shall be designed and installed to minimize parts falling from the trolley in case of age.

1910.179(e)(4)

Rail sweeps. Bridge trucks shall be equipped with sweeps which extend below the top of the rail and project in front of the truck wheels.

1910.179(e)(5)

Guards for hoisting ropes.

1910.179(e)(5)(i)

If hoisting ropes run near enough to other parts to make fouling or chafing possible, guards shall be installed to prevent this condition.

1910.179(e)(5)(ii)

A guard shall be provided to prevent contact between bridge conductors and hoisting ropes if they could come into contact.

1910.179(e)(6)

Guards for moving parts.

1910.179(e)(6)(i)

Exposed moving parts such as gears, set screws, projecting keys, chains, chain sprockets, and reciprocating components which might constitute a hazard under normal operating conditions shall be guarded.

1910.179(e)(6)(ii)

Guards shall be securely fastened.

1910.179(e)(6)(iii)

Each guard shall be capable of supporting without permanent distortion the weight of a 200-pound person unless the guard is located where it is impossible for a person to step on it.

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(f)(4)

Brakes for trolleys and bridges.

1910.179(f)(4)(i)

Foot-operated brakes shall not require an applied force of more than 70 pounds to develop manufacturer's rated brake torque.

1910.179(f)(4)(ii)

Brakes may be applied by mechanical, electrical, pneumatic, hydraulic, or gravity means.

1910.179(f)(4)(iii)

Where necessary brakes shall be provided with adjustment means to compensate for wear.

1910.179(f)(4)(iv)

The wearing surface of all brake drums or discs shall be smooth.

1910.179(f)(4)(v)

All foot-brake pedals shall be constructed so that the operator's foot will not easily slip off the pedal.

1910.179(f)(4)(vi)

Foot-operated brakes shall be equipped with automatic means for positive release when pressure is released from the pedal.

1910.179(f)(4)(vii)

Brakes for stopping the motion of the trolley or bridge shall be of sufficient size to stop the trolley or bridge within a distance in feet equal to 10 percent of full load speed in feet per minute when traveling at full speed with full load.

1910.179(f)(4)(viii)

If holding brakes are provided on the bridge or trolleys, they shall not prohibit the use of a drift point in the control circuit.

1910.179(f)(4)(ix)

Brakes on trolleys and bridges shall have ample thermal capacity for the frequency of operation required by the service to prevent impairment of functions from overheating.

1910.179(f)(5)

Application of trolley brakes.

1910.179(f)(5)(i)

On cab-operated cranes with cab on trolley, a trolley brake shall be required as specified under paragraph (f)(4) of this section.

1910.179(f)(5)(ii)

A drag brake may be applied to hold the trolley in a desired position on the bridge and to eliminate creep with the power off.

1910.179(f)(6)

Application of bridge brakes.

1910.179(f)(6)(i)

On cab-operated cranes with cab on bridge, a bridge brake is required as specified under paragraph (f)(4) of this section.

1910.179(f)(6)(ii)

On cab-operated cranes with cab on trolley, a bridge brake of the holding type shall be required.

1910.179(f)(6)(iii)

On all floor, remote and pulpit-operated crane bridge drives, a brake of non-coasting mechanical drive shall be provided.

1910.179(g)

Electric equipment -

1910.179(g)(1)

General.

1910.179(g)(1)(i)

Wiring and equipment shall comply with subpart S of this part.

1910.179(g)(1)(ii)

The control circuit voltage shall not exceed 600 volts for a.c. or d.c. current.

1910.179(g)(1)(iii)

The voltage at pendant push-buttons shall not exceed 150 volts for a.c. and 300 volts for d.c.

1910.179(g)(1)(iv)

Where multiple conductor cable is used with a suspended pushbutton station, the station must be supported in some satisfactory manner that will protect the electrical conductors against strain.

1910.179(g)(1)(v)

Pendant control boxes shall be constructed to prevent electrical shock and shall be clearly

marked for identification of functions.

1910.179(g)(2)

Equipment.

1910.179(g)(2)(i)

Electrical equipment shall be so located or enclosed that live parts will not be exposed to accidental contact under normal operating conditions.

1910.179(g)(2)(ii)

Electric equipment shall be protected from dirt, grease, oil, and moisture.

1910.179(g)(2)(iii)

Guards for live parts shall be substantial and so located that they cannot be accidently deformed so as to make contact with the live parts.

1910.179(g)(3)

Controllers.

1910.179(g)(3)(i)

Cranes not equipped with spring-return controllers or momentary contact pushbuttons shall be provided with a device which will disconnect all motors from the line on failure of power and will not permit any motor to be restarted until the controller handle is brought to the "off" position, or a reset switch or button is operated.

1910.179(g)(3)(ii)

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

1910.179(g)(3)(iii)

The controller operating handle shall be located within convenient reach of the operator.

1910.179(g)(3)(iv)

As far as practicable, the movement of each controller handle shall be in the same general directions as the resultant movements of the load.

1910.179(g)(3)(v)

The control for the bridge and trolley travel shall be so located that the operator can readily face the direction of travel.

1910.179(g)(3)(vi)

For floor-operated cranes, the controller or controllers if rope operated, shall automatically return to the "off" position when released by the operator.

1910.179(g)(3)(vii)

Pushbuttons in pendant stations shall return to the "off" position when pressure is released by the crane operator.

1910.179(g)(3)(viii)

Automatic cranes shall be so designed that all motions shall fail-safe if any malfunction of operation occurs.

1910.179(g)(3)(ix)

Remote-operated cranes shall function so that if the control signal for any crane motion becomes ineffective the crane motion shall stop.

1910.179(g)(4)

Resistors.

1910.179(g)(4)(i)

Enclosures for resistors shall have openings to provide adequate ventilation, and shall be installed to prevent the accumulation of combustible matter too near to hot parts.

1910.179(g)(4)(ii)

Resistor units shall be supported so as to be as free as possible from vibration.

1910.179(g)(4)(iii)

Provision shall be made to prevent broken parts or molten metal falling upon the operator or from the crane.

1910.179(g)(5)

Switches.

1910.179(g)(5)(i)

The power supply to the runway conductors shall be controlled by a switch or circuit

breaker located on a fixed structure, accessible from the floor, and arranged to be locked in the open position.

1910.179(g)(5)(ii)

On cab-operated cranes a switch or circuit breaker of the enclosed type, with provision for locking in the open position, shall be provided in the leads from the runway conductors. A means of opening this switch or circuit breaker shall be located within easy reach of the operator.

1910.179(g)(5)(iii)

On floor-operated cranes, a switch or circuit breaker of the enclosed type, with provision for locking in the open position, shall be provided in the leads from the runway conductors. This disconnect shall be mounted on the bridge or foot walk near the runway collectors. One of the following types of floor-operated disconnects shall be provided:

1910.179(g)(5)(iii)(a)

Nonconductive rope attached to the main disconnect switch.

1910.179(g)(5)(iii)(b)

An under voltage trip for the main circuit breaker operated by an emergency stop button in the pendant pushbutton in the pendant pushbutton station.

1910.179(g)(5)(iii)(c)

A main line contactor operated by a switch or pushbutton in the pendant pushbutton station.

1910.179(g)(5)(iv)

The hoisting motion of all electric traveling cranes shall be provided with an overtravel limit switch in the hoisting direction.

1910.179(g)(5)(v)

All cranes using a lifting magnet shall have a magnet circuit switch of the enclosed type with provision for locking in the open position. Means for discharging the inductive load of the magnet shall be provided.

1910.179(g)(6)

Runway conductors. Conductors of the open type mounted on the crane runway beams or overhead shall be so located or so guarded that persons entering or leaving the cab or crane foot walk normally could not come into contact with them.

1910.179(g)(7)

Extension lamps. If a service receptacle is provided in the cab or on the bridge of cab-operated cranes, it shall be a grounded three-prong type permanent receptacle, not exceeding 300 volts.

1910.179(h)

Hoisting equipment -

1910.179(h)(1)

Sheaves.

1910.179(h)(1)(i)

Sheave grooves shall be smooth and free from surface defects which could cause rope damage.

1910.179(h)(1)(ii)

Sheaves carrying ropes which can be momentarily unloaded shall be provided with close-fitting guards or other suitable devices to guide the rope back into the groove when the load is applied again.

1910.179(h)(1)(iii)

The sheaves in the bottom block shall be equipped with close-fitting guards that will prevent ropes from becoming fouled when the block is lying on the ground with ropes loose.

1910.179(h)(1)(iv)

Pockets and flanges of sheaves used with hoist chains shall be of such dimensions that the chain does not catch or bind during operation.

1910.179(h)(1)(v)

All running sheaves shall be equipped with means for lubrication. Permanently lubricated, sealed and/or shielded bearings meet this requirement.

1910.179(h)(2)

Ropes.

1910.179(h)(2)(i)

In using hoisting ropes, the crane manufacturer's recommendation shall be followed. The rated load divided by the number of parts of rope shall not exceed 20 percent of the

nominal breaking strength of the rope.

1910.179(h)(2)(ii)

Socketing shall be done in the manner specified by the manufacturer of the assembly.

1910.179(h)(2)(iii)

Rope shall be secured to the drum as follows:

1910.179(h)(2)(iii)(a)

No less than two wraps of rope shall remain on the drum when the hook is in its extreme low position.

1910.179(h)(2)(iii)(b)

Rope end shall be anchored by a clamp securely attached to the drum, or by a socket arrangement approved by the crane or rope manufacturer.

1910.179(h)(2)(iv)

Eye splices. [Reserved]

1910.179(h)(2)(v)

Rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope. Spacing and number of all types of clips shall be in accordance with the clip manufacturer's recommendation. Clips shall be drop-forged steel in all sizes manufactured commercially. When a newly installed rope has been in operation for an hour, all nuts on the clip bolts shall be retightened.

1910.179(h)(2)(vi)

Swaged or compressed fittings shall be applied as recommended by the rope or crane manufacturer.

1910.179(h)(2)(vii)

Wherever exposed to temperatures, at which fiber cores would be damaged, rope having an independent wirerope or wire-strand core, or other temperature-damage resistant core shall be used.

1910.179(h)(2)(viii)

Replacement rope shall be the same size, grade, and construction as the original rope furnished by the crane manufacturer, unless otherwise recommended by a wire rope

manufacturer due to actual working condition requirements.

1910.179(h)(3)

Equalizers. If a load is supported by more than one part of rope, the tension in the parts shall be equalized.

1910.179(h)(4)

Hooks. Hooks shall meet the manufacturer's recommendations and shall not be overloaded.

1910.179(i)

Warning device. Except for floor-operated cranes a gong or other effective warning signal shall be provided for each crane equipped with a power traveling mechanism.

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.

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, drain 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.

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 contact of 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(l)

Maintenance -

1910.179(l)(1)

Preventive maintenance. A preventive maintenance program based on the crane manufacturer's recommendations shall be established.

1910.179(l)(2)

Maintenance procedure.

1910.179(l)(2)(i)

Before adjustments and repairs are started on a crane the following precautions shall be taken:

1910.179(l)(2)(i)(a)

The crane to be repaired shall be run to a location where it will cause the least interference with other cranes and operations in the area.

1910.179(l)(2)(i)(b)

All controllers shall be at the off position.

1910.179(l)(2)(i)(c)

The main or emergency switch shall be open and locked in the open position.

1910.179(l)(2)(i)(d)

Warning or "out of order" signs shall be placed on the crane, also on the floor beneath or on the hook where visible from the floor.

1910.179(l)(2)(i)(e)

Where other cranes are in operation on the same runway, rail stops or other suitable means shall be provided to prevent interference with the idle crane.

1910.179(l)(2)(ii)

After adjustments and repairs have been made the crane shall not be operated until all guards have been reinstalled, safety devices reactivated and maintenance equipment removed.

1910.179(l)(3)

Adjustments and repairs.

1910.179(l)(3)(i)

Any unsafe conditions disclosed by the inspection requirements of paragraph (j) of this section shall be corrected before operation of the crane is resumed. Adjustments and repairs shall be done only by designated personnel.

1910.179(l)(3)(ii)

Adjustments shall be maintained to assure correct functioning of components. The following are examples:

1910.179(l)(3)(ii)(a)

All functional operating mechanisms.

1910.179(l)(3)(ii)(b)

Limit switches.

1910.179(l)(3)(ii)(c)

Control systems.

1910.179(l)(3)(ii)(d)

Brakes.

1910.179(l)(3)(ii)(e)

Power plants.

1910.179(l)(3)(iii)

Repairs or replacements shall be provided promptly as needed for safe operation. The following are examples:

1910.179(l)(3)(iii)(a)

Crane hooks showing defects described in paragraph (j)(2)(iii) of this section shall be discarded. Repairs by welding or reshaping are not generally recommended. If such repairs are attempted they shall only be done under competent supervision and the hook shall be tested to the load requirements of paragraph (k)(2) of this section before further use.

1910.179(l)(3)(iii)(b)

Load attachment chains and rope slings showing defects described in paragraph (j)(2) (iv) and (v) of this section respectively.

1910.179(l)(3)(iii)(c)

All critical parts which are cracked, broken, bent, or excessively worn.

1910.179(l)(3)(iii)(d)

Pendant control stations shall be kept clean and function labels kept legible.

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.

1910.179(o) Other requirements, general -

1910.179(o)(1) Ladders.

1910.179(o)(1)(i)

The employer shall insure that hands are free from encumbrances while personnel are using ladders.

1910.179(o)(1)(ii)

Articles which are too large to be carried in pockets or belts shall be lifted and lowered by hand line.

1910.179(o)(2) Cabs.

1910.179(o)(2)(i)

Necessary clothing and personal belongings shall be stored in such a manner as not to interfere with access or operation.

1910.179(o)(2)(ii)

Tools, oil cans, waste, extra fuses, and other necessary articles shall be stored in the tool box, and shall not be permitted to lie loose in or about the cab.

1910.179(o)(3)

Fire extinguishers. The employer shall insure that operators are familiar with the operation and care of fire extinguishers provided.

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STANDARD FOR
LIFTING DEVICES AND EQUIPMENT

NASA TECHNICAL STANDARD

FOREWORD

This standard is approved for use by NASA Headquarters and all NASA Installations and contractors as specified in their contracts. The standard establishes uniform design, testing, inspection, maintenance, operational, personnel certification, and marking requirements for lifting devices and associated equipment used in support of NASA operations. A NASA operation is defined as any activity or process that is under NASA direct control or includes major NASA involvement.

NASA's goal for achieving "best class" status as an organization poised for preventing mishaps requires perfecting our processes in four areas of excellence. These areas are: management commitment and employee involvement; system and worksite hazard analysis; hazard prevention and control; and safety and health training. This standard was developed to address hazard prevention and control as well as safety and health training and expands on NPG 8715.3, "NASA Safety Manual," policy and guidelines for safety assurance. It is a compilation of pertinent requirements from the Occupational Safety and Health Administration (OSHA), American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), Crane Manufacturers Association of America (CMAA), and unique NASA requirements. The standard combines the knowledge of all NASA Installations and contractors including NASA operations in host countries, standardizes definitions, clarifies/documents OSHA interpretations, addresses the subject of criticality, and conveys standardized requirements. With the exception of Alternative Standard for Suspended Load Operations contained in Appendix A, this standard is not a substitute for OSHA or local government (including such host country requirements as those in Australia or Spain) requirements which apply to NASA operations in full.

Significant changes in this revision of the standard include the coverage for Mobile Aerial Platforms, Powered Industrial Trucks, and Jacks. Appendices C and D have been added concerning lifting personnel with a crane and using a crane to load test other lifting equipment, respectively. The designation of an installation Lifting Devices and Equipment Manager (LDEM) is also required with this revision.

Compliance with this standard is mandatory for all NASA-owned and NASA contractor-supplied equipment used in support of NASA operations at NASA installations. The individual installation safety organizations are responsible for assuring implementation. This document establishes minimum safety requirements; NASA installations are encouraged to assess their individual programs and develop additional requirements as needed.

Requests for information, corrections, or additions to this standard should be directed to the ~~National Aeronautics and Space Administration Headquarters, Director, Safety and Risk Management Division, Code QS, Washington, DC 20546~~. Requests for general information concerning NASA Technical Standards should be sent to NASA Technical Standards Program Office, ED41, MSFC, AL, 35812. This and other NASA Standards may be viewed and downloaded free-of-charge from our NASA Standards Homepage: http//standards.nasa.gov. This NASA Technical Standard cancels NSS/GO-1740.9, dated November 1991 as updated March 1993.

Michael A. Greenfield, Ph.D.
Acting Associate Administrator for
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New Address:
Director, Safety and Assurance Requirements Division
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REVISION LOG

REVISION	DESCRIPTION	DATE
Initial Issue	NASA-STD-8719.9, NASA Standard for Lifting Devices and Equipment. Significant Changes. Converts document to NASA-STD format. Adds sections on mobile aerial platforms, powered industrial trucks, and jacks. Adds appendices on lifting personnel with a crane and using a crane to load test other lifting equipment. Designation of an installation Lifting Devices and Equipment Manager (LDEM) is also required.	May 9, 2002
Change 1	Document is revalidated without changes other than updates to Cover, Foreword (address), and Revision Log.	October 1, 2007 JWL4

A note concerning the history of this document:

The original NASA Safety Standard for Lifting Devices and Equipment was issued as NSS/GO-1740.9 in July 1982. In July 1988 it was revised and Revision A was issued reflecting significant changes related to mobile cranes, hoist supported personnel platforms, personnel lifting buckets, and guidance concerning super critical lifts. In November 1991 it was revised again and Revision B was issued which deleted the guidance on super critical lifts and added the NASA Alternate Standard for Suspended Load Operations. Additional revisions were issued as change pages in March 1993 to expand operational test requirements for special hoist supported personnel lifting devices. When it came time to update the standard again, in addition to the technical changes to the document (synopsized in the Revision Log above) the format and numbering were changed to reflect current practices and conventions for NASA Standards.

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

Excerpts from NASA Standard 8719.9

NASA-STD-8719.9 w/Change 1
May 9, 2002

National Aeronautics and
Space Administration

Expiration Date: October 1, 2012

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.

NASA STANDARD 8719.9

Excerpts

Sections:

10.0 through 10.7

(Rigging)

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 Daily Inspections. 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 Periodic Inspections. 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 Operations. 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.

Goddard Procedural Requirement

GPR 8834.1B

Lifting Operations Requirements

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

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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.

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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

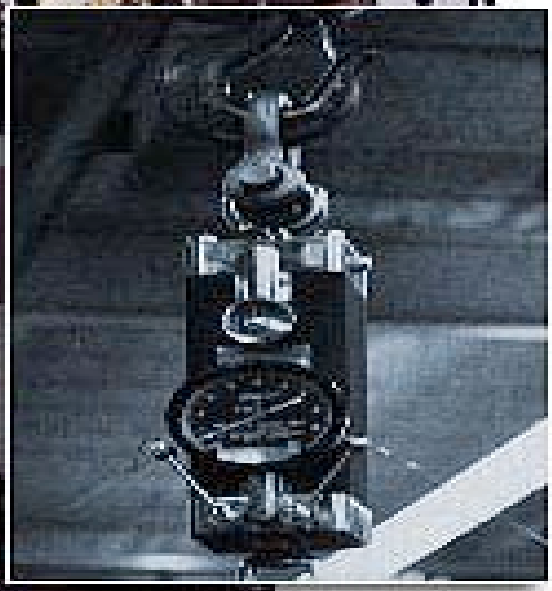
Safety/Facilities Manager

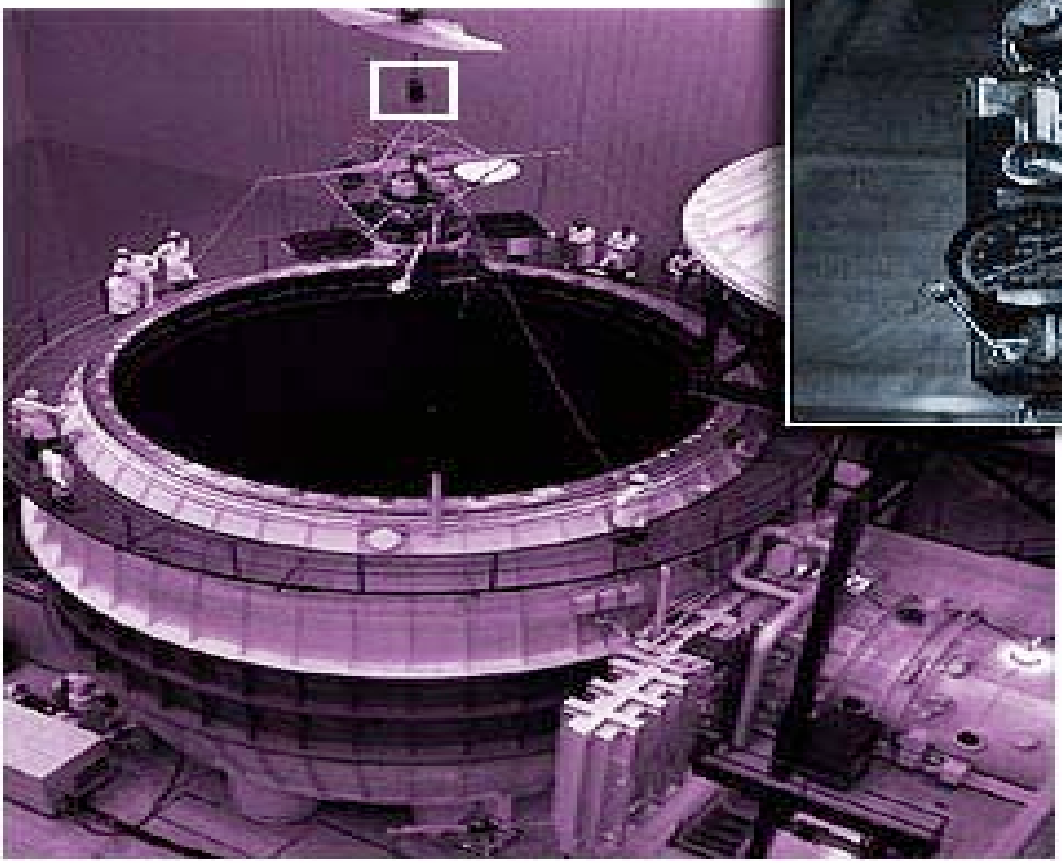
Notes:
1. A signed copy of Appendix C shall be sent to the RECERT Manager.
2. A signed copy of the OLOC Risk Assessment shall be sent to the RECERT Manager.

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.

Hydra-Sets





HYDRA-SET

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

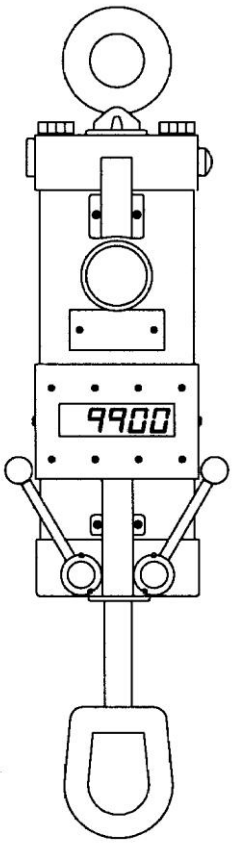
October 2004

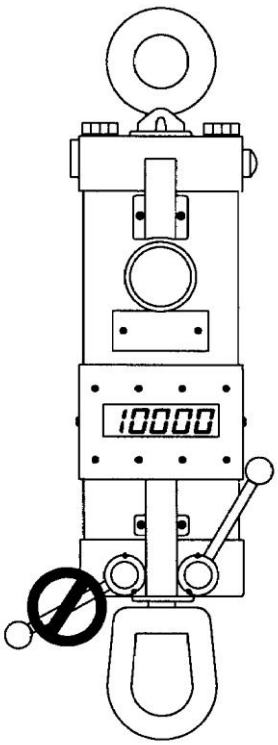
DELMAR®

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**





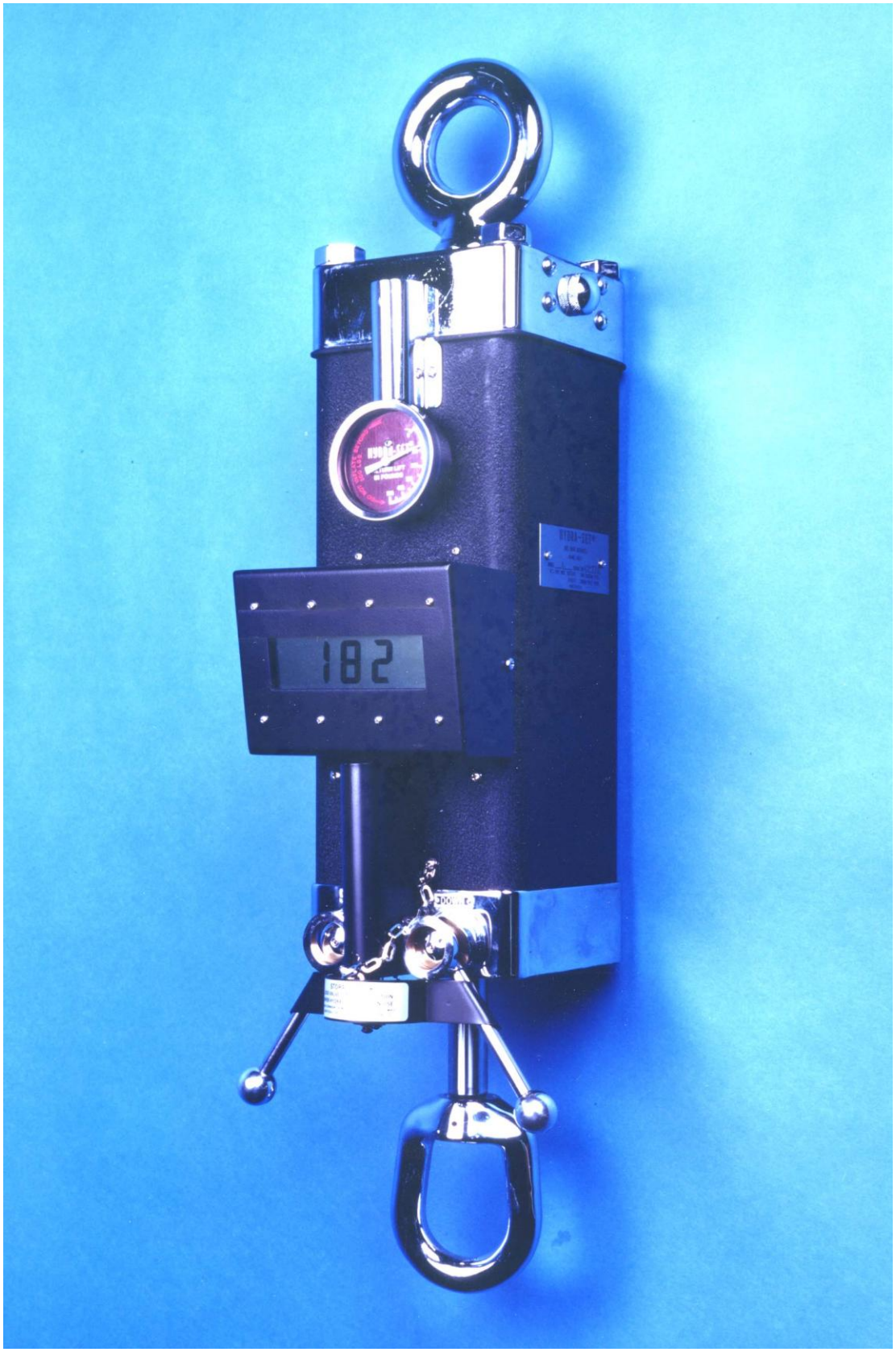


Figure 1. Typical Hydra Set

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.

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.

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.

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 <u>your</u> 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

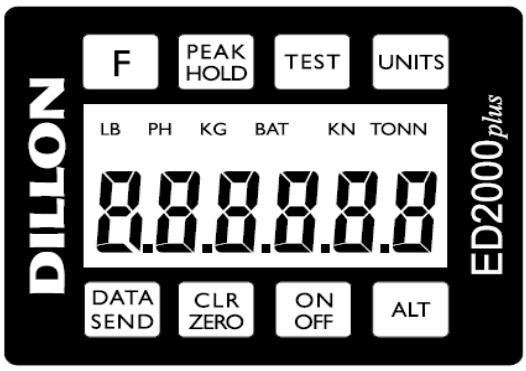


Figure 1
Electronic Dynamometer Front Panel

DILLON

Force Measurement Equipment

ED Series Crane Scales

EDxtreme & EDjunior Crane Scales

Dillon ED Series Crane Scales

Advanced Weighing

> **Guesswork is not acceptable.** When you have people working around massive loads, there is no room for error. You have to have complete confidence in the strength and the accuracy of your measurement tools.

Since 1937, Dillon Dynamometers have been chosen for the jobs where only the best will do. Now, Dillon has once again lifted the performance bar and set the standard for others to follow — Dillon ED Series Crane Scales.

Two ED Series models are available: The **high-end EDxtreme** (also called EDx), and the **affordable EDjunior.** Choose EDxtreme for the most demanding applications; EDxtreme is built with the best materials and designed with cutting-edge features like radio control. Where cost is a concern, and reliability is a requirement, choose EDjunior – the perfect crane scale for simple jobs.

EDxtreme – The ultimate in reliability & accuracy

Popular industry-standard shackles insure proper fit

Sturdy aircraft-quality aluminum (shown) or plated alloy steel case

Battery compartment – easy access without tools

High-resolution dot-matrix LCD display offers large numbers without confusing abbreviations or multipliers

Injection molded, thick Lexan panels offer superior impact protection

Softkey interface allows easy and intuitive operation and configuration

NEMA 4X / IP55 designed for weather and water resistance

All EDxtreme Crane Scales include storage crate, instructions, and certificate of calibration.

Hook Choices

Reliable, high quality Crosby hooks are used on all EDx Crane Scales.

- **Non-Swivel Hook (left)** – basic hook for low-cost, low-headroom weighing.
- **Basic Swivel Hook (center)** – Used to align rigging to the crane.
- **Bearing Swivel Hook (right)** – Used for precise positioning under load .

Capacities available from 2500 to 50,000 lbf (1000 to 20000 kgf).

Specifications and dimensional details *are available from an authorized Dillon Distributor or the website at www.dillonforce.com.*

EDxtreme – Signature features

Xtreme accuracy: 0.1%

Accurate repeatable readings are essential to proper weighing. The higher standards set for the EDx Crane Scales meant taking the time to ensure that material characteristics, load element design and strain gage meshed perfectly. The result of that effort is a typical accuracy of 0.1% of full scale capacity. The enhanced resolution mode of 1 part in 5000 provides the level of readability needed for refined weighing.

Xtreme ease

- **Exclusive SOFTKEY interface –** Eliminates confusing menus for faster setup and simple operation.
- **Local gravity correction –** Unit adjusts to local gravitational conditions, without recalibration.
- **Custom units of measure –** User-defined units of measure mean the instrument adapts to changing requirements.
- **Wide-angle, backlit LCD –** Provides improved readability over a wider viewing angle and has backlighting for low light conditions.
- **Battery operation –** Powered by two standard C-cell batteries. Batteries are easily accessible for fast replacement.

Xtreme engineering

Building a precision instrument that can survive real-world punishment requires masterful engineering. This is where Dillon's experience shines through. The engineers assigned to the EDx Crane Scale drew on a depth of industrial application knowledge and conducted exhaustive materials testing to achieve the highest structural integrity.

- **Superior strength and corrosion resistance –** High capacity models are constructed of powder coated aircraft-quality alloy steel. Lower capacity models are powder coated aircraft-quality aluminum.
- **5:1 factor of safety –** This measure of strength and safety is maintained at all capacities. Computer modeling confirms the low stress and long product life that is inherent in the EDx Crane Scale design.
- **NEMA 4X/IP55 –** The EDx Crane Scale is clearly the choice for reliability in any environment – in-plant or out on the job site.

Expandable Scale Network

A basic stand-alone model can be easily expanded to accommodate changing needs. Data acquisition and single point monitoring of multiple scales are all easy with the hardwired or radio communication option.

Optional Remote Communicator, showing four crane scale readings and total of all.

Typical Configurations

1 Stand-alone EDx for simple, direct measurement applications.

2 Single network with one EDx radio Crane Scale and Communicator.

3 Single network with multiple EDx Crane Scales and one Communicator. The Communicator monitors the load at each scale, plus the total weight.

4 Multiple networks with multiple EDx Crane Scales and Communicators.

An RS-232 interface is standard on both the EDxtreme and Communicator for connection to a host PC.

KEY: plant airspace discrete radio channel

ED Junior – The market leader in accuracy & value

The EDjunior is all about value. Behind its simple design and easy operation, you will find the quality and performance not found elsewhere. With the EDjunior, Dillon proves that economy can go hand-in-hand with accuracy, long service life and, most importantly, worker safety – just compare the Dillon EDjunior to the competition. Nothing else comes close!

Measurement Capabilities

The EDjunior provides peak detection as well as live load readings. Selectable units of measure include lbf, kgf and Newtons.

Accuracy — The load element design and strain gauges chosen for the EDjunior produce an accuracy of 0.2 % (full scale). This level of precision offers flexibility for use in a broad range of applications. Capacities up to 10,000 lb (5000 kg) available.

Resolution — Readings are displayed with a resolution of 1 part in 1000 to ensure the level of readability required for critical lifting applications.

Control Interface

The exclusive Dillon SOFTKEY interface provides direct access to setup and display functions without the typical confusing menu structure. The 6-digit dot-matrix display features 1 inch (25 mm) high numerals for greater visibility.

High Strength, Low Weight

Heavy, cumbersome tools make tough jobs even harder. Through the use of aircraft quality materials, Dillon has made the EDjunior an easy-to-position, highly mobile instrument with exceptional strength. It offers an impressive factor of safety at all capacities.

All Environments

With its NEMA4/IP55 design, the EDjunior is at home in virtually any environment and ideally-suited to outdoor job-site applications as well as in-plant use.

Hook Choices

- **Basic Swivel Hook (left) –** Used to align rigging to the crane
- **Non-Swivel Hook (right) –** basic hook for low-cost, low-headroom weighing.

Specifications and dimensional details *are available from an authorized Dillon Distributor or the website at www.dillonforce.com.*

Dillon on the job

Dillon force measurement equipment is the preferred choice of public utilities, nuclear facilities, tower erectors, armed services and material handlers throughout the world. Dillon also manufactures mechanical crane scales, high accuracy mechanical and electronic dynamometers and overload protection devices.

AUTHORIZED DISTRIBUTORS

Ask the experts. Dillon distributors offer complete service capabilities from application assistance to sales and product support. Their experienced representatives are the most knowledgeable experts that you will find in the force measurement industry. We recommend that you consult these capable specialists for all of your measuring needs.

Please call us or visit www.dillonforce.com for your nearest Dillon distributor.

DILLON

Force Measurement Equipment

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PN 09736-0010C Printed in USA

DILLON

ED-2000plus Electronic Dynamometer with HR-2000 Remote User's Manual

UNITED STATES

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CANADA

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de la Class A prescrites dans le Reglement sur le brouillage radioelectrique que edicte par le ministere des Communications du Canada.

EUROPEAN COUNTRIES

WARNING

This is a Class A product. In a domestic environment this product may cause radio interference in which the user may be required to take adequate measures.

CAUTION

Risk of electrical shock. Do not remove cover. No user serviceable parts inside. Refer servicing to qualified service personnel.

Weigh-Tronix reserves the right to change specifications at any time.

02/16/00 2000USER.P65 PN 29641-0012e1 Printed in USA

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—This manual is for reference only.—

ED-2000plus Specifications

Capacities:

2,000 x 0.5 lb	1,000 x 0.2 kg	10 x 0.002 kN	1 x 0.0002 T
5,000 x 1 lb	2,000 x 0.5 kg	20 x 0.005 kN	2 x 0.0005 T
10,000 x 2 lb	5,000 x 1 kg	50 x 0.01 kN	5 x 0.001 T
20,000 x 5 lb	10,000 x 2 kg	100 x 0.02 kN	10 x 0.002 T
50,000 x 10 lb	20,000 x 5 kg	200 x 0.05 kN	20 x 0.005 T
100,000 x 20 lb	50,000 x 10 kg	500 x 0.1 kN	50 x 0.01 T

Construction: Aluminum alloy (2-, 5-, and 10,000 lb)
Stainless steel (20-, 50-, and 100,000 lb)

Enclosure: NEMA 4X / IP66 (sealed against dust, hosedown, and corrosive agents)

Units of measure: Selectable pounds, kilograms, kiloNewtons, metric tons. The selected unit of measure is saved when the power is switched off.

Accuracy: 0.1% of rated capacity

Repeatability: 0.1% of rated capacity

Display update rate: 2 times per second

Internal update rate:
Normal mode: 8 times per second
Peak hold: 60 times per second

Ultimate safety factor: 5:1

Display: 6 LCD digits, 0.9" (22.5 mm) height

Outputs: RS-232 output from dynamometer or Radio-Link remote display unit.

Annunciators: LB, KG, KN, TONN, PH (peak hold), BAT (low battery)

Control keys: On/Off, Test, Clear/Zero, Peak hold, Function key, Units

Power: Standard 9V battery, alkaline or lithium. The ED-2000plus has approximately 200 hours of use with the 9V alkaline battery. Battery life can be extended with the use of a 9V lithium battery. These values represent “average” use; mode of operation, typical period of use, battery recovery, and other variables determine the ultimate battery life. With the optional radio link installed, the 9V battery life is approximately 36-48 hours.

Operating temp: -4° to 140°F (-20° to 60°C)

Calibration: Traceable to the National Institute of Standards and Technology (NIST). Calibration Certificate with each unit.

Optional Radio link:
Open air range: Up to 300 feet
Update rate: 2 times per second
RF signal output: 0 dBm in 50 at 25 C in accordance to FCC Part 15.249, and in Canada under TRS RSS-210.
Frequency: 916.5 MHz

ED-2000plus Introduction

The ED-2000plus dynamometer is an electronic portable force or weight measurement instrument.

The ED-2000plus is available with low-power radio communications. This option permits wireless communication between the ED-2000plus and an HR-2000 handheld remote display. The ED-2000plus system offers additional flexibility by the ability to have several (up to 255) devices controlled by a single HR-2000 display. This is called a multidrop system.

Data can be extracted from either the ED-2000plus or the HR-2000. This data can be sent to a computer by pressing the **DATA SEND** key or requested by the computer by sending an ENQUIRE code.

This guide describes the operation of the ED-2000plus series of Dillon electronic dynamometers and the procedures for configuring the device to your specific needs.

The display consists of six 7-segment digits and six annunciators which appear when appropriate. See Figure 1 below.

There are three modes of operation:

- Normal operating mode, which covers the daily use of the device.
- Device information mode, allows information about the device to be viewed but not edited. Information that can be viewed includes serial number, range, date of last calibration, etc.
- Configuration mode, which enables the user to configure the device.

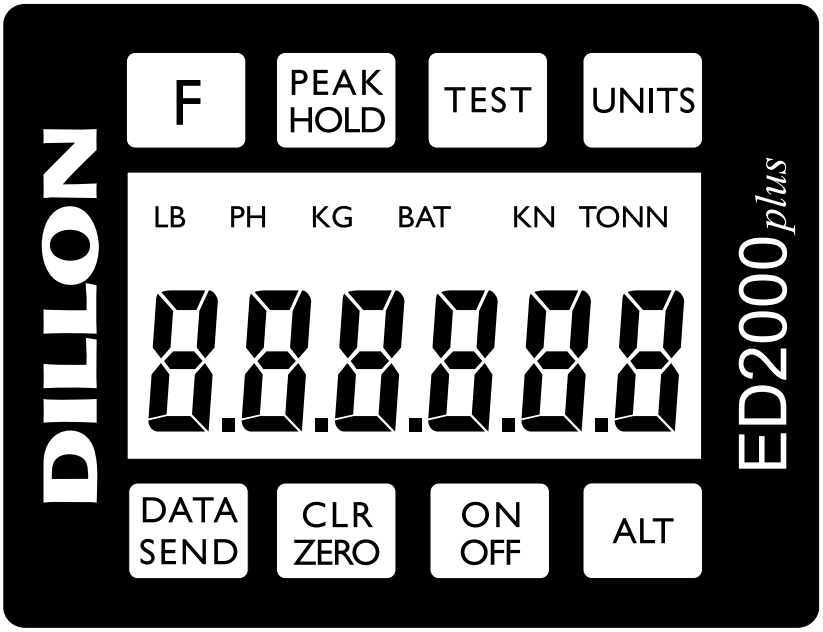


Figure 1
Electronic Dynamometer Front Panel

Normal Operation Mode

During normal operation mode most of the basic functions are available by pressing one key. Some of the functions require that the F-key is pushed simultaneously. This is indicated by F+[key]. Table 1 explains the key functions.

Key	Function	Display
ON/OFF	Hold for ½ second to turn unit on. On start-up the device is initialized and starts measuring with previous units selected. ON/OFF key is disabled in peak hold, device information and configuration modes.	Shows the current gross value with the appropriate annunciator visible (***LB***, ***KG***, ***KN*** or ***TONN***). With Version 3.0 software the display will show ***OFF 3A*** when turning the unit off.
CLR/ZERO	Tare the device and show net reading.	Reads net force value. Can be positive or negative. Can tare up to 100% of capacity.
SEND DATA	Send displayed information via RS-232	No change in the display.
ALT	Not used with the ED-2000plus	
F+CLR/ZERO	Reverts to gross reading.	Shows the gross force value.
UNITS	Scrolls through the four possible units of measure and converts the reading to the selected unit. Selected unit of measure is saved when power is switched off.	The units legends will change in the sequence ***LB***->***KG***->***KN***->***TONN***->***LB*** etc., and the display will update accordingly.
F+PEAK HOLD	Toggles the device between normal and peak hold mode. In peak hold mode it will update the reading at 60 times per second.	Activates the "***PH***" annunciator if in peak hold mode. The annunciators will flash and the top segment of the left most digit will illuminate to indicate maximum is being displayed.
PEAK HOLD	If the device is in peak hold mode, toggles between minimum and maximum readings.	The top segment of the left most digit illuminates if maximum reading is being displayed. The bottom segment illuminates if the minimum reading is being displayed.
TEST	Performs an internal shunt test of the measuring bridges. (You must hold the key down until the display stabilizes.)	A value is displayed that is within ±0.1% of capacity in the currently selected measuring units. If displayed value is greater than ±0.1%, recalibrate the unit. Depending on the filter value currently selected (see Configuration Mode), the display may take some time to settle to a stable reading.
F+UNITS	Switches device from normal operating mode to device information mode.	
F+TEST	Switches device from operating mode to configuration mode.	
F+ON (from power off)	Puts device in RS-232 mode. This function also conserves battery life. If you are not using the radio function, we recommend placing the device in RS-232 mode.	

Table 1
Key Functions in Normal Operation Mode

RS-232 Operation

You can operate the ED-2000plus with a computer or other data logging device via RS-232. Place the ED-2000plus in RS-232 mode by pressing the **F** and **ON** keys simultaneously. This operation is transparent to the user. It is important that the ED-2000plus and the external device are set at a baud rate of 2400 for RS-232 communication.

When you press the **DATA SEND** key in RS-232 mode, or send an enquire code from the external device to the ED-2000plus, the following information is sent to the external device:

xxxxx.x uu CR/LF

x = force value
u = unit of measure (LB, KG, KN or T)
CR/LF = carriage return and line feed

The force value received is right justified with any leading zeroes replaced by spaces. Negative values will show a minus sign before the first digit. The decimal point will not be printed if it follows the significant digits.

The enquire code is a single question mark (?). When the ED-2000plus receives this code from the external device, the above information is sent.

If your RS-232 port is receiving garbled data, check to be sure you are in RS-232 mode or that an HR-2000 is not trying to communicate with the ED-2000plus by radio.

Device Information Mode

The device information mode is activated from normal operating mode by simultaneously pressing **F** and **UNITS**. Return the unit to normal operations by pressing **F**+**CLR/ZERO**.

Upon entering device information mode, the selected unit annunciator will flash (indicating that the device is out of the normal operating mode) and the display will show the device serial number. Use the keys described in Table 2 to view the information fields described in Table 3.

Key	Function	Display
PEAK HOLD	Scroll down the list of information fields, i.e. the next field in the list.	The "label" for the field is shown briefly when the key is kept depressed. The actual information value is then shown.
TEST	Scroll up the list of information fields, i.e. the previous field in the list	Same as for **PEAK HOLD**
UNITS	Show the label of the current information field.	Same as for **PEAK HOLD**
F+CLR/ZERO	Return to normal operating mode.	

Table 2
Key Function in Device Information Mode

Table 3 contains the information fields and typical values you can view in the device information mode. The fields appear in the sequence shown. Scrolling past the last item in the list will return the display to the first item in the list.

Label	Typical Display	Description
SErno	***512056***	The device serial number (6 digits).
Eltno	***201360***	Load element number.
SoFt	***2.60***	The software release number.
rAnGE	***20^1 Lb***	Device range in 1,000s of pounds.
C-dAt	***96.08.02***	Year, Month and Day of last calibration.
C-rEF	***100123***	Reference to calibration document number (6 digits).
C-cnt	***3***	Total number of calibrations performed.
OLOAd	***0***	Number of times the device has been overloaded beyond 125% of full capacity.
Addr	***100***	The communication address assigned to the device in multidrop applications.

Table 3
Device Information Fields

Configuration Mode

The configuration mode is activated from normal operation mode by simultaneously pressing **F** and **TEST**. Return to normal operation by pressing **F+CLR/ZERO**.

Upon entering configuration mode, the selected unit annunciator will flash (indicating that the device is out of the normal operating mode) and the display will show the current value for setpoint 1.

The configuration values may be changed and permanently stored in nonvolatile memory within the device. Consequently, use these functions with care. Note that the values will be changed immediately in the EEPROM, but some changes will only take effect when the unit is switched off and then back on. These values are noted with an asterisk in the "Label" column of Table 5

Table 4 shows the keys you use to set configuration to your needs. Table 5 contains the configuration items you can view and change.

Key	Function	Display
PEAK HOLD	Scroll down in list of information fields, i.e. the next field in the list.	The "label" for the field is shown briefly when the key is kept depressed. The actual information value is then shown.
TEST	Scroll up in list of information fields, i.e. the previous field in the list.	Same as for **PEAK HOLD**.
UNITS	Show the label of the current information field.	Same as for **PEAK HOLD**.
F+PEAK HOLD	Increment the value shown with wraparound.	Dependent upon function selected.
F+TEST	Decrement the value shown with wraparound.	Dependent upon function selected.
F+CLR/ZERO	Return to basic function mode.	

Table 4
Key Functions in Configuration Mode

Table 5 contains the information fields and typical values you can view in the configuration mode. The fields appear in the sequence shown. Scrolling past the last item in the list will return the display to the first item in the list.

Disabling the Radio-Link Software to Save Battery Power

The ED-2000plus software allows you to use the Radio-Link option. If the Radio-Link option is installed but not being used, disable the radio portion of the software to increase battery life. Also, if your system is not equipped with the Radio-Link option, disable the software.

To disable the Radio-Link software see the ***SErch*** section in Table 5 below. Notice that the change will not take effect until the ED-2000plus has been switched off and then back on.

Label	Typical Display	Description
SEt-1**	***100***	Typically not used.
SEt-2**	***110***	Typically not used.
FiLt	***2***	Filter values (damping factors) on the load cell signal. Acceptable values are from 0 (no damping) to 7 (maximum damping).
SErch*	***rS-485*** ***rAdio***	Changes the serial communication link between RS-485 and radio link. Press F + TEST key to toggle between the two choices. Select RS-232 communication by depressing F+ON/OFF at power up and RS-485 and radio will be bypassed.
Addr*	***100***	The communication address assigned to the device in multidrop applications. Values should be between 33 and 255.
bAud*	***2400***	Communication baud rate. Available values are 300, 1200, 2400, 4800, 9600, and 19,200 baud. System default is 2400 baud. Radio communication at 2400 baud by default.

*Change takes effect only after the unit has been switched off and then back on.
**Used only in special software applications

Table 5
Configuration Items

Sleep Mode

Sleep mode is a non-configurable battery saving feature of the ED-2000plus. It functions all the time. If signal changes from the strain gages are not received by the microprocessor, certain high drain functions are shut down. The display does not change and any communication with the unit or signal from the gages reactivates the unit instantly. The function of the sleep mode is transparent to the user.

Battery Replacement

ED-2000plus connected to an HR-2000 by wire receives power from the HR-2000. A battery is not recommended in the ED-2000plus in this situation.

The HR-2000 does not contain a low battery detector. It merely displays the low battery warning from the loadcell. Because of this, change batteries in both the ED-2000plus and HR-2000 when the battery warning lights up. (Radio-Link systems only)

When the low battery annunciator appears, you have approximately five hours of usage left. To change the nine-volt battery in the ED-2000plus, follow these steps:

1. Remove the two knurled thumb screws from the battery compartment cover. (Be careful not to lose these screws.) See Figure 6.

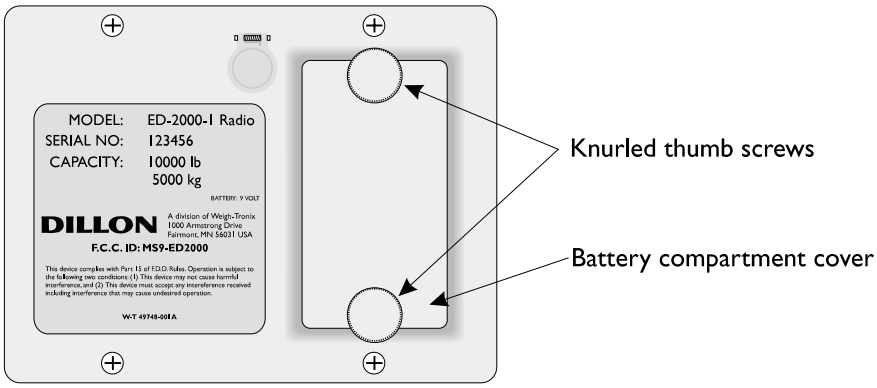


Figure 6
Battery compartment cover

2. Remove the battery compartment cover.
3. Slide the battery down and pry the free end of the battery out of the compartment opening. See Figure 7.

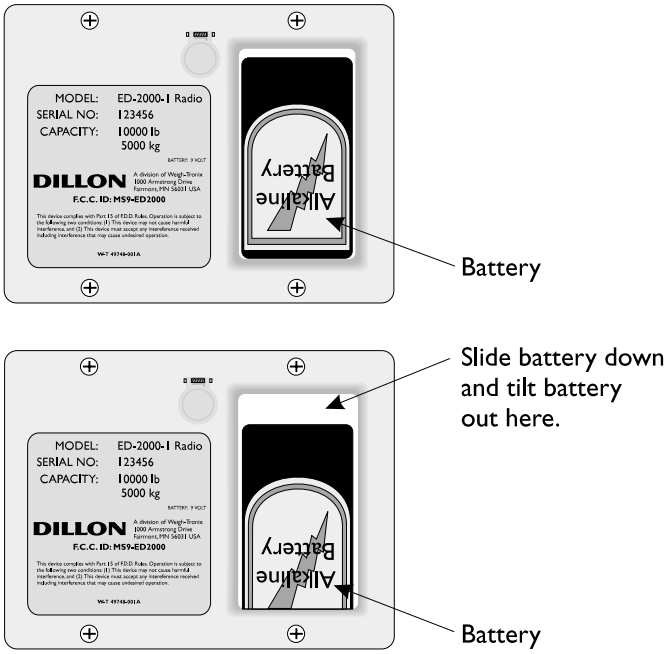


Figure 7
Battery removal

4. Pull the battery out of the compartment and disconnect the battery from the battery lead.
5. Connect new battery to the lead and reverse the disassembly procedure.

HR-2000 Introduction and Operation

Introduction

*To reduce battery drain when not using the Radio-Link option, with the HR-2000 unit on, press both the **PEAK/HOLD** and the **ON/OFF** key. This disables the radio portion of the software and will increase battery life.*

The HR-2000 operates as a remote keyboard and display for the ED-2000plus electronic dynamometer. Communication between the HR-2000 and the ED-2000plus takes place in RS-485 format via cable or low power radio communication.

The HR-2000 has the following communication parameters "hardwired" into the device.:

- Communication mode: RS-485 half duplex
- Baud rate: 2400 bits per second
- Own address: Configurable
- Initial remote address: Last address used

Addresses

High frequency signals are subject to absorption by the ground and the atmosphere, as well as reflections from metallic surfaces. For low power systems, it is normal that variations of range will be experienced, even in “open air” conditions in different environments. Due to combinations of absorption and reflection, pockets with weak and strong signals will be experienced inside the range.

The dominant absorption factor is the ground. As a general rule, the higher the antennas are above the ground, the better the signal.

Addresses are important with the ED-2000plus and HR-2000 because of the manner in which they communicate. The HR-2000 sends out a signal (poll signal) requesting that the instrument with a specific address send its display reading. The ED-2000plus looks at the poll signal that the remote sent and determines if the address matches. If it does match, the ED-2000plus responds with its reading.

The concept of addresses is relatively transparent if the system consists of a single ED-2000plus and an HR-2000. The system will communicate with little (if any) addressing ever required. However, if several ED-2000plus instruments are in the same area, they each need to be uniquely identified so that the HR-2000 knows which ED-2000plus it is talking to.

If several HR-2000 remotes are in the same area, each remote needs to know when it is its turn to use the airwaves. This is also accomplished by assigning the remote a unique address, and by telling it how many other remotes are in the area.

The following pages describe the operation of the HR-2000, both in one-on-one and multiple applications.

Operation

The key functions for the HR-2000 are listed in Table 6.

Key	Function	Display
ON/OFF	Turns the unit on in radio mode. RS-485 wireline communication will also function.	rAdio
F + ON/OFF (while unit is off)	Press these two keys to power up the unit in RS-485 wireline mode. This disables radio function and preserves battery life.	rS-485
F+ ON/OFF (while unit is on)	Puts the unit into addressing mode and shows the address that is to be polled.	SEtuP-100
PEAK HOLD	Increments the address by 1 count.	101
TEST	Decrements the address by 1 count	99
F + PEAK/HOLD	Increments the address by 10	110
F + TEST	Decrements the address by 10	90
F + ON/OFF	Returns unit to normal display mode.	-donE-
ON/OFF	Turns the unit off	OFF
ALT + ON (while unit is off)	Forces unit into RS-232 mode	-duAL-
F + ALT	Places remote in LISTEN mode. The remote waits for a poll signal from the attached peripheral, requests the reading from the ED-2000plus and returns the reading to the peripheral.	LiStEn

Table 6
Key Functions for HR-2000

Powering Up

For Radio Communication

While operating the HR-2000, the lower part of the leftmost digit may be observed to flash. This occurs when the HR-2000 wants to transmit a message and is waiting for access or for an answer. Operating under good radio conditions, this will be rarely seen.

To power up for use with the radio link, press the **ON/OFF** key on the ED-2000plus then the press the **ON/OFF** key on the HR-2000.

When you turn on the HR-2000 for radio use, the display will show the software revision number (probably ***hr2001***), then the word ***rAdio***. Until the corresponding ED-2000plus is powered up and communicating with the HR-2000, the letter ***r*** will flash back and forth between inverted and upright. When communication is established and working properly the display will mirror the ED-2000plus display and the leftmost decimal point will blink every ½ second. If communication is broken, the display will flash a small ***o*** in the lower left corner of the display. If communications are not resumed within ten seconds, the display will show ***rAdio*** and the letter ***r*** will flash back and forth between inverted and upright.

Radio Operation with RS-232

You can connect the HR-2000 with a computer or other data logging device via RS-232. There are two communication modes for the HR-2000; normal operation mode and listen mode. It is important that the ED-2000plus, the HR-2000 and the external device all be set at a baud rate of 2400 for RS-232 communication.

In normal operating mode, the ED-2000plus and HR-2000 are in constant contact and the HR-2000 screen reflects what the ED-2000plus screen shows. Information can be sent to an external device by pressing the **DATA SEND** key on the HR-2000.

In listen mode, the HR-2000 waits to receive an enquire code from the external device, polls the ED-2000plus for the information, then returns it to the external device.

To enter listen mode press the **F** and **ALT** keys simultaneously. In listen mode the display shows the word LISTEN and keys are nonfunctional.

Following is the format of the information sent to the external device:

xxxxx.x uu CR/LF (if in LISTEN mode, a less than symbol (>), ASCII code 62, is also sent after the line feed)

x = force value
u = unit of measure (LB, KG, KN or T)
CR/LF = carriage return and line feed

The enquire code for the HR-2000 is a question mark plus a carriage return (?,CR or ASCII Codes 63,13). When the HR-2000 receives this code from the external device, the above information is sent.

The action of sending information or polling for information can introduce delays in communication between the HR-2000 and ED-2000plus.

If your HR-2000 does not automatically detect the RS-232 connection, turn off the unit, then power up by pressing the **ALT** and **ON** keys simultaneously. This forces the unit into RS-232 operation.

The force value received is right justified with any leading zeroes replaced by spaces. Negative values will show a minus sign before the first digit. The decimal point will not be printed if it follows the significant digits.

WARNING!
HR-2000 is intended to send only force/weight readings. Although the HR-2000 can remotely configure an ED-2000plus, unpredictable output may result if Print or Enquire actions occur while the ED-2000plus is in configuration mode.

For Wireline Communication

To power up for use with wired communication, press the **F** key and the **ON/OFF** key. Powering up this way will turn off the radio communication and save battery power in the HR-2000.

When you turn on the HR-2000 for wireline communication, the display will show the software revision number (probably ***hr2001***), then ***rS-485***. When communication with the connected ED-2000plus is established the display will mirror the ED-2000plus display and the leftmost decimal point will blink every ½ second. If communication is broken with the ED-2000plus, the display will show a small ***o*** in the lower left of the display. If communication is not resumed within ten seconds the display will show ***rS-485*** and the letter ***r*** will flash back and forth between inverted and upright.

Addressing Mode

You can set the address for each HR-2000 and ED-2000plus operating in a given area so that they can work without interference. If several systems are operating in the same airspace each HR-2000 and ED-2000 must have a unique address. Since more instruments must share the same airwaves, the update time for each unit will increase. Approximate times are shown in Table 7.

It is recommended to keep the ED-2000plus instrument addresses at 100 or higher.

In multiple system environments the remotes must have their Source addresses and Poll parameters set appropriately. The source address must start from address 32 and increase sequentially. The poll value must be equal to the number of HR-2000s in the area.

You need to set the addresses according to the number of systems you have operating in the area. See Table 7 below for the proper settings.

Number of HR-2000s	HR-2000 Source address	Poll value	ED-2000plus Destination address	Update time
2	32	2	100	1 second
	33	2	101	1 second
3	32	3	100	1.5 second
	33	3	101	1.5 second
	34	3	102	1.5 second
4	32	4	100	2 second
	33	4	101	2 second
	34	4	102	2 second
	35	4	103	2 second

Table 7
Addresses for multiple systems

The Destination address must match with the address entered in the ED-2000plus. This value has a default of 100.

Entering a destination address of 0 will cause the remote to send a signal called a "Broadcast signal". The first ED-2000plus that responds with its value will then be locked in.

To assign the correct address for each part of the system, you must access the address mode. Follow these steps to access and set the proper address.

1. Press the **F** key and the **ON/OFF** key at the same time. . .

   SEtuP is displayed then ***100***. This is the Destination address currently assigned to the ED-2000plus.

2. Increment or decrement the address number using the keys described in Table 6 until the address you want is on the screen.

   Remember to follow the recommendations in Table 7.

3. Press the **UNITS** key to save the change and move to the next item in the address mode. . .

   SourcE is displayed while the **UNITS** key is held then the Source address is displayed when the key is released. This is the address currently assigned to the HR-2000.

4. Increment or decrement the address number using the keys described in Table 6 until the address you want is on the screen.

   Remember to follow the recommendations in Table 7.

5. Press the **UNITS** key to save the change and move to the next item in the address mode. . .

   POLL is displayed while the **UNITS** key is held then the poll value is displayed when the key is released. This value identifies the number of remotes that may be operating in a given airspace. This value has a default of one. Changing the value will have the effect of increasing the time between display updates.

6. Increment or decrement the address number using the keys described in Table 6 until the address you want is on the screen.

Two special modes can be flagged with the Poll value:

- A Poll value of zero places the remote in Manual Poll mode. The remote will only poll the instrument when the UNITS key is pressed by the operator. The ED-2000plus will reply and the HR will display the reading until the unit is polled again (or until the screen blanks after ten seconds of non communication). Manual poll mode is designed for situations in which constant updates are not necessary, to conserve battery life or reduce airwave clutter.

- A Poll value of 255 places the unit in Monitor mode. The instrument is completely passive and only **ON/OFF** or **F**+**ON/OFF** keys are functional. It will need a second HR-2000 operating actively, and the ***dEStin*** and ***SourcE*** address must match the active HR-2000 exactly. The passive HR-2000 will display any traffic FROM the ED-2000 TO the active HR-2000, as long as it is within receiving distance. Monitor mode is designed for situations where a second remote is required for the same ED-2000plus.

7. Press the UNITS key to save the change and move to the next item. . .

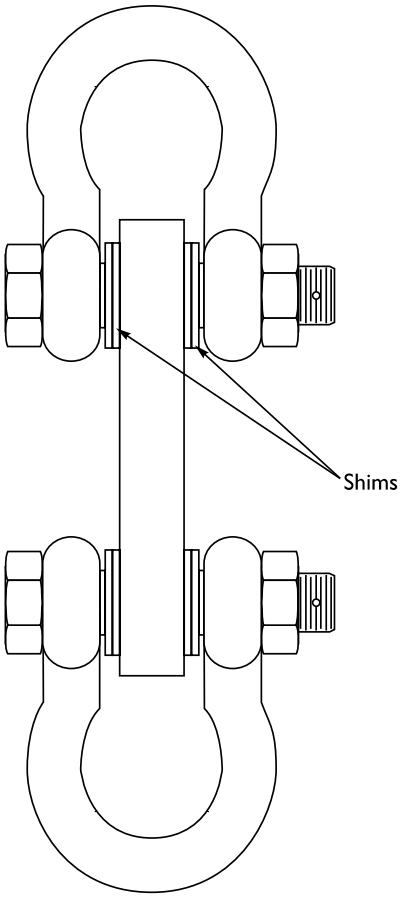
dEStin is displayed while the key is pressed then the destination value. You are now back at the top of the list of items in address mode.

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

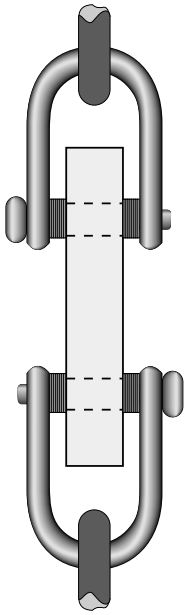
Torque and bending should be avoided. Use swivels on the lifting wire for antitorque and avoid side forces.

Certified Gear

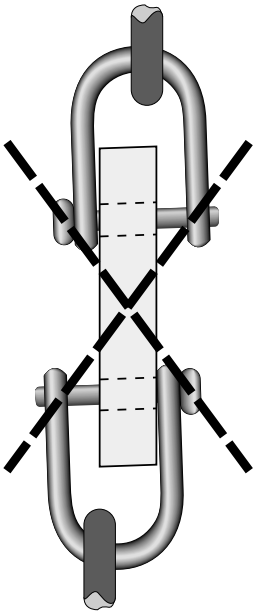
Certified shackles and lifting gear should always be used in accordance to local laws and federal legislation.

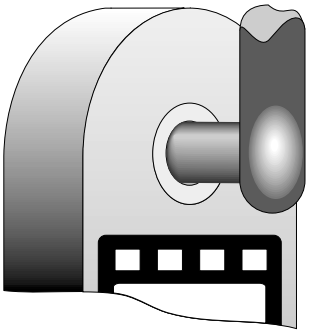
Safety

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.

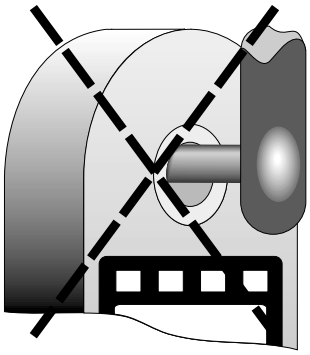


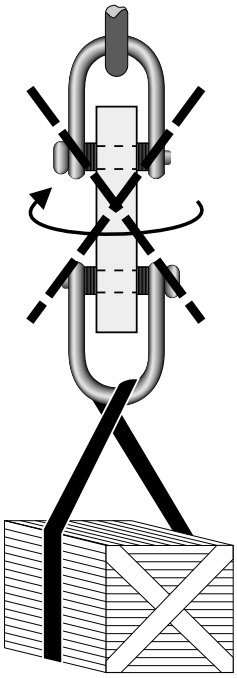
Center the load
on the shackle pin.

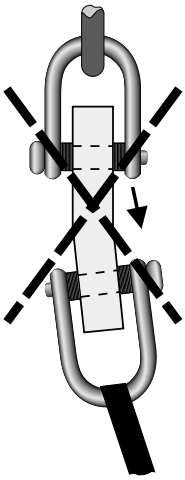


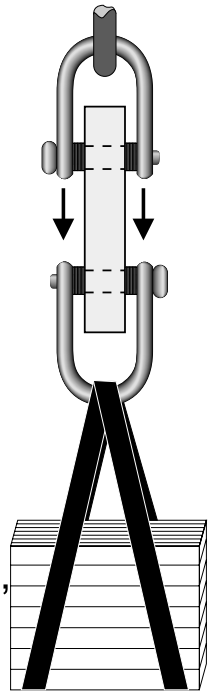


Use only with
a pin of the
same diameter
as the original
factory equipment.

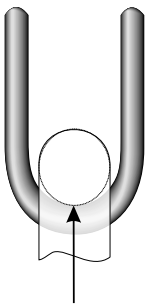


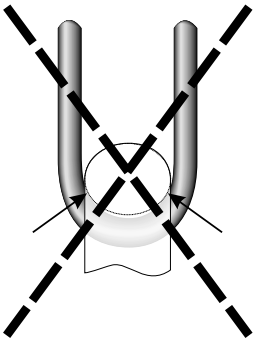






Do not torque,
bend or
sideload.





Use hardware that allows
single point attachment
and freedom of alignment.
Do no use hardware that
is oversize and restricts
self-alignment. This results in
off-axis loading.

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MSI9300

Porta-Weigh+ Crane Scale

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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.

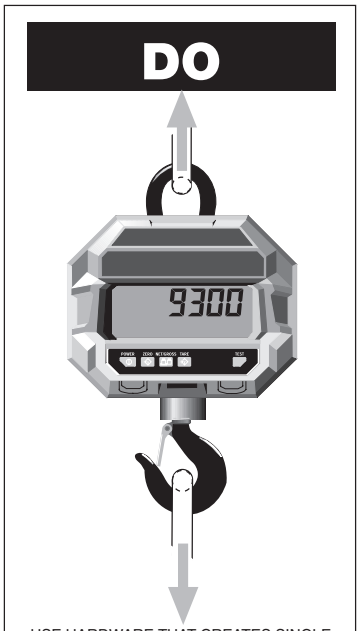
INSTALLATION

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.

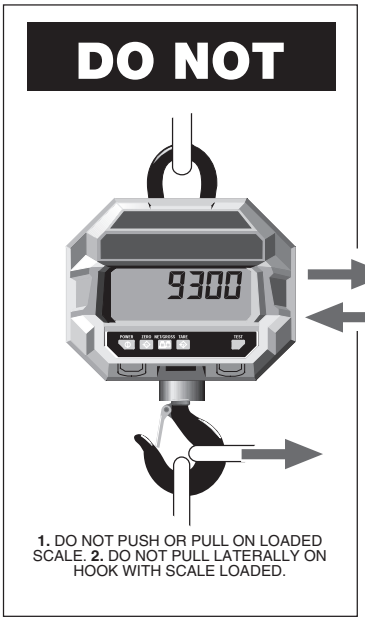
One of the most common installation problems is using an oversize shackle or too large a hook to interface with the 9300. This can cause off center loading and stress points that will reduce the life of the 9300 lifting eye or hook. Use the appropriate interface hardware for the capacity of the scale. 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.

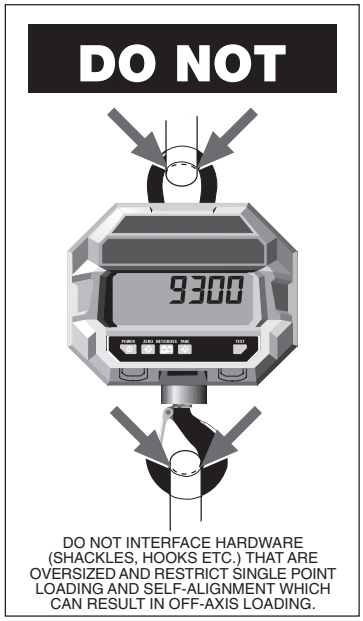
Regular maintenance inspections of the lifting system should be performed to ensure safety. Pay particular attention for signs of stress on any element in the load train.



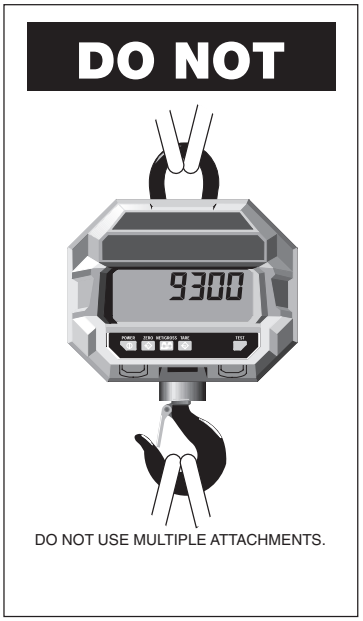
USE HARDWARE THAT CREATES SINGLE POINT ATTACHMENTS AND ALLOWS THE SCALE FREEDOM OF ALIGNMENT.



1. DO NOT PUSH OR PULL ON LOADED SCALE. **2.** DO NOT PULL LATERALLY ON HOOK WITH SCALE LOADED.



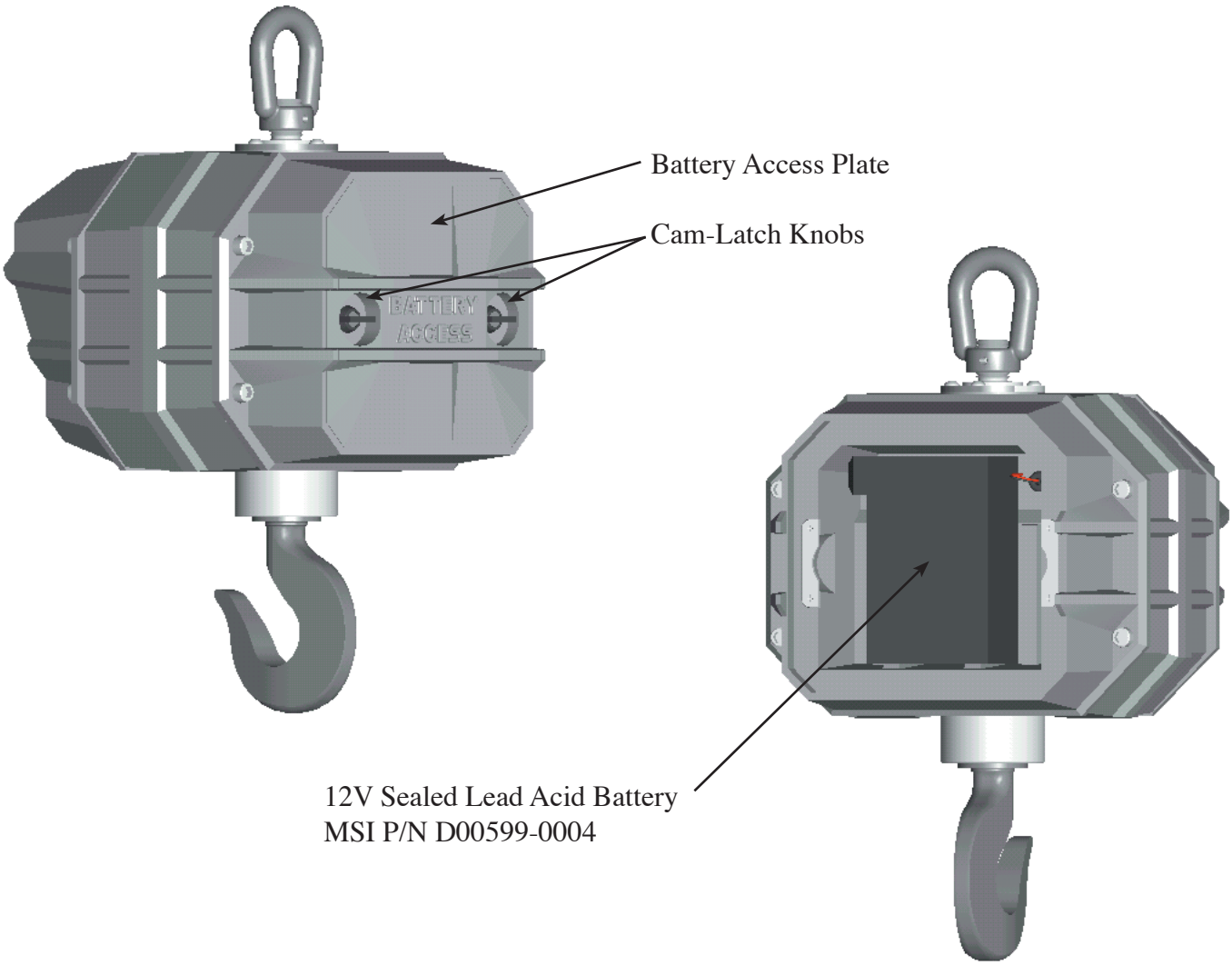
DO NOT INTERFACE HARDWARE (SHACKLES, HOOKS ETC.) THAT ARE OVERSIZED AND RESTRICT SINGLE POINT LOADING AND SELF-ALIGNMENT WHICH CAN RESULT IN OFF-AXIS LOADING.



DO NOT USE MULTIPLE ATTACHMENTS.

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.

BATTERY LIFE

The 9300 battery life depends on a number of factors: Brightness of the LED and number of segments lit, the amount of RF activity, and the age and condition of the SLA (sealed lead acid) battery. The 9300 will automatically turn the scale off when the SLA battery drops to approximately 10.5V. You must recharge the battery when this happens. Leaving a discharged battery in the scale, which has a maintenance battery drain, can result in a deep discharged battery which will shorten its service life.

SLA batteries do not suffer from memory effects and actually benefit from frequent rechargings. Recharge the battery whenever it is convenient even when it still has available life. Due to the maintenance discharge imposed on the battery by the 9300 electronics, **do not store the 9300 away with the battery inside**. Remove the battery.

Battery Use Guidelines

1) Recharge whenever convenient. Do not wait for the scale to shut itself off if your work situation permits.
2) If you need the scale continuously, keep a fully charged spare battery. Replace the drained battery as close as possible to the low battery warning, or earlier.
3) SLA Batteries that have not been deep discharged should withstand 500 to 1500 charging cycles.
4) The low battery warning will indicate about 2-4 hours of additional use before the 9300 turns itself off.
5) If the 9300 is not going to used again soon, remove the SLA battery to prevent deep discharge while the unit is in storage.

BATTERY CHARGER

Each 9300 is shipped with a battery charger designed to charge and maintain the battery. Exact charging time will depend on the degree of discharge of the battery. A battery removed when the low battery warning first appears should take about 4 hours to fully charge.

Using the Charger

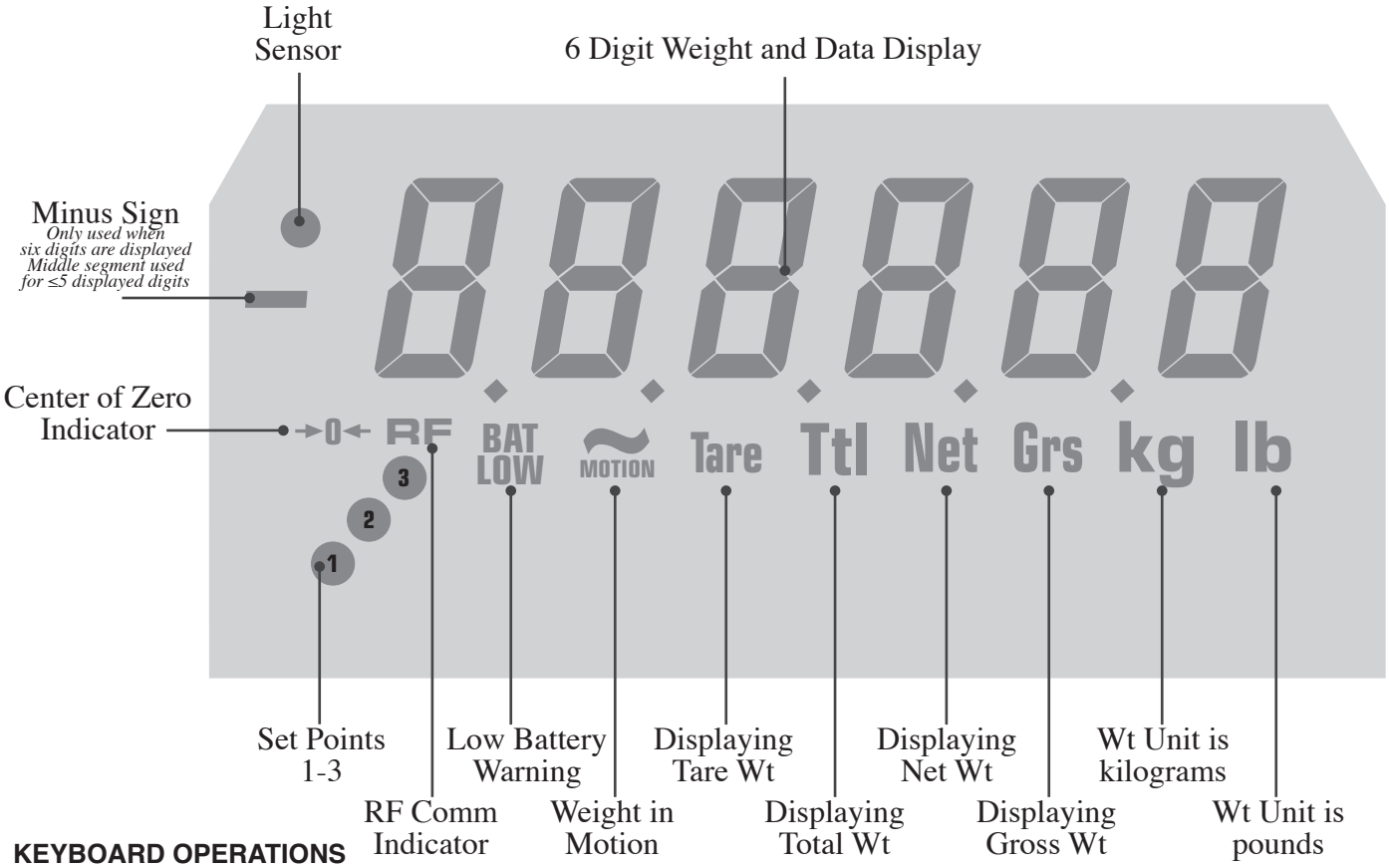
1) Remove the Battery from the 9300. See previous page for removal instructions.
2) Connect the charger assembly to the AC supply (86-260VAC). The Power Status light should be green. If the power status light fails to illuminate, check your AC power connection and make sure the Vin jack is fully seated. AC power cords suitable for any world location are available from MSI.
3) Plug in the polarized connector to the jacks on the battery.
4) The Charge Status light should turn ORANGE indicating fast charge.

   If the status light remains Green when the battery is first plugged in, the battery may be defective.
5) Charge until the status light turns GREEN.

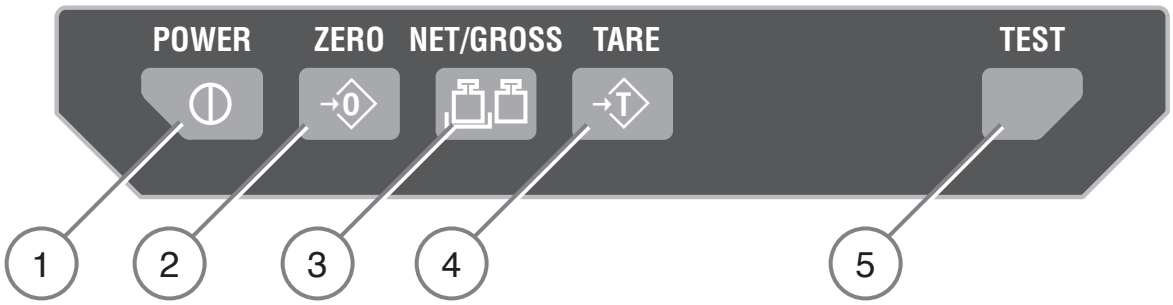
When the charge cycle is complete you can (and should) leave the battery on the charger until it is needed. The charger keeps a maintenance float charge on the battery to ensure the best possible operation times. For scales that are in high usage, MSI recommends obtaining a spare battery so one can always be on the charger.

9300 PORTA-WEIGH PLUS DISPLAY

The 9300 has six 1.2” (30.5mm) ultrabright LED Digits along with annunciators. The brightness of the display is automatically adjusted to the lighting conditions. When the ambient light is dim, the LEDs are lower in intensity. When ambient light is bright, the LED intensity level is increased to allow sunlight readability.



KEYBOARD OPERATIONS



1) POWER – Push to turn the scale on or off.

2) ZERO – Used to zero the scale. The zero range is usually 100% of full scale unless prohibited by legal-for trade settings.

3) NET/GROSS – Switches scale between NET and GROSS weight readings (assuming a Tare value has been stored).

4) TARE – When in GROSS mode, pushing TARE will zero any weight on the scale and cause the scale to go into the NET mode. When in NET mode, pushing TARE will display the TARE value for 2 seconds, then revert back to the NET weight display. In NET mode, pushing TARE twice will set a new Tare. Pushing TARE followed immediately by ZERO will clear the Tare value and revert the scale to Gross Mode

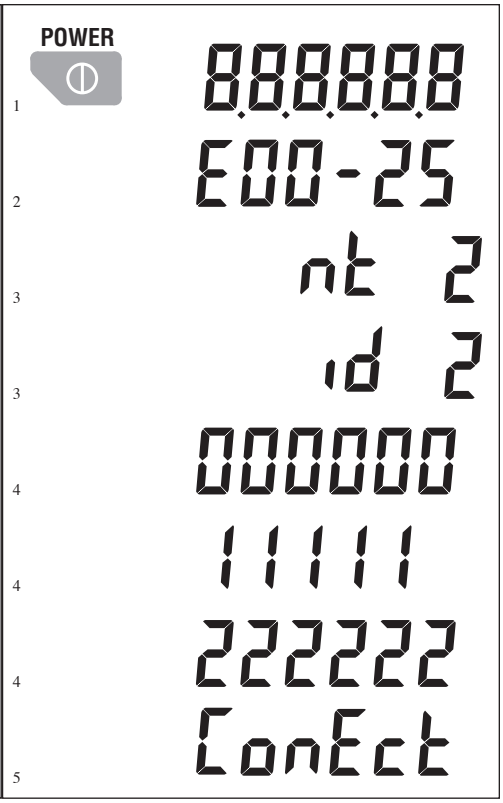
5) TEST/USER Key – When pushed, this causes a display segment check, and provides battery and RF Network information. Also programmable for USER desired functions. See SETUP USER KEY. User Key Functions Available: Units (kg/lb) • Total • Test (default) • Scan List Increment (multi-channel systems) • °F/°C

SECTION 2 – SCALE OPERATION

POWER

To Turn On the Power

1) Push POWER. The system performs a display check: All segments and annuciators illuminate for 3 seconds.
2) The LED displays the firmware Rev number.
3) Next, the display shows the Network address followed by the ID address. This is the operating network address for any slave device to log onto.
   The network and ID Address are usually but not always the same. Numbers for Network range from 0 to 31 and for address from 0-254. Initially the 9300 display will not know the Network address and will skip this step.
4) The display begins a numeric test while the CellScale component is establishing Network and Comm Port connections. The count up pattern will continue for 10-20 seconds and will sometimes restart. This is normal.
5) Once the RF Network is established and the Comm Port connection to the display is set the display will read "Conect" (sic). The scale is now ready for operation.



MULTIPLE SCALE CHANNELS

The 9300 is capable of hosting multiple independent scale inputs. These are connected wirelessly using 6260CS or 9300 crane scales setup as Network Slaves, or by special order, additional inputs can be wired directly into the 9300. In addition, the CellScale Math channels can be used for manipulating the scale data. To directly access additional channels, the TEST/USER key can be programmed to "S List" to scroll through the available scale channels. See "USER KEY FUNCTION" in this manual. See the CellScale User Guide for the procedure to add additional channels. The 9300 keypad operates on the displayed channel only.

ZERO

Sets the zero reading of the scale. Use the zero key to take out small deviations in zero when the scale is unloaded. (See "TARE" for zeroing (Taring) package or pallet weights)

To Zero

Push ZERO. The weight reading must be stable within ±1 division for the zero function to work.
The backup memory stores the zero reading, and can restore it even if power fails.

The numeric digits display "0" (or 0.0 or 0.00, etc.).

Rules for Use:

1) Works in GROSS mode or NET mode. Zeroing while in Net mode will zero the gross weight causing the display to show the negative Tare value.
2) The scale must be stable. The scale will not zero if the motion detect annunciator is on.
3) The scale will accept a zero setting over the full Range of the scale (NTEP and other Legal-for-trade models may have a limited zero range). Zero settings above 4% of full scale will subtract from the overall capacity of the scale. For example if you zero out 100 lb. on a 1000 lb. scale the overall capacity of the scale will reduce to 900 lb. plus the allowed over-range amount.

TARE

Tare is typically used to zero out a known weight such as a packing container or pallet and display the load in NET weight. A Tare value is entered in one of three ways:

1) AUTO TARE – When the TARE key is pushed twice, the current weight is zeroed and Net Weight is displayed. This is the only Tare function available from the 9300 keypad.
2) KEYBOARD TARE – Available from a 3750CS or 9750 Indicator only. Using the numeric keys, the operator keys in the desired Tare Weight then pushes the ENTER Key. See the 3750CS or 9750 User Guides.
3) TARE UP/DOWN – Available from a 3750CS Indicator only. Using the Scroll Keys, the Tare value is changed one scale division at a time. TARE UP/DOWN is useful for increasing or decreasing the current Tare value slightly. The Keyboard Tare and Tare Up/Down modes can be disabled through the use of SETUP TARE. In the "AUTO" mode a single push of the TARE key will enact AUTO TARE. See the 3750CS User Guide.

To Auto Tare (in Gross Mode)

1) From Gross Mode, push TARE. The current weight is stored in the Tare register, the display mode changes to Net, and the display reads 0. All following readings are deviations from the set Tare value.	1 TARE → 0 Net

To Read the Current Tare Value

1) From Net Mode, push TARE. The current weight stored in the Tare register is displayed for 2 seconds. Then the display mode reverts to Net Weight.	1 TARE → 1234 Tare 2 → 4444 Net

To Auto Tare (in Net Mode)

1) From Net Mode, push TARE. The current Tare value is displayed. 2) Within 2 seconds, push TARE again. Assuming no motion, the current Gross weight is stored to the Tare register, and the mode is set to Net weight with the new tare value. All following readings are deviations from the set Tare value.	1 TARE → 1234 Tare 2 TARE → 0 Net

To Clear Tare and Revert to Gross Mode

Use the Net/Gross to return to Gross Mode without clearing the Tare value.

1) From Net Mode, push TARE. The current Tare value is displayed. 2) Within 2 seconds, push ZERO. The current Tare weight is cleared from the Tare register, and the mode is set to Gross weight.	1 TARE → 1234 Tare 2 TARE → 5565 Gross

Tare - Rules for Use:

1) Only positive gross weight readings can be tared. Weight can be tared in both the NET and GROSS modes. When in the NET mode, the TARE is not cumulative, all the weight is zeroed.
2) The motion annunciator must be off. The weight reading must be stable.
3) Setting or changing the tare has no effect on the Gross zero setting.
4) Taring will reduce the apparent over range of the scale. For example, taring a 10 lb. container on a 60 lb. scale, the scale will overload at a net weight of 50 lb. (60-10) plus any additional allowed overload (usually ~4% or 9d).
5) The scale stores the Tare value in the current ID Code memory until cleared. Each available ID Code can store independent Tare values.

Multiple Tare Memories

The 9300 is capable of storing Tare values through the use of the ID Codes. Each ID code stores an independent Tare. ID Codes are accessible through the 3750CS or 9750, or through a Modem using Host Commands.

SPECIAL TARE MODES

The Tare function has two special modes. These modes are configured through the Comm Port. See the Model 9000 User Manual for information on configuring the Tare Mode.

UNIV TAR

The Universal Tare feature allows a single Tare value to be shared by all ID Codes. With UNIV TAR enabled the individual Tares stored with each ID Code are ignored (but not erased). Disabling UNIV TAR will restore the original Tare values. UNIV TAR is intended for those applications where a common carrier or pallet is used, but multiple ID Codes are necessary for data collection.

AUTO CLR

Enabling “AUTO CLR” causes the 9300 to clear the Tare Value after each lift greater than 0 NET. The Tare Value is cleared and the display mode reverts to Gross Weight once the load is removed (the weight goes below 0 NET). The “ON TOTAL” setting clears the Tare Value after the load is totaled. The default for the “AUTO CLR” function is “DISABLED” . When disabled, the Tare Value can only be cleared manually (see “To Clear Tare and return to Gross Mode”.)

NET/GROSS

Switches the display between Net and Gross modes. Net Weight is defined as Gross Weight minus a Tare Weight.

To Switch Between Net Mode and Gross Mode

Switching back to Gross mode from Net mode will not clear the Tare value. This allows the operator to use the Gross Mode temporarily without having to reestablish the Tare value. Only manually clearing the Tare or setting a new Tare will change the tare value held before switching into Gross Mode.OIML Legal-for-trade units only: The NET/GROSS key is temporary action only. The Gross weight is displayed for 2 seconds and then the display returns to the Net Mode. The only way to return to permanent Gross readings is to clear the Tare (see Clear Tare procedure).

1) Starting in the NET weight mode, push NET/GROSS. The weight mode will change to Gross weight. *If you are in Gross Mode and a Tare value has not been established, the Net/Gross key has no effect.* 2) Pushing NET/GROSS again will revert the display to the NET mode.	1 NET/GROSS GRS 2 NET/GROSS NET

UNITS

Allows easy weight units conversions. Although the CellScale offers up to 8 units, the 9300 will only display pounds or kilograms.

This operation requires that the Test/User Key function is set to Units. See “Setup USER key Function ”.

To Change the UNITS

Push the TEST/USER key (programmed as UNITS). The weight display will toggle between kg and lb.	1 TEST kg TEST lb

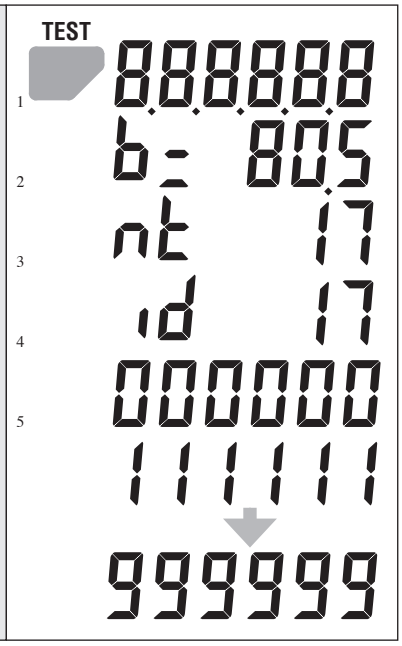
TEST

Provides a functional system test, and an on-demand display check without disturbing the current weighment. The Test function can be interrupted by pushing any key during the test.

To start the Test

Push the TEST/USER key (programmed as TEST). The display will do the following steps:

1) All LEDs are illuminated for 1 second.
2) The battery condition in approximate per cent of remaining life is displayed.
3) The Network Address is displayed.
   Numbered from 0-31
4) The Network ID is displayed.
   Numbered from 0 to 254
5) The display digits count up from 0 to 9.
6) Returns to normal weight mode.



INTERNAL TEMPERATURE DISPLAY

The 9300 can monitor its internal temperature. This feature is for use in Foundry applications or any other Crane use around high temperature sources. The temperature display can be set to display automatically at 20 second intervals (see page 15) and will display in degrees C or degrees F. The purpose of monitoring the internal temperature is to ensure that the scale is not damaged by overlong exposure to high temperatures. The 9300 offers a heat shield option for foundry use that increases the dwell time possible when lifting melt pots.

CAUTION

The 9300 must be removed from the high heat source when the internal temperature reaches 185°F or 85°C.

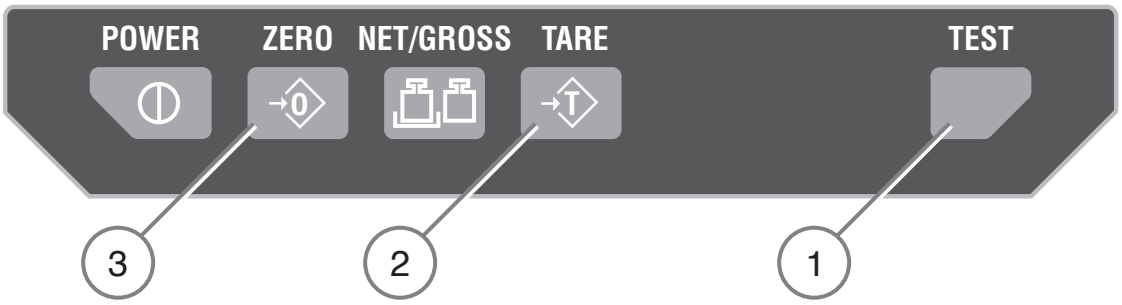
To Manually Display the 9300 Internal Temperature

USER key Function set to " °F °C ". Temperature units are set in the Setup Menus.

Push the TEST/USER key. The current internal temperature will display for 2 seconds.

SECTION 3 – 9300 SETUP MENU

KEY FUNCTIONS DURING SETUP

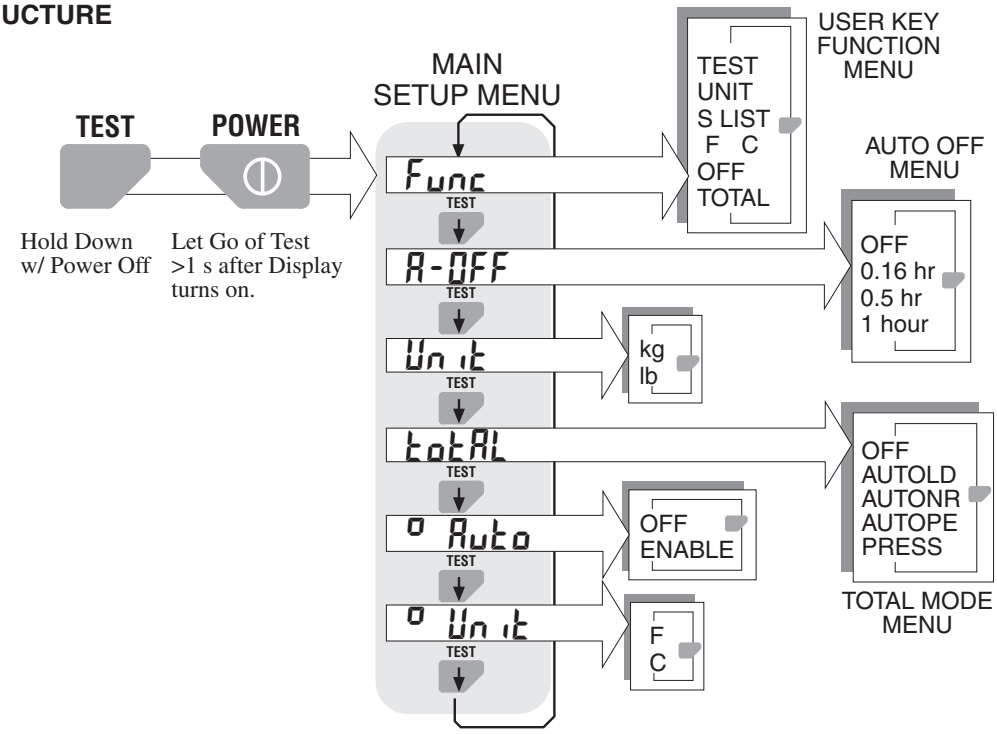


1) The Test key is used to scroll through menu selections.
2) The Tare key is used to select the displayed menu choice.
3) The Zero key is used to exit out of the current menu. At the root level the Zero key turns off the Setup mode and returns the 9300 to weight display.

To Start the Setup Menu

1) If the 9300 is on, turn it off with the POWER key. 2) Press and hold the TEST key. 3) While still holding the TEST key, turn on the 9300 with the POWER key. 4) Release the TEST key after the segment test screen is finished. 5) After a few seconds, the display will show the first Setup Menu item, “FUNC”.	TEST hold POWER 888888 TEST release Func

SETUP MENU STRUCTURE



USER KEY FUNCTION

The TEST/USER key can be programmed to 1 of 6 functions:

1) TEST – Default function. Provides segment test of the display, battery level, and RF Network information.
2) UNIT – Switch between pounds (lb) and kilograms (kg).
3) S LIST – (Scan List) Change displayed channel to the next channel in the CellScale Scan List. Applicable to multichannel systems only.
4) °F °C – Displays the internal 9300 temperature for 2 seconds.
5) OFF – No function
6) TOTAL – If manual total is enabled, pushing the TEST/USER key will add the current weight to the Total register. Subsequent pushes will display the totaled weight until Total is reset by returning to zero (below the total threshold, see the CellScale User Guide for more information on total threshold). If in any Auto-Total mode, the USER key functions as View Total, displaying the Total Weight for two seconds.

To Set the User Key Function

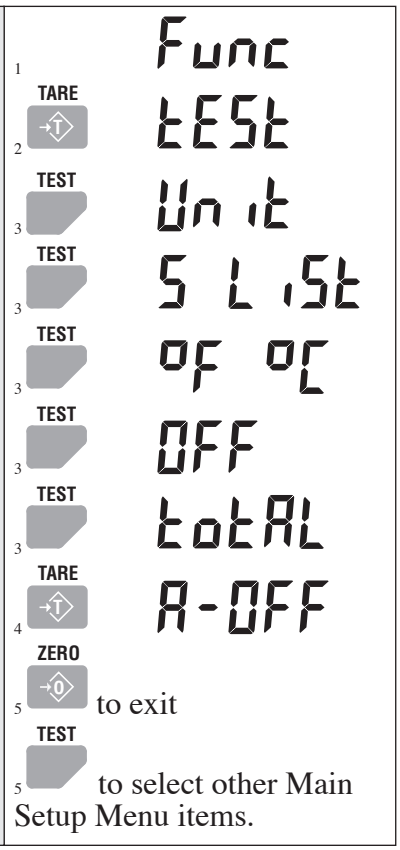
1) Start the Setup Mode using the procedure on the previous page.

2) With the display reading "Func" press the TARE (Select) key. The currently programmed USER key mode will display flashing.
The example assumes the dejault function TEST is the current USER key function.

3) Use the TEST (Scroll) key to scroll through the choices.
In this example the TEST key function will be changed to TOTAL.

4) When the desired choice is shown, Press TARE (Select) to select it.
Pushing TARE (Select) places the displayed function as the USER key function, and exits the FUNC menu.

5) The next Main Menu item, "A-OFF" will appear. Either select another Setup procedure with the TEST (Select) key, or return to weighing mode by pushing ZERO (Exit).



AUTOMATIC OFF

The 9300 can be set to turn itself off in periods of inactivity by enabling the Automatic Off feature. The Auto Off timer is reset whenever a button is pushed or weight changes. There are 4 settings:

1) OFF – Feature disabled
2) 0.16 hr – 9300 will turn off in approximately 10 minutes
3) 0.5 hr – 9300 will turn off in ~30 minutes
4) 1 hour – 9300 will turn off in ~1 hour.

To Setup Automatic Off

1) Start the Setup Mode using the procedure on page 12.	1 Func
2) Use the TEST (Scroll) key to scroll to “A-OFF”.	2 TEST A-OFF
3) With the display reading “A-OFF” press the TARE (Select) key. The currently programmed Auto-Off setting will display flashing. *The example assumes the Auto-Off function was OFF.*	3 TARE OFF 4 TEST 0.16 hr
4) Use the TEST (Scroll) key to scroll through the choices. *In this example the Auto-Off function will be set to 1 hour.*	4 TEST 0.50 hr 4 TEST 1 hour
5) When the desired choice is shown, Press TARE (Select) to select it. *Pushing TARE (Select) places the displayed setting as the Auto-Off mode, and exits back to the Main Setup Menu.*	5 TARE Unit
6) The next Main Menu item, “Unit” will appear. Either select another Setup procedure with the TEST (Select) key, or return to weighing mode by pushing ZERO (Exit).	6 ZERO to exit 6 TEST to select other Main Setup Menu items.

UNITS

The 9300 will display and convert weight in pounds or kilograms. The TEST/USER key can be set to switch between lb and kg if desired. If only 1 weight unit is needed, use this procedure to set the desired unit.

To Setup the Weight Unit

1) Start the Setup Mode using the procedure on page 12.	1 Func
2) Use the TEST (Scroll) key to scroll to “Unit”.	2 TEST A-OFF 2 TEST Unit
3) With the display reading “Unit” press the TARE (Select) key. The currently programmed Unit setting will display flashing.	3 TARE Unit lb
4) Use the TEST (Scroll) key to switch between kg and lb. *In this example the unit will be changed to kg.*	4 TEST Unit kg
5) When the desired choice is shown, Press TARE (Select) to select it. *Pushing TARE (Select) sets the weight unit, and exits back to the Main Setup Menu.*	5 TARE totAL
6) The next Main Menu item, “Total” will appear. Either select another Setup procedure with the TEST (Select) key, or return to weighing mode by pushing ZERO (Exit).	6 ZERO to exit 6 TEST to select other Main Setup Menu items.

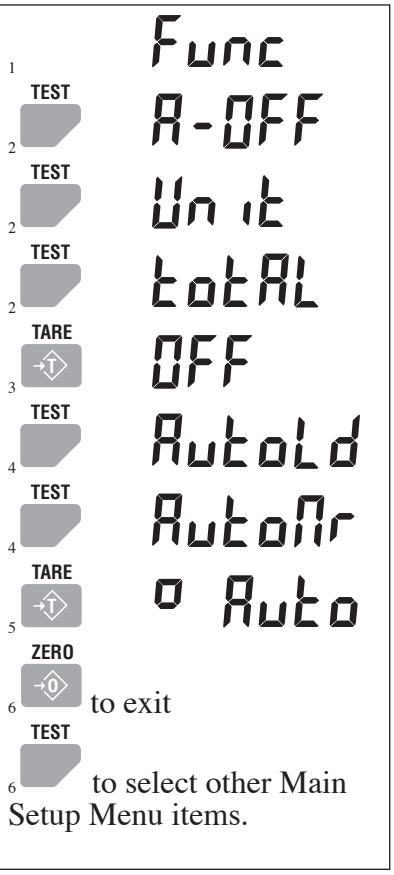
TOTAL

The 9300 CellScale feature set provides Total and Statistics capabilities. The 9300 keypad allows the enabling and display of some of these features. More extensive total and statistics capability is provided when a 9750 or 3750CS meter is part of the network. However, the 9300 allows the setting of the following Total features:

1) OFF – Total feature turned off
2) Autoload – The autoload feature provides an algorithm for totaling that requires a 3750CS equipped with an auxiliary push button. Intended for commodity loading into containers. See the CellScale User Guide for a complete description of the Autoload feature.
3) Autonorm – The Autonorm Total will automatically total all steady weights above the auto total threshold. Once totaled, the weight must return to near zero before the scale will autototal again. The autonorm total totals the last settled weight before the scale went back to zero, so be sure the weight is removed rapidly from the scale.
4) Autopeak – Similar to Autonorm except the weight totaled will be the highest settled weight before the weight returns to near zero.
5) Press – Indicates that a manual total key must be pressed to cause a total to occur. This can be the USER key programmed to total, or total keys found on the 3750CS or 9750 indicators.

To Set the Total Mode

1) Start the Setup Mode using the procedure on page 12.
2) Use the TEST (Scroll) key to scroll to “Total”.
3) With the display reading “Total” press the TARE (Select) key. The currently programmed Total setting will display flashing.
4) Use the TEST (Scroll) key to scroll through the total modes.
   In this example the mode will be changed to “AutoNorm” (AutoNr).
5) When the desired choice is shown, Press TARE (Select) to select it.
   Pushing TARE (Select) sets the Total mode, and exits back to the Main Setup Menu.
6) The next Main Menu item, “° Auto” will appear. Either select another Setup procedure with the TEST (Select) key, or return to weighing mode by pushing ZERO (Exit).

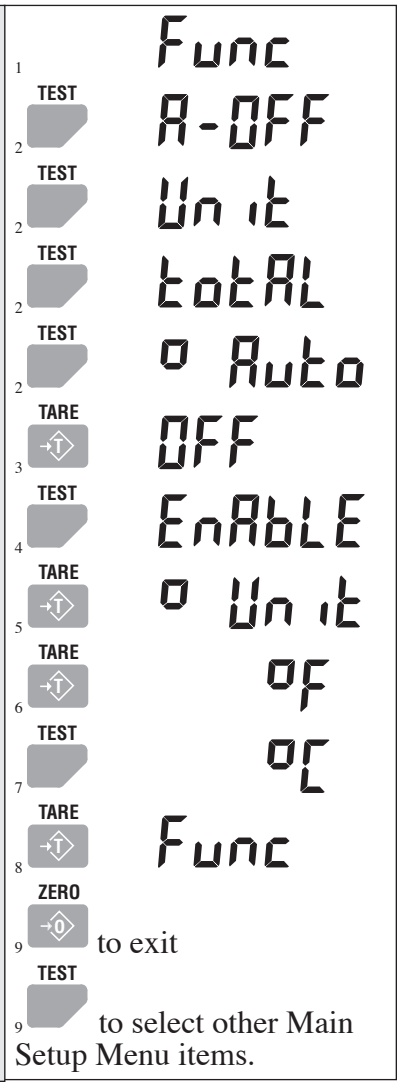


AUTOMATIC TEMPERATURE DISPLAY

The 9300 will display its internal temperature once every 20 seconds if enabled with the following procedure.

To Enable Auto Temp Display (° Auto) & Set Temperature Units

1) Start the Setup Mode using the procedure on page 12.
2) Use the TEST (Scroll) key to scroll to "° Auto".
3) With the display reading "° Auto" press the TARE (Select) key. The currently programmed Auto-Temperature setting will display flashing.
4) Use the TEST (Scroll) key to Enable the Auto-Temperature mode.
5) When the desired choice is shown, Press TARE (Select) to select it.
   Pushing TARE (Select) sets the Auto-Temp mode either OFF or Enable, and exits back to the Main Setup Menu.
6) The next Main Menu item, "° Unit" will appear. Push TARE (Select) to setup the desired temperature unit (°F or °C).
7) Use the TEST (Scroll) key to select °C or °F.
8) Push TARE (Select) to set the temperature unit.
9) The next Main Menu item, "Func" will appear. Either select another Setup procedure with the TEST (Select) key, or return to weighing mode by pushing ZERO (Exit).



SECTION 4 – THE EMBEDDED CELLSCALE

ACCESSING THE CELLSCALE

The 9300 is a shell interface to an embedded CellScale. To access the advanced features of the CellScale a Comm Port is provided on the 9300 front casting. This Comm Port is only used for interfacing to the CellScale and cannot be used as an output of any kind.

The CellScale offers Set Points, ID Codes, and other advanced features which are controlled either through a remote Indicator such as the 3750CS or the 9750 Handheld. These features are also accessed by connecting a terminal program in a PC to the Comm Port. Tested terminal programs that function well with the CellScale include ProComm Plus, Qmodem, HyperTerm (shipped with many versions of Windows), WinTerm, and ZTerm or Microphone (for Macintosh). Usually a VT102 emulation is used. All commands are single letter except when entering data.

Settings for your terminal program are: 9600 baud, 8 bit, 1 start bit, 1 stop bit, no parity, Handshaking usually not required, but you can turn on Xon/Xoff if you desire.

While the Comm Port is in use, the 9300 display is in standby with the message “C-Port” displayed. The only key that will function in this mode is the Power key.

The CellScale Terminal Access Mode is used to set Network parameters, Scale parameters, Set Points, and other various setup conditions. Refer to the CellScale User Guide for detailed information.

CONNECTION PROCEDURE

The 9300 must be on and finished with its startup sequence before connecting the terminal cable to a PC.

1) Without connecting the PC or Terminal to the 9300, turn the 9300 on. Wait for the startup sequence to complete (usually about 10-15 seconds). When weight is displayed, the 9300 is ready.

2) Connect the PC to the 9300 through the Comm Port. When the 9300 detects a valid Comm Port from your PC or Terminal, it will automatically switch into the “C-Port” mode.

Some Computers might have trouble connecting to the 9300 (“C-PORT” does not appear) due to handshake lines or incompatible output levels. If this happens, press and hold the NET/GROSS key and then push TEST. This will force the 9300 into the “H-PORT” mode and provide access to the embedded CellScale.

3) With “C-PORT” or “H-PORT” displayed you can access the Terminal menus in the CellScale.

4) Send a Break command (keystroke varies between terminal programs) to restart the Terminal Access Mode menus in the CellScale. Sometimes it is necessary to send the R character to refresh the screen. The ESC key will back out of menus.

5) Once in the Terminal Access Mode menus, commands are usually a single number or letter. Refer to the 9000 CellScale User Guide for further information.

COMM PORT CABLE

The 9300 comes standard with one Comm port cable wired for RS-232 (MSI P/N 501705-0001) following the AT standard for 9 pin serial cables (DCE). An unterminated cable is available (MSI P/N 12023) if you wish to wire your own serial cable for RS-232.

Comm Port Cable Color Code RS-232

Brown – Transmit output from CellScale, connect to receive of DTE.

Black – Receive input to CellScale, connect to transmit of DTE.

White – CTS Input to CellScale. Connect to RTS or RTR output of DTE.

Grey – RTS/RTR output from CellScale. Connect to CTS input of DTE.

Blue – Signal Ground

Drain Wire – Connect to metal shell.

SET POINTS

The Internal CellScale can monitor up to 32 Set Points. Set Points are used for safety warnings and process control. The 9300 has LED annunciators for Set Points 1 through 3. Set Points are programmed from a 3750CS, a 9750, or through the Terminal Access Mode. On special order MSI can supply audible alarms, sirens, or other warning devices for Set Point outputs.

SCALE CALIBRATION

The 9300 is best calibrated using a remote indicator such as the 3750CS or the 9750 Handheld. Calibration procedures using these devices are covered in their respective User Guides. If the 9300 is not RF equipped, the only way to calibrate it is through the Comm Port using the Terminal Access Mode. The Calibration Procedure for this is covered in the CellScale Model 9000 User Manual.

MSI recommends having test weights of at least 50% capacity to properly calibrate the Crane Scale. The calibration procedures will operate with as little as 12.5% of capacity, though rated accuracy cannot be guaranteed. Very large capacity scales are often calibrated using transfer techniques. Weigh something on a truck scale, then pick it up on the Crane scale and match the weight during the calibration procedure. The CellScale software permits multi-point calibration (up to 9 span points + Zero), but multi-point calibration is not usually necessary with our standard product line, being very linear from zero to capacity. The need for Multi-Point calibration is left up to the Scale Technician.

Calibration Tips

1) Make sure that the scale and load are stable (not swinging or vibrating) for every calibration step.
2) Prevent off-center loading during calibration. The scale must be perpendicular to the earth to prevent cosine theta errors. Adjust the rigging as necessary so that the pull is straight through the center of the scale.
3) Calibration always starts with the zero load. Remove all rigging that is not always present on the scale. However, it is sometimes best to calibrate zero with the rigging necessary for picking up the test weights attached to the scale. It's effect on dead load can be zeroed out later.
4) If rigging has not been zeroed out, make sure you add its weight to the test weight when entering the calibration weight.
5) Multi-point calibration can be done in any random order, as long as the zero step is first.

CELLSCALE SETTINGS FOR 9300

Certain Terminal Access Settings are required for compatibility with the 9300 display board. These settings should not be changed. The default settings should be:

MAIN > SYSTEM > POWER: Set to AC (Display board checks battery, do not set to 12V SLA).

MAIN > SYSTEM > LEDs: Turn all off and turn Power to Low. (LEDs can't be seen anyway, saves power to turn them off).

Do not modify Comm Port 1 baud rate settings. This could interfere with communications with the display board.

APPENDIX – SPECIFICATIONS & DIMENSIONS

HARDWARE OVERVIEW

Electronics

- μC Board: 6 layer SMD, AM186ESLV based w/ Flash Memory – 512kbytes of Flash Program Memory, 512kbytes of non-volatile RAM.
- Power Supply / I/O Board: power regulation and I/O for MM – Input range 10-16V. Optional direct AC board 90-260VAC.
- 2 Channel A/D Board: 4 layer SMD, 24bit A/D.
- Highly integrated Radio Modem: 2.4GHz Spread Spectrum. Protected Antenna.
- Display Board: 4 Layer SMD with six 1.2” (30mm) digits and 14 backlit annunciators.

Housing

- Alodined Cast Aluminum. Double O-ring gasketed. NEMA 4, IP66

Load Train

- Load Cell: 4340 Aircraft Quality Steel
- Industry Standard Lifting Eyes and Bottom Hooks

GENERAL FEATURES

Channels 1-4 – Scale Input Channels

- Internal Load Cell connected to Channel 1. Optional additional scale inputs by special order for multipoint lift situations.

Channel 5

- Channel 5 allows remote access to inputs on remote Slave CellScales

Channel 6

- Channel 6 is math calculations. Up to 8 separate math channels can be used to combine conversions from multiple scale channels. Supported functions are: multiply, divide, add, subtract, absolute value, square root, and constants. Multiple levels of parentheses are available for any scaling or channel data manipulation formulas.

Excitation

- 5 V (+5V relative to ground). Current limited and over-voltage protected to Factory Mutual standards. AC (switched DC) or DC excitation.

Radio Link

- Frequency Hopping Spread Spectrum in 32 channels @ 2.4 GHz. Allows 32 collocated networks of scales and peripheral devices (MSI Models 9020, 9750, 3750CS, etc.).

Calibration

- Via RF or Input Comm Port. Calibration is accomplished through a computer program residing on any computer. The calibration program is user friendly, with menus that are easy to use on a full graphics screen. Calibration is also available using the 3750CS or 9750 Meters. Sealing the system is not necessary due to password protected calibration routines. Seal can be provided on front panel in Legal-For-Trade systems.

GENERAL SPECIFICATIONS

Calibration Parameters (Programmed via Terminal Access Mode)

- CAL – Zero then Span, up to 10 point calibration (counting 0)
- AZM – OFF, ON (.5d), 1d to 255d Programmable
- Motion Detect – OFF, ON (.5d), 1d to 255d (programmable in 1d steps)
- Software Filter – None, LOW, HIGH
- Zero – 100% of capacity, limited by Legal-for-trade settings.
- Units – lb, kg on 9300 display. Ton, Ton (metric), oz, g, daN, or user defined using the math channels through remote indicators (3750CS or 9750).
- Standard Crane Scale Capacities – 500 lb / 250 kg, 2000 lb / 1000 kg, 5000 lb / 2500 kg, 10000 lb / 5000 kg, 20000 lb / 10000 kg, 30000 lb / 15000 kg, 50000 lb / 25000 kg, 70000 lb / 35000kg, 100000 lb / 50000kg. Larger capacities available on request. MSI can provide load cells to 500 tons. Any scale can be calibrated to a smaller capacity. e.g. a 2000 lb scale could be calibrated to overload at 1800 lb.
- "d" Scale divisions – Any resolution from 10,000 divisions or less. Standard 9300 resolution is 2000d to 5000d. Having more resolution than needed can cause settling delay.

Power Consumption

- Battery Life – 20-30 Hrs depending on brightness and average number of segments on. Without RF Modem 40-60 Hrs.

Approvals (pending)

- NTEP, OIML, Factory Mutual, NEMA, FCC

Temperature

- Operating -40°C to 85°C (-40° to 185° F)
- NTEP/OIML -10°C to 40°C (14° to 104° F)

RFI/EMI Shielding

- Exceeds NIST HB44 and European Standards.

Real Time Clock

- Supports date/time stamping in US or European time and date. Backed up by a replaceable Lithium Battery (Typical life >5 years). Clock data available via RF interfaces (3750CS, 9750, 9020).

Data I/O

- Any scale data is available via RF Modem or through the 3750CS or 9750 Indicators.

Totalization and Statistics

- Push button or Automatic. Total weight up to 999,999,999. Weighments counter up to 65,535. Totals are stored with each ID register. Min, Max, Average, Standard Deviation, and Coefficient of Variance computed and stored for each ID.

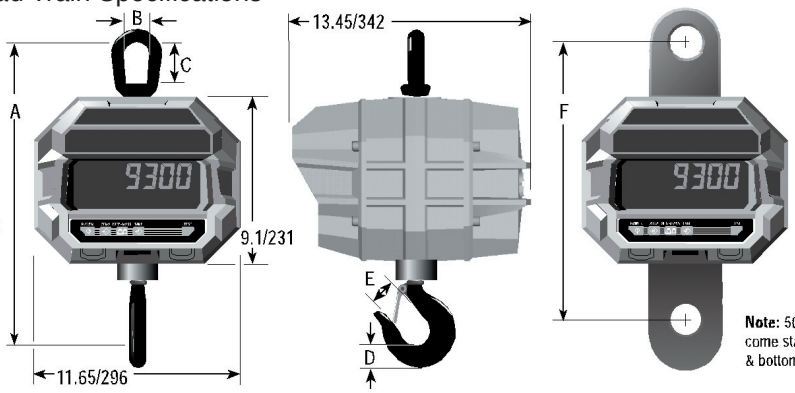
Internal Set Points

- 3 Contacts internal (SS Relays). Programmable for form A or form B (normally open or normally closed). Relays rated for 60V @ 350mA. 2.5Ω maximum contact resistance. Accessible by special order.

9300 Porta-Weigh + Crane Scale

Dimensions and Load Train Specifications

CR= Crosby or equivalent.
* These dimensions also apply to 50/70/100,000 pound models with hook and shackles.
** Resolution subject to change for NTEP and OIML approved units.
*** Ultimate overload - 490% of kg capacity.
**** Ultimate overload - 475% of lb capacity/430% of kg capacity.
***** Ultimate overload - 450% of kg capacity.



FRONT VIEW

SIDE VIEW

FRONT VIEW
(50/70/100,000 LB MODELS)

Note: 50/70/100,000 lb models come standard with top shackle & bottom swivel hook.

DIMENSIONS AND SPECIFICATIONS

CAPACITY	RESOLUTION**	A*	B*	C*	D*	E*	F	HOOK	EYE NUT OR SHACKLE	APPROX. SHIP WT.
500 lb	0.2 lb	18.3 in	2.25	3.06	1.44	1.34	-	3 ton	CR #7	53 lb
250 kg	0.1 kg	465 mm	57.1	77.7	37.0	34.0	-	Swivel	Eye Nut	24 kg
2,000 lb	1 lb	18.3 in	2.25	3.06	1.44	1.34	-	3 ton	CR #7	53 lb
1,000 kg	0.5 kg	465 mm	57.1	77.7	37.0	34.0	-	Swivel	Eye Nut	24 kg
5,000 lb	1 lb	20.5 in	2.50	3.50	1.81	1.69	-	5 ton	CR #8	62 lb
2,500 kg	0.5 kg	521 mm	64.0	89.0	46.0	42.9	-	Swivel	Eye Nut	28 kg
10,000 lb	2 lb	20.5 in	2.50	3.50	1.81	1.69	-	5 ton	CR #8	62 lb
5,000 kg	1 kg	521 mm	64.0	89.0	46.0	42.9	-	Swivel	Eye Nut	28 kg
20,000 lb	5 lb	28.5 in	4.00	6.25	2.59	2.25	-	10 ton	CR #11	105 lb
10,000 kg	2 kg	724 mm	101.6	159	65.8	57.2	-	Swivel	Eye Nut	47 kg
30,000 lb	10 lb	30.0 in	4.00	6.25	3.00	3.00	-	15 ton	CR #11	125 lb
15,000 kg	5 kg	762 mm	101.6	159	76.2	76.2	-	Swivel	Eye Nut	55 kg
50,000 lb	10 lb	41.0 in	5.00	6.00	3.66	3.63	15.0	25 ton	CR 25 ton	235 lb
25,000 kg	5 kg	1041 mm	127	152	93.0	92.0	381	Swivel***	Shackle #2130	106 kg
70,000 lb	20 lb	43.2 in	5.00	6.00	4.56	3.75	15.0	35 ton	CR 40 ton	270 lb
35,000 kg	10 kg	1097 mm	127	152	116	95.0	381	Swivel****	Shackle #2140	121 kg
100,000 lb	20 lb	52.1 in	5.75	6.65	5.06	4.25	16.25	CR 45 ton	CR 55 ton	420 lb
50,000 kg	10 kg	1324 mm	146	169	129	108	413	S1 Swivel*****	Shackle #2140	189 kg

OPTIONS AND ACCESSORIES

- Substitute Shackle for bottom swivel hook
- Oversized top lifting eye or shackle
- Direct wired input power, AC or DC, (specify required voltage)
- Audible Alarm or Very Loud Siren
- Heat Shield for Foundry Operations
- Stand-alone Option – Remove CellScale RF Modem
- Slave Load Cell Input – RF 9300 or 6260CS units can function as slave Crane Scale inputs to a 9300 or other CellScale based products. Up to three RF connected slaves are possible.
- Fast SLA Battery Charger (Included) – Cordsets available for Europe, UK, Australia, and USA/Japan.
- 24V Battery Charger for Vehicle Applications
- Serial Input Cable 4m (Included) – MSI P/N 501705-0001. Not usable for data output. Used for addressing the embedded CellScale for Setup and/or Calibration.
- Spare 12V SLA Battery – MSI P/N D00599-0004

THE MSI LIMITED WARRANTY

MEASUREMENT SYSTEMS INTERNATIONAL, INC., WARRANTS load sensing elements and meters against defects in workmanship and materials for a period of one year from date of purchase and warrants electrical cables and batteries against the same defects for a period of ninety (90) days from date of purchase.

Any device which proves defective during the warranty period will be replaced or repaired at no charge; provided that the defective device is returned to the Company freight pre-paid.

In no event shall the Company be liable for the cost of any repairs or alterations made by others except those repairs or alterations made with its specific written consent, nor shall the Company be liable for any damages or delays whether caused by defective workmanship, materials or otherwise.

The Company shall not be liable for any personal injury or property damage resulting from the handling, possession or use of the equipment by the customer.

The warranty set forth herein is exclusive and is expressly in lieu of all other warranties, express or implied, including without limitation any implied warranties of merchantability or fitness, or of any other obligations or liability on the part of the Company.

The liability of the Company under this warranty is limited solely to repairing or replacing its products during the warranty periods; and the final judgment and disposition of all claims will be made by MEASUREMENT SYSTEMS INTERNATIONAL, INC.

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Goddard Procedural Requirement

GPR 8719.1B

Certification and Recertification of Lifting Devices and Equipment and Its Operators

GSFC
Code 540
Recertification Program
LDE and PVS Certification/Recertification

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

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Table 1 Load Test Requirements for New, Repaired, or Modified LDs

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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 <u>optional</u> 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.

Basic Overhead Crane Safety Video and Review

End of Video Review

Basic Overhead Crane Safety
Name: _____
Employee ID#: _____
Date: _____

MULTIPLE CHOICE (Circle One Answer Only)

1. What does ASME stand for?
   A) American Society of Mobile Equipment
   B) American Society of Mechanical Engineers
   C) All Safety Manufacturer of Equipment
   D) None of the above

2. Which of the following is NOT to be considered a wire rope deformation?
   A) Kinking
   B) Abrasion
   C) Lubrication
   D) None of the above

3. Which of the following components are checked under the system condition?
   A) Load Blocks
   B) Hoist Connections
   C) Load Line
   D) None of the above

4. ASME B30.2 states that a hoist without a lower limit must have a minimum of ___ complete wraps of wire rope on the drum of the hoist when the load block is at its lowest point.
   A) 5
   B) 2
   C) 8
   D) None of the above

5. Moving the crane and load block directly above the load will help to reduce?
   A) Shock Loading
   B) Side Loading
   C) Boom Deflection
   D) None of the above

6. To verify that the load brakes work properly and to minimize load swing you should?
   A) Lift the load a few inches off the ground and hold it
   B) Lift the load up to the upper limit switch
   C) Jog the load left and right several times
   D) None of the above

7. If you find a warning tag affixed to your overhead crane and its meaning is unclear you should?
   A) Disregard the tag and use the crane
   B) Discuss it with your supervisor
   C) Remove the tag, so no one else will be confused
   D) None of the above

8. OSHA standards allow up to a _____% increase in the throat opening of the hook.
   A) 10
   B) 5
   C) 15
   D) None of the above

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9. Which OSHA standard specifically addresses overhead cranes requirements for cranes used in General Industry?
   A) 1910.180
   B) 1910.179
   C) 1910.184
   D) None of the above

10. Which of the following items are NOT required to be inspected on a daily or shift basis.
   A) Runway Systems
   B) Control Stations
   C) Hook Block Assemble
   D) None of the above

TRUE/FALSE (Circle A or B)

11. A daily operator inspection is only required at the beginning of each 24 hour day, regardless of shift changes resulting in new operators.
   A) True B) False

12. If sheaves catch and bind during the daily operator inspection it is ok, they will be pulled free under the stress of a load.
   A) True B) False

13. The proper function of a safety latch is to snap back and leave the throat of the hook open.
   A) True B) False

14. All function and warning labels must be clearly legible.
   A) True B) False

15. When lifting a load, slowly raise the hook block to remove the slack from the rigging gear.
   A) True B) False

16. Finding a DO NOT OPERATE tag affixed to an overhead crane means that it is not to be operated until the proper authority removes that tag.
   A) True B) False

17. OSHA standards allow hooks to have up to 15 degrees twist from the plane of the unbent hook, or any portion of the hook.
   A) True B) False

18. When moving a suspended load you must never pass it over anyone.
   A) True B) False

19. When setting loads into position it is proper practice to set the loads on top of their rigging gear.
   A) True B) False

20. Understanding and complying with the manufacturers' recommended safe operation procedures are the responsibility of the operator.
   A) True B) False

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Energizing and De-Energizing

Crane Mainline Disconnects

The Left Hand Rule

&

Arc Flash

Arc Blast

Information

The Left Hand Rule

Energizing and De-energizing Electrical Disconnects

It is important that when we throw (turn on or off) an electrical disconnect that we do it properly. When we utilize disconnects to lockout a machine some may think that it is just a matter of pulling down the switch, but there is much more to it.

Arc flash, which is a short circuit through the air that flashes over from one exposed live conductor to another conductor or to ground, can be one of the dangers in throwing a disconnect. These electrical explosions, similar to lightning, are instantaneous and contain so much energy that severe burns and even death can occur if you are directly in the path.

EXAMPLE of REPORTED ARC BLAST

Recently we had an arc flash explosion on a busway. An employee re-energized a disconnect on the roof for a blower motor fan after un-jamming the cyclone. The busway became the weak point of failure during the energization as the motor itself was never turned off. The disconnect was utilized as the on/off switch so when energized, this caused a huge flow of energy through the system that one of the areas on the busway could not handle.

It is important to turn off the motors and/or machines prior to throwing an electrical disconnect. Never utilize the disconnect itself as an on/off switch.

There is also a specific way to turn on/off a disconnect called the "Left Hand Rule". Most disconnect handles are mounted on the RIGHT side of the switch while the hinges are on the left. To turn off a disconnect:

a) ALWAYS WEAR PROPER PPE based on category of Arc Flash Rating for the disconnect you will be operating.
b) Stand to the right side of the switch, not in front of the box.
c) Ensure that all personnel are clear of the area
d) Grab the disconnect with your LEFT hand
e) Turn your body and face away from the switch
f) Close your eyes.
g) Take a deep breath and hold it.
h) Actuate the disconnect.

Using this method helps protect you if an arc flash does occur within the cabinet during the activity. This keeps you out of the direct line of fire as an arc flash explosion can blow the hinged door right off the electrical box. Taking a deep breath and holding it ensures that if an explosion occurs, you don’t gasp and breathe in the flames.

Keep in mind that proper PPE must be used when actuating a disconnect switch.

The Left Hand Rule

A thorough evaluation of the location of the disconnect and any encumbrances must be assessed and the best method to ensure the safety of the person actuating the disconnect, as well as personnel in the area. If the Left Hand Rule is not feasible due to the location or construction of the disconnect, or physical limitations of the personnel actuating the disconnect, follow at a minimum the following precautions.

a) ALWAYS WEAR PROPER PPE based on category of Arc Flash Rating for the disconnect you will be operating.
b) Position your body as far away as possible from the disconnect but within comfortable means to actuate the disconnect with proper force.
c) Ensure that all personnel are clear of the area
d) Firmly grip the actuating lever/switch with Right or Left Hand (depending on location or construction of disconnect).
e) Always Turn your head away from the disconnect.
f) Close your eyes.
g) Take a deep breath and hold it
h) Actuate the disconnect.

Remembering these rules next time you go to actuate a piece of equipment at the disconnect could save you and others from injury and possible death. Arc flash explosions are rare, but they can cause life changing injuries. These quick and easy measures help protect you from years of pain and suffering.

HAZARD

BURN INJURY FACTS

-Arc Flash / Blast-

PREVENTION

April 2006
Report # 86-1-2006

Electricity can cause two types of burns: electrical burns from direct contact with current and thermal burns from arc flashes and blasts. An arc flash occurs when powerful, high-amperage currents travel, or arc, through the air. This can occur when high voltage differences exist across a gap between conductors. The result is an instant release of tremendous amounts of energy. Temperatures as high as 36,000˚F have been recorded in arc flashes.

Hazards of Arc Flash/Blast

- The intense heat and light emitted by an arc flash can cause severe burns, destroying skin and tissue. An arc flash can ignite or melt clothing, resulting in further burns. Victims sometimes require skin grafts or amputations. Death is more likely with increased severity of burns, the percent of body area affected and age.

- A high-amperage arc can produce a pressure wave blast with a force of up to 1000 pounds. The victim can be thrown by the force of this pressure. Injuries can occur from falling or colliding with nearby objects. Hearing loss may also result from the blast.

- The intense heat may melt metal electrical components and blast molten droplets considerable distances. These droplets harden rapidly and can lodge in a person's skin, ignite clothing and may cause lung damage.

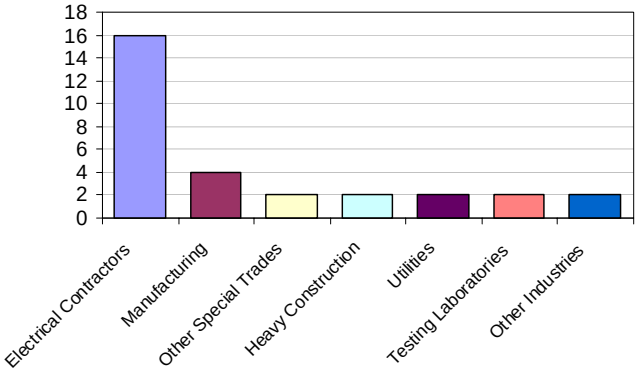
The Consequences of Arc Flash Burns Are Severe

Physically, victims may suffer from chronic pain and scarring. Workers may also have difficulty re-integrating into the community, and may experience anxiety, depression, or other psychological symptoms. The social and economic costs may also be high. Workers' compensation pays only a portion of lost wages. Some workers may not be able to return to their pre-injury job. Employers bear the costs associated with lost productivity, reduced competitiveness, employee rehiring and retraining, as well being subject to increases in workers' compensation premiums.

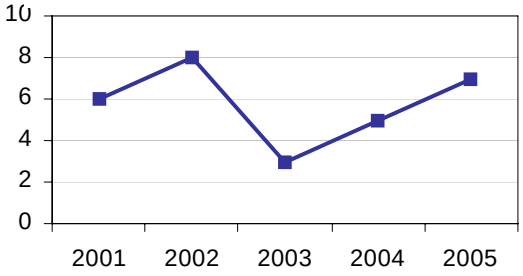
Washington State Workers and Arc Flash Burns

From September 2000 through December 2005, 350 Washington workers were hospitalized for serious burn injuries occurring at work. Of these, 30 (9%) were due to arc flash/blast explosions. Total Workers' Compensation costs associated with these 30 claims exceeded $1.3 million, including reimbursement for almost 1,800 days of lost work time.

Number of Arc Flash Burns by Industry in Washington State, 9/2000 – 12/2005



Number of Arc Flash Burns by Year of Injury in Washington State



Just a Few Workers' Stories…

Case 1: A Journeyman Electrician was working on an electrical panel when an arc flash/blast occurred. He was pushed back by the force of the blast and his shirt caught fire. He sustained burns to 20% of his body, including deep burns to his wrists and hands.

Case 2: An Electrical Foreman with over 20 years experience was working on a high-voltage circuit that he thought was de-energized. Unfortunately, he had de-energized the wrong circuit. He was thrown back by an arc flash/blast and received burns to his arm, neck, and face.

Case 3: A Journeyman Lineman was holding an energized 2,200 volt wire when it grounded out through his leg. He sustained electric shock burns to his trunk and leg and associated flash burns to his hands.

Case 4: A Journeyman Electrician was installing a high voltage panel when an arc blast occurred for unknown reasons. The explosion caused the worker to lose consciousness. He sustained burns to his hands, wrists, and face.

Summary: Each of these workers was hospitalized, some required multiple hospitalizations and surgeries. In addition, at least two of these workers suffered psychological symptoms, including post-traumatic stress disorder as a result of the arc flash incidents.

No worker has ever been injured or killed by an arc flash while working in an Electrically Safe Work Condition!

Burns from Arc Flash Explosions are Preventable

Job planning and adherence to the "Hierarchy of Controls" can greatly reduce the likelihood of one of these tragic accidents. "The Hierarchy of Controls" details a strategy for the elimination and mitigation of hazards. It recognizes that multiple safety precautions may be required in different situations. Generally, safety precautions should be implemented in the order below.

- **Elimination/Substitution –** Can jobs be scheduled so that power sources can be de-energized, grounded and tested thereby eliminating the hazard? Can an outdated or worn piece of electrical equipment be removed from service or can a newer safer model replace it?

- **Engineering Controls –** Prevent accidents by engineering barriers to dangerous locations. Locked electrical vaults and high fences around transformers are examples of engineering controls.

- **Administrative Controls –** An effective lockout/tagout program that includes all necessary training and equipment needed to implement it is an example of an administrative control. To be successful it must have the earnest support of management and labor.

Lock-out tag-out saves lives.

- **Work Practice Controls –** These are matters of supervisor and worker knowledge, training and education. Does management set expectations for safe work practices? Do workers meet or exceed safety rules and best work practices? Do supervisors encourage and if necessary enforce safety rules and best practices? Is a culture of safety proactively endorsed and practiced by all levels of the organization?

- **Personal Protective Equipment PPE –** This is normally considered the least effective method of protection. However, sometimes PPE may be necessitated by administrative or work practice controls and by the potential hazards of the work being performed. For instance, wearing insulated gloves, fire resistant clothing and a face shield when working on energized electrical equipment.

Working on energized equipment should be the EXCEPTION not the RULE.

Work Safely… Work De-Energized!

Initial Response to an Electrical Injury and First Aid

- If an injured worker is in contact with an energized circuit, **do not touch the victim, shut off the power and call 911!** If you can't de-energize the circuit, dislodge the victim from the circuit with non-conductive material. Rescue should only be performed by knowledgeable persons trained in electrical hazards and rescue techniques. If the victim is on fire, smother or douse the flames. Remove smoldering clothing, but not clothing that is melted to the skin.

- Tell a conscious victim not to move. There may be other associated injuries besides the burns, such as a neck or spine injury. **Moving an injured person can make injuries worse.**

- **Check for respiration and pulse.** If the victim is not breathing, rescue breathing from trained personnel should begin immediately. If a pulse is absent, the victim needs CPR. To be effective CPR should begin in less than 4 minutes.

- **Run cool, not cold, water over the burn.** Do not apply creams, ointments or ice. After the burn has been cooled, cover it with a clean dry cloth. Keep the victim warm.

- **Do not give the victim any food or water.**

- **Always see a doctor following an electrical shock or burn.** Even a victim who feels OK may have suffered internal injuries that won't become apparent until later.

For More Information

- **Division of Occupational Safety and Health Services Consultation Program**
  Washington State Department of Labor and Industries
  www.LNI.wa.gov/Safety/KeepSafe/Assistance/Consultation

  Region 1 – (Northwest Washington) Everett, 425-290-1300
  Region 2 – (King County) Seattle, 206-515-2800
  Region 3 – (Pierce, Kitsap, Clallam, and Jefferson Counties) Tacoma, 253-596-3800
  Region 4 – (Southwest Washington) Olympia, 360-902-5799
  Region 5 – (Central and Southeastern Washington) East Wenatchee, 509-886-6500
  Region 6 – (Eastern Washington) Spokane, 509-324-2600

- **NFPA 70E 2004 Edition, Article 130.1-130.7F –** *Standard for Electrical Safety in the Workplace* - for best work practices

- **Washington Administrative Code (WAC) 296-155-Part I-** for mandatory requirements

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Please consider the above information as you make safety decisions or recommendations for your company or constituency. The information in this narrative is based on preliminary data only and does not represent final determinations regarding the nature of the incident or conclusions regarding the cause of the injury.

Developed by the Safety & Health Assessment & Research for Prevention (SHARP) Program at the Washington State Department of Labor and Industries, supported in part by a cooperative agreement from the National Institute for Occupational Safety and Health (U60 OH008487).

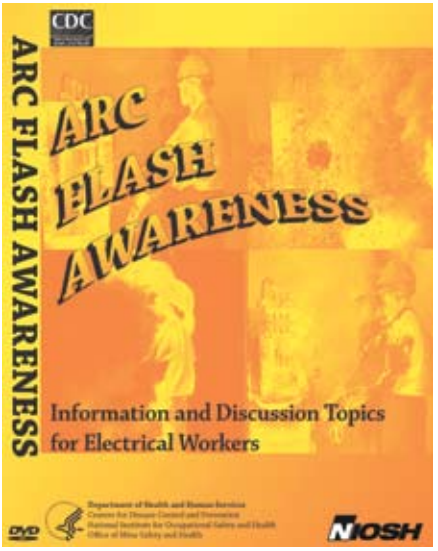
Don't get burned by arc flash!

What is hotter than the surface of the sun, explodes with the energy of dynamite, and kills one to two workers a day, each year? *An arc flash.*

An arc flash is the sudden release of electrical energy through the air when a high-voltage gap exists and there is a breakdown between conductors.

An arc flash happens without warning and too fast for you to react. The heat will reach as high as 35,000 degrees Fahrenheit—about four times as hot as the surface of the sun. High-voltage arcs can also produce considerable pressure waves by rapidly heating the air and creating a blast. This pressure burst can hit a worker with great force, and send molten metal droplets from melted copper and aluminum electrical components great distances at extremely high velocities that can result in critical burns, blindness, loss of hearing, and even death.

Surprisingly, it has just been in recent years that the term "arc flash" has garnered much attention, and that companies have started to raise awareness about the problem. However, many companies do not think arc flash is a concern to them, because they have never had an incident. Awareness about this deadly effect is critical, and will help prevent even more injuries and deaths.



What causes an arc flash?

An arc flash can be spontaneous or result from inadvertently bridging electrical contacts with a conducting object. Other causes may include dropped tools or the buildup of conductive dust or corrosion.

Conditions under which an arc flash can occur:

- Working on an energized circuit
- Electrical equipment failure

How large is the problem?

According to CapSchell, Inc., a Chicago-based research and consulting firm that specializes in workplace injury prevention, there are five to 10 arc flash explosions every day in the United States.

The final cost to employers and their insurers for a single, serious injury can approach $10 million (CapSchell).

2,000 workers are admitted annually to burn centers for extended injury treatments caused by arc flash, according to the U.S. Department of Labor.

A recent study from the National Institute for Occupational Safety and Health (NIOSH) determined that during the period from 1992 through 2001, there were 44,363 electricity-related injuries involving days away from work. The number of non-fatal electrical shock injuries was 27,262, while 17,101 injuries were caused by electric arc-flash burns.

With statistics like these, companies cannot afford to ignore electrical safety issues surrounding accidental electrocution from arc flash explosions, especially when an arc flash incident could account for more than $15 million in direct and indirect costs.

To address this issue, the Electrical Safety Foundation International (ESFI) has teamed with NIOSH and the Centers for Disease Control to distribute an arc flash awareness DVD available in English and Spanish. The DVD includes basic information about arc flash awareness and tells the stories of several electrical workers who were injured by an arc flash.

These tasks and many other electrical safety awareness programs are available through ESFI, which is committed to make the public more knowledgeable about hazards relating to electrical dangers on the job. ei

PPE Category Level Chart

NFPA 2009

Category 0

What Personal Protection Equipment (PPE) You Should Wear:
[X] Cotton Undergarments
[X] Long Sleeved Shirt (Natural Fiber)
[X] Long Pants (Natural Fiber)
[X] Safety Glasses or Goggles
[X] Hearing Protection (Inserts)
[X] Leather Gloves (as needed) or Insulating Gloves w/Protectors

Category 1

What Personal Protection Equipment (PPE) You Should Wear:
[X] Cotton Undergarments
[X] Arc Rated Long Sleeved Shirt (or FR Coveralls)
[X] Arc Rated Long Pants (or FR Coveralls)
[X] Hard Hat with Arc Rated Face Shield
[X] Hearing Protection (Inserts)
[X] Safety Glasses or Goggles
[X] Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes (as needed)

Category 2

What Personal Protection Equipment (PPE) You Should Wear:
[X] Cotton Undergarments
[X] Short Sleeved "T" Shirt (Natural Fiber)
[X] Arc Rated Long Sleeved Shirt and Long Pants
or Arc Rated Coveralls instead
[X] Hard Hat with Arc Rated Face Shield w/Sock Balaclava
[X] Safety Glasses or Goggles
[X] Hearing Protection (Inserts)
[X] Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes (as needed)

Category 3

What Personal Protection Equipment (PPE) You Should Wear:
[X] Cotton Underwear
[X] Short Sleeved "T" Shirt (Natural Fiber)
[X] Arc Rated Long Sleeved Shirt and Long Pants
[X] Arc Rated Coveralls (Over the above)
[X] Arc Rated (25 cal) Arc Flash Suite Jacket
[X] Arc Rated (25 cal) Arc Flash Suit Pants
[X] Arc Rated (25cal) Arc Flash Suite Hood
[X] Hard Hat
[X] Safety Glasses or Goggles
[X] Hearing Protection
[X] Arc Rated Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes

Category 4

What Personal Protection Equipment (PPE) You Should Wear:
[X] Cotton Underwear
[X] Short Sleeved "T" Shirt (Natural Fiber)
[X] Arc Rated Long Sleeved Shirt and Long Pants
[X] Arc Rated Coveralls (Over the above)
[X] Arc Rated (40 cal) Arc Flash Suite Jacket
[X] Arc Rated (40 cal) Arc Flash Suit Pants
[X] Arc Rated (40 cal) Arc Flash Suite Hood
[X] Hard Hat
[X] Safety Glasses or Goggles
[X] Hearing Protection
[X] Arc Rated Leather Gloves or Insulating Gloves w/Protectors
[X] Leather Shoes

Toll-Free
866-851-9993

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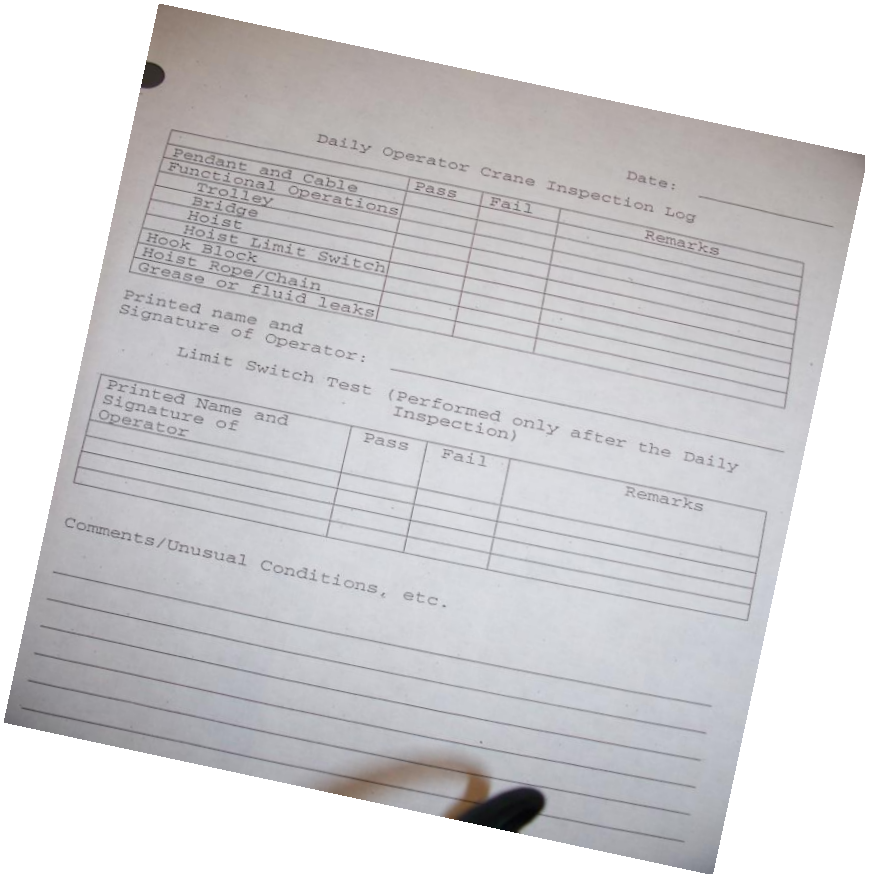
Lifting Device Operator Daily Crane and Hoist Inspection and Limit Switch Test



Daily Operator Crane Inspection Log

Date: _____

Pendant and Cable Functional Operations	Pass	Fail	Remarks
Trolley			
Bridge			
Hoist			
Hoist Limit Switch			
Hook Block			
Hoist Rope/Chain			
Grease or fluid leaks			

Printed name and Signature of Operator: _____

Limit Switch Test (Performed only after the Daily Inspection)

Printed Name and Signature of Operator	Pass	Fail	Remarks

Comments/Unusual Conditions, etc.

LIFTING DEVICE OPERATOR DAILY CRANE AND HOIST INSPECTION
AND
LIMIT SWITCH TEST

CRANE # _____

RECERT-42-001

APRIL 1991

REVISED APRIL 1992, AUGUST 1995, NOVEMBER 2004

PREPARED BY: _____
Original signatures of A. Zorn and D. Burger Date
On file

REVIEWED BY: Warren Thomas 11/10/04
W. Thomas, Manager, Recertification Function, ManTech Date

APPROVED BY: 11/10/2004
S. Y. Chan, RECERT Manager, Code 540, NASA/GSFC Date

Mechanical Systems Division
Goddard Space Flight Center
Greenbelt, Maryland 20771

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Appendix I - Log with Instruction Sheet

1.0 INTRODUCTION

This document defines the procedures for daily and limit switch inspection for cranes and hoists. This function is important to 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 Section 1910.179 of OSHA 29 CFR 1910.

1.1.2 Goddard Space Flight Center (GSFC) Daily inspections are performed by the certified operator prior to first use each day the crane is used. Daily inspections include the items listed in Sections 4.4.4 and 6.4.4 of NASA-STD-8719.9, as applicable.

1.1.3 Periodic inspections are performed a minimum of once a year. OSHA 29 CFR 1910, Section 1910.179(j)(3); NASA-STD-8719.9, Sections 4.4.5 and 6.4.5, as applicable.

1.1.4 Daily inspections of all functional operating mechanisms performed a minimum of once a day by the certified operator. OSHA 29 CFR 1910, Section 1910.179(j)(2); NASA-STD-8719.9, Sections 4.4.4 and 6.4.4, as applicable.

1.1.5 Limit Switch Test. A test of the initial upper limit switch with no load by the operator at the beginning of the shift. OSHA 29 CFR 1910, Section 1910.179(n)(4); NASA-STD-8719.9, Sections 4.7k and 6.7h), as applicable.

1.1.6 Discrepancy. Any deviation from the normal operating process or any change from the original design or intended configuration of the crane or associated equipment.

1.1.7 "Red" Warning tag. A tag used to alert all concerned of a hazardous condition or defective equipment. "Red" Warning tags shall be used until the hazard is eliminated.

2.0 DESCRIPTION

This document specifically addresses the procedures for the daily inspection of all cranes and hoists according to NASA, OSHA, and ANSI requirements. These procedures define daily inspections and limit switch inspections. These inspections do not require detailed written reports, but do require log

sheet entries to verify that the inspections were performed, when and by whom it was performed. The log sheet is included as an Appendix to this document. Consistent with the requirements defined in the applicable standards, the task shall be performed as outlined below.

3.0 REFERENCES

The following reference material is located in the file of the ManTech Lifting System Inspectors, Building 7, Truck Lock at GSFC and Building N-159 at WFF.

3.1 Standard For Lifting Devices and Equipment, NASA-STD-8719.9 latest revision.

3.2 OSHA Safety and Health Standards, Part 1910, Title 29 CFR. U.S. Dept. of Labor, Occupational Safety and Health Administration, latest revision.

3.3 American National Standards Institute. Overhead and Gantry Cranes, ANSI B30.17 latest revision.

3.4 GMI 1710.6, "Certification and Recertification of Lifting Devices and Equipment and Critical Lift Requirements" to be superseded by GPR 8719.1, "Certification and Recertification of Lifting Devices and Equipment," latest revision.

3.5 Maintenance History File.

3.6 CMAA Specification #74, latest revision.

4.0 SAFETY REQUIREMENTS

4.1 Cetified 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 cranes or performing inspections. Safety glasses and gloves are required when operating the main electrical disconnect switch. (Reference: OSHA 29 CFR 1910, Section 1910.133.)

4.4 If a crane 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 red tag, lock out the disconnect, and report his/her findings to the following personnel in the order noted:

1. His/her Manger or Supervisor
2. ManTech RECERT, 6-5181 at GSFC; 1714 at WFF
3. RECERT Manager, S. Chan, 6-4209 at GSFC; Prasad Hanagud, 1359 at WFF
4. FOM
5. Others as appropriate or directed

Red tags are available from the Shift Leader, RECERT Office, or Safety Offices at Greenbelt and Wallops.

4.5 All discrepancies shall be noted on the log and shall be reported to the Recertification Function.

5.0 REQUIRED PERSONNEL

The daily inspection and the limit switch test shall be performed by a certified crane operator (Critical or Noncritical) assigned to operate the crane. (Reference NASA-STD-8719.9, Section 4.6 and Section 6.6, as applicable.)

6.0 REQUIRED EQUIPMENT

Hard Hat
Safety Shoes
Safety Glasses
Gloves
Binoculars (optional)
Barrier Material
(Reference OSHA 29 CFR 1910, Section 1910.133.)

7.0 DAILY INSPECTION PROCEDURE FOR ELECTRIC CRANES AND HOISTS

This procedure shall be performed by the certified operator prior to first use each day. The intent of this inspection is to detect crane discrepancies that occurred during or after its last use.

7.1 Check the log book located near the crane disconnect switch to ascertain when the last daily inspection was made. If the daily inspection has not been made on the intended day of use, perform the required inspection. If the daily inspection has been made on this day, the operator may omit Paragraphs 7.2 through 7.18 and proceed directly to Paragraph 8.0 of this procedure.

7.2 Grasp the pendant and insure that all control buttons operate smoothly and efficiently without sticking.

7.3 Visually inspect the condition of the pendant and cable for loose connections, cuts, chafing, abrasions, excessive wear, dirt, or grease.

7.4 Locate the main electrical disconnect switch for the crane to be inspected. All crane switches are marked with the crane identity. Remove the lock and turn on the disconnect switch.

Lockout and Tag Out Procedure

Safety glasses and gloves shall be worn during this portion of the procedure. Observe the proper method to engage/disengage an electrical switch. Stand to the right of the switch, turn face and eyes away from switch, and push the switch with the left hand.

7.5 Operate push button control, if applicable, for return position check before power is turned on.

7.6 Grasp the pendant and push the power button "ON." Then try the emergency "STOP" button to be sure the reset drops out before proceeding with the inspection.

7.7 Operate radio control switches, if applicable, for return position check before power is turned on.

7.8 Push the power button on and, if necessary, move the crane to the inspection location. Be sure to look over your walk area before moving the crane. Use caution when equipment or personnel are in the vicinity.

7.9 Functional Operations of Crane Mechanisms

7.9.1 Bridge operation. Move the bridge about 10 feet in each direction. Listen and observe for start, smooth travel, brake action, and any unusual noise.

7.9.2 With the bridge moving, depress the power button to "STOP" and confirm that bridge travel ceases.

7.9.3 Carefully move the bridge into the bridge limit switch to confirm bridge travel ceases. Move bridge in opposite direction and repeat procedure.

7.9.4 Trolley Operation. Move the trolley about 10 feet in each direction. Listen and observe for start, smooth travel, brake action, and any unusual noise.

7.9.5 With the trolley moving, depress the power button to "STOP" and confirm trolley travel ceases.

7.9.6 Carefully move the trolley into the trolley limit switch to confirm trolley travel ceases.

Move the trolley in opposite direction and repeat procedure.

7.9.7 Hoist Operation. Move the hoist block to eye level. Listen and observe for start, smooth travel, braking action, unusual noise, or any loose parts or components. During lowering, check all speed functions available on the pendant.

7.9.8 With the hoist moving, depress the power button to "STOP" and confirm hoist movement ceases.

7.9.9 Carefully move the hoist block into the upper hoist limit switch to confirm hoist movement ceases. Move block in the down direction and confirm hoist movement ceases.

7.10 Examine the Hook Block side plate bolts and the sheave pin keepers for looseness.

7.10.1 Visually examine the Hook Block sheaves for excessive wear or broken flanges.

7.11 Hook Inspection. Check the Hook for the following:

7.11.1 Visual signs of wear, cracks, or deformation.

7.11.2 Throat opening is normal.

7.11.3 The tip of the hook and the shank of the hook are in the same plane.

7.11.4 The safety latch is on the hook and the latch operates properly.

7.11.5 The hook rotates freely and the hook bearing shows no excessive wear.

7.12 Visually inspect the wire rope for twists, kinks, broken wires, excessive wear, and proper seating in the Hook Block Sheaves. If you grasp the wire rope for any reason, wear gloves to avoid a possible injury from a broken steel wire.

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.

7.13 Operate the hoist in the up direction. While raising the block, check all speed functions available on the pendant.

7.14 From the floor, look for any noticeable oil leaks on the underside of the crane. Look at the position of the hoist cable as it winds on and off the drum and through the upper sheaves. Use binoculars to aid in this check if the crane is high and difficult to see with naked eyes. If binoculars are required, contact your Shift Leader or Supervisor. If unavailable, you may contact the Recertification Function Office on extension 6-1179.

7.15 Raise the hoist block to a position above head level and move the crane to its normal parking area.

7.16 Turn off the Pendant power switch.

7.17 Wear safety glasses and gloves during this operation. Pull the main electrical disconnect switch and install the appropriate crane lock. Use the proper method to engage/disengage the electrical switch. Stand to the right of the switch, turn face and eyes away from switch, and push the switch with the left hand.

7.18 In the Crane Inspection Log, enter the date; print and sign your name (no initials); check off the results of the inspection and note any departure from this procedure.

<u>Note: Any discrepancies discovered during the inspection shall be handled in accordance with Paragraphs 4.4 and 4.5 of this procedure.</u>

8.0 SHIFT LIMIT SWITCH TEST PROCEDURE (For electric cranes and hoists only)

This procedure shall be performed by each certified operator who uses the crane after the daily inspection has been performed for that day. The operator shall perform this test before starting normal operations.

8.1 The initial upper hoist limit switch shall be tested under no load condition. With extreme care, the block will be "inched" into the limit switch at slow speed.

8.2 If the limit switch fails to stop hoist motion:

8.2.1 Immediately turn off the pendant power switch.

8.2.2 Pull the main electrical disconnect switch and install the appropriate crane lock.

8.2.3 Attach a "Red" tag to the electrical disconnect switch.

Lockout and Tag Out Procedure

Safety glasses and gloves shall be worn during this portion of the procedure. Observe the proper method to engage/disengage an electrical switch. Stand to the right of the switch, turn face and eyes away from switch, and push the switch with the left hand.

8.2.4 In the Inspection Log, enter the date; print and sign your name (no initials); check off the results of the inspection; and note any departure from this procedure.

Note: Any discrepancies discovered during this test shall be handled in accordance with Sections 4.4 and 4.5 of this procedure.

8.3 If no problem is encountered with the limit switch, turn off the Pendant power switch.

8.4 In the log, enter the date; print and sign your name (no initials); and check off the test results.

Note: Crane is now ready for routine operational use by operator. Subsequent operators shall perform the same procedure before using the crane.

9.0 DAILY INSPECTION PROCEDURE FOR MANUAL CRANES AND HOISTS

This procedure shall be performed prior to first use each day the crane is used. The intent of this inspection is to detect crane discrepancies that occurred during or after its last use.

9.1 Check the log book located near the crane to ascertain when the last daily inspection was made. If the daily inspection has not been made on the intended day of use, perform the required inspection. If the daily inspection has been made on this day, the operator may omit Paragraphs 9.2 through 9.8 and proceed directly to the lift.

9.2 If necessary, move the crane to the inspection location. Be sure to look over your walk area before moving the crane. Use caution when equipment or personnel are in the vicinity.

9.3 Functional Operations of Crane Mechanisms

9.3.1 Bridge Operation. Move the bridge about 10 feet in each direction. Listen and observe for smooth travel and any unusual noise.

7.14 From the floor, look for any noticeable oil leaks on the underside of the crane. Look at the position of the hoist cable as it winds on and off the drum and through the upper sheaves. Use binoculars to aid in this check if the crane is high and difficult to see with naked eyes. If binoculars are required, contact your Shift Leader or Supervisor. If unavailable, you may contact the Recertification Function Office on extension 6-1179.

7.15 Raise the hoist block to a position above head level and move the crane to its normal parking area.

7.16 Turn off the Pendant power switch.

7.17 Wear safety glasses and gloves during this operation. Pull the main electrical disconnect switch and install the appropriate crane lock. Use the proper method to engage/disengage the electrical switch. Stand to the right of the switch, turn face and eyes away from switch, and push the switch with the left hand.

7.18 In the Crane Inspection Log, enter the date; print and sign your name (no initials); check off the results of the inspection and note any departure from this procedure.

<u>Note: Any discrepancies discovered during the inspection shall be handled in accordance with Paragraphs 4.4 and 4.5 of this procedure.</u>

8.0 SHIFT LIMIT SWITCH TEST PROCEDURE (For electric cranes and hoists only)

This procedure shall be performed by each certified operator who uses the crane after the daily inspection has been performed for that day. The operator shall perform this test before starting normal operations.

8.1 The initial upper hoist limit switch shall be tested under no load condition. With extreme care, the block will be "inched" into the limit switch at slow speed.

8.2 If the limit switch fails to stop hoist motion:

8.2.1 Immediately turn off the pendant power switch.

8.2.2 Pull the main electrical disconnect switch and install the appropriate crane lock.

8.2.3 Attach a "Red" tag to the electrical disconnect switch.

9.3.2 Trolley Operation. Move the trolley about 10 feet in each direction. Listen and observe for smooth travel and any unusual noise.

9.3.3 Hoist Operation. Move the hoist block to eye level. Listen and observe for smooth travel, unusual noise, or any loose parts or components.

9.4 Examine the Hook Block side plate bolts and the sheave pin keepers for looseness.

9.4.1 Visually examine the Hook Block sheaves for excessive wear or broken flanges.

9.5 Hook Inspection. Check the Hook for the following:

9.5.1 Visual signs of wear, cracks, or deformation.

9.5.2 Throat opening is normal.

9.5.3 The tip of the hook and the shank of the hook are in the same plane.

9.5.4 The safety latch is on the hook and the latch operates properly.

9.5.5 The hook rotates freely and the hook bearing shows no excessive wear.

9.6 Visually inspect the wire rope or fiber rope for twists, kinks, broken wires or strands, excessive wear, and proper seating in the Hook Block Sheaves. If you grasp the wire rope for any reason, wear gloves to avoid a possible injury from a broken steel wire.

If the crane is equipped with a hoist chain or hand chain, 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.

9.7 Raise the hoist block to a position above head level and move the crane to its normal parking area.

9.8 In the Crane Inspection Log, enter the date; print and sign your name (no initials); check off the results of the inspection and note any departure from this procedure.

<u>Note: Any discrepancies discovered during the inspection shall be handled in accordance with Paragraphs 4.4 and 4.5 of this procedure.</u>

Instruction Sheet for Daily Inspections and Limit Switch Log

A. After the daily inspection has been made, enter the following information on the log sheet.

1. Enter the day's date, e.g., 2-1-91

2. Enter a (√) mark in the appropriate "Pass" or "Fail" Column for each of the items listed.

   If any item is indicated under "Fail," use the remarks section to indicate the failure type.

3. Print your name, then sign your name.

Note: If a discrepancy is encountered during the daily inspection, appropriate action shall be taken in accordance with Sections 4.4 and 4.5 of the Daily and Limit Switch Test Procedure.

B. After the operator limit switch test has been made:

4. Enter a (√) mark in the appropriate "Pass" or "Fail" Column. If "Fail" is indicated, use the remark section to indicate the failure type.

5. Print your name, then sign your name.

6. Enter any comments or conditions that in your judgment are unusual. Initial your comments, e.g., Found lock open on switch AGZ.

C. Exceptions

7. Use the remarks area opposite the affected device to indicate anything that deviates from this procedure; e.g., Crane has no bridge limit switches, only bridge bumpers.

Date: MM/DD/YY 1

Daily Operator Crane Inspection Log

	Pass	Fail	Remarks
Pendant and Cable			
Functional Operations			
Trolley	2		
Bridge			
Hoist			
Hoist Limit Switch			
Hook Block			
Hoist Rope/Chain			
Grease or fluid leaks			

Printed name and
Signature of Operator: 3

Limit Switch Test (Performed only after the Daily Inspection)

Printed Name and Signature of Operator	Pass	Fail	Remarks
5	4		

Comments/Unusual Conditions, etc.

6

Date: _____

Daily Operator Crane Inspection Log

	Pass	Fail	Remarks
Pendant and Cable			
Functional Operations			
Trolley			
Bridge			
Hoist			
Hoist Limit Switch			
Hook Block			
Hoist Rope/Chain			
Grease or fluid leaks			

Printed name and
Signature of Operator: _____

Limit Switch Test (Performed only after the Daily Inspection)

Printed Name and Signature of Operator	Pass	Fail	Remarks

Comments/Unusual Conditions, etc.

_____

_____

_____

_____

_____

_____

Operating With A Radio Control

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.

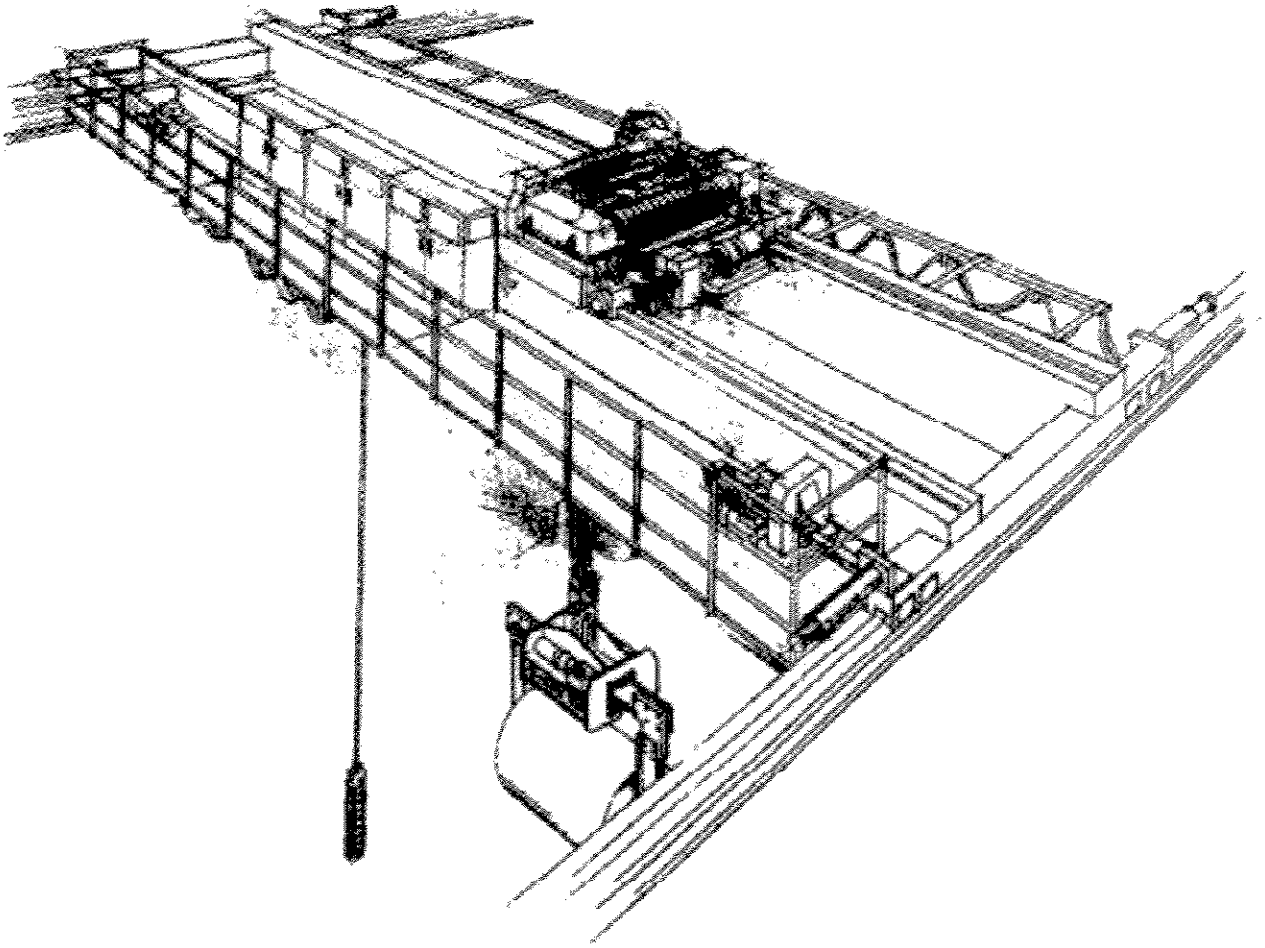
Radio controlled cranes operate basically the same as pendant or cab controlled cranes. The difference lies in the ability of the operator to move in areas not necessarily relative to the position of the crane, i.e., one has no fixed connection to the crane. Due to this freedom, it is imperative that 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.

The Basics of the PulseStar 610 JLT Radio

Cranes 5-5, 10-1, 24-1, 29-1, 29-2, 29-3, 29-4,



PulseStar® 610

Remote Crane Controls

Instruction Manual

ELECTROMOTIVE SYSTEMS
by MagneTek

PS610STAN-96A 2/8/00
Part Number: 900-4141
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PulseStar•610 System Overview

Introduction

This chapter introduces the basic conceptual information that you should know before installing, wiring, and operating the PulseStar•610 system.

Theory of Operation

The PulseStar•610 system consists of a transmitter kit and a receiver. The transmitter, using PulseStar's synthesizer technology, electronically generates a carrier frequency over which it and the receiver communicate. PulseStar•610 transmitters and receivers operate over the 400-470 Mhz frequency range (70 cm. band). To guarantee safety when the crane is being operated in conjuction with other radio controls, the receiver and transmitter are configured with the same address code. This way, the receiver only seeks out and accepts commands from the transmitter with the same address code.

NOTE: ***The PulseStar•610 receiver and transmitter already have their address code set up before they are shipped. Never change the address code in the receiver. The only time you should need to change the address code inside the transmitter is when you are setting up a spare or replacement transmitter. If you have any questions about address codes and how they are used, contact Electromotive Systems.***

Active Emergency Stop (E-STOP) Function

One of the most important features of the PulseStar•610 is **Active E-STOP**. The transmitter continuously sends the **Active E-STOP** status signal, followed by the desired crane function. This constant communication between the transmitter and the receiver confirm that the ongoing operations are safe. If the **Active E-STOP** push-button is pressed on the transmitter, the **Active E-STOP** relay module in the receiver opens, and crane motion then ceases. The receiver is then in **Safe Mode.**

To restart the system after activating **Active E-STOP** via the **Active E-STOP** push-button, pull out the **Active E-STOP** push-button and press the **START/HORN** push-button.

NOTE: ***There are other situations in which the system automatically goes into* Active E-STOP *without the operator pressing the* Active E-STOP *push-button on the transmitter. These are explained in later sections of the manual.***

Active E-STOP responds faster than any other PulseStar function. When **Active E-STOP** occurs, the system ignores any other signal it receives. **Active E-STOP** is the only signal that is recognized until the problem is corrected.

Active E-STOP is fail-safe and self-monitoring in both the transmitter and receiver. When you apply power to the receiver, it performs a self-test to make sure the **Active E-STOP** circuitry is working properly. If the receiver detects an error in the **Active E-STOP** circuitry, the system automatically goes into **Safe Mode.**

When you first turn on the transmitter, it also performs a self-test to make sure CPU circuitry is working properly. If it detects an error, the transmitter will not begin transmitting.

Time-Out Modes

Receiver Safe Mode

A PulseStar•610 safety feature is the **Safe Mode**. The receiver will go into **Safe Mode** if any of the following should occur.

- Interference caused by other transmitters or other radio-controlled products in the area.
- The transmitter is taken out of its operating range (330 feet).
- The **Active E-STOP** push-button is activated.
- There is a failure with the **Active E-STOP** circuitry.

When the receiver loses the transmitter carrier frequency signal, the **Time Out Waiting Period** process begins. The **Time Out Waiting Period** is factory set at 450msec, however it can be extended to 2 seconds. If the receiver does not regain the transmitter carrier frequency signal before the **Time Out Waiting Period** expires, the receiver immediately goes into **Safe Mode.** When in **Safe Mode** the receiver shuts off power to the output modules, and drops out the mainline contactor by opening the **Active E-STOP** relay module.

To restart the system, make sure the transmitter carrier frequency signal is being picked up by the receiver. Then press the **START/HORN** push-button on the transmitter.

Startup and Test Procedures

WARNING

- Only authorized personnel are permitted to perform testing or service work.
- Make sure the crane is clear of any obstructions, and there is no load on the hook.
- Serious injury or component damage can occur if the PulseStar•610 system is not properly installed and tested.

Pre-operation check list

Before you begin operating the PulseStar•610 system to control your overhead crane, confirm the following check list to ensure that your system is working safely and correctly.

- There is a fully-charged battery in the transmitter.
- The second battery is in the charger being charged at all times. Ensure that the battery charger is plugged into a power source that is not turned off at night with the crane.
- The **Active E-STOP** push-button on the transmitter is pushed in.
- The joysticks and/or paddle levers are in the center (off) position.

GLT Transmitter Functions

The following describes the basic functionality of the GLT transmitter. Please reference for the location of these functions.

START/HORN Push-button. The **START/HORN** push-button activates the mainline contactor and sounds the horn (when provided). Once the mainline contactor has been turned on, pressing this push-button sounds the horn only (when provided).

Active E-STOP Push-button. Pressing the **Active E-STOP** push-button will turn off the mainline contactor. The **Active E-STOP** push-button must be pulled out for the transmitter to control the crane motions.

NOTE: ***The* Active E-STOP *push-button is for emergency situations only. Do NOT use it as an Off switch. Use the key switch to turn the transmitter on and off.***

Power LED. As soon as the GLT is turned on, this light will flash once. The transmitter then goes through a diagnostic check. If the transmitter passes the diagnostic check the Power LED flashed green. This indicates that the transmitter is powered up.

Key Switch. The key switch turns the transmitter on and off. It only works with the key cap inserted, and the key cap can only be removed while in the OFF position.

Joysticks. The standard GLT joysticks provide stepless proportional speed control without detents of up to six crane motions. This number of motions can be increased by using the **SELECTOR** toggle switch for independent/combined control of cranes or trolley/hoists.

Paddle Levers. The standard GLT paddle lever provide stepless proportional speed control without detents of up to four crane motions. The number of motions can be increased by using the **SELECTOR** toggle switch for independent/combined control of cranes or trolley/hoists.

OPTION Toggle Switch. This switch controls the **OPTION** function connected to the PulseStar•610 receiver (lights, for example). The function will begin when the switch is moved to the On position. The function will continue working until the switch is moved to the Off position.

SELECTOR Toggle Switch. The **SELECTOR** toggle switch allows the operator to control multiple cranes from a single transmitter, or multiple crane motions from a single joystick or paddle lever. When the **SELECTOR** toggle switch is set to A, the transmitter activates the Select A relay inside the receiver. When the **SELECTOR** toggle switch is set to B, the transmitter activates the Select B relay inside the receiver. When the **SELECTOR** toggle switch is set to A+B, both Select A and Select B relays inside the receiver are activated.

NOTE: ***The PulseStar•610 receiver provides an A and a B control signal the same way that a pendant station with a rotary A, A+B, B select switch does. The crane controls must have existing A, A+B, B select relay logic in order for independent/combined control from the PulseStar transmitter to work.***

Start-up and Operation

Holding the Transmitter

Before using the PulseStar•610 transmitter, refer to the following information on how to hold the PulseStar•610 transmitter the correct way.

WARNING

To make sure that you are oriented correctly in relation to the directional push-buttons, paddle levers or joysticks. Hold the transmitter as shown.

NVT Transmitter

Please refer to Figure 3.9: NVT Transmitter Orientation on how to properly hold the NVT transmitter.

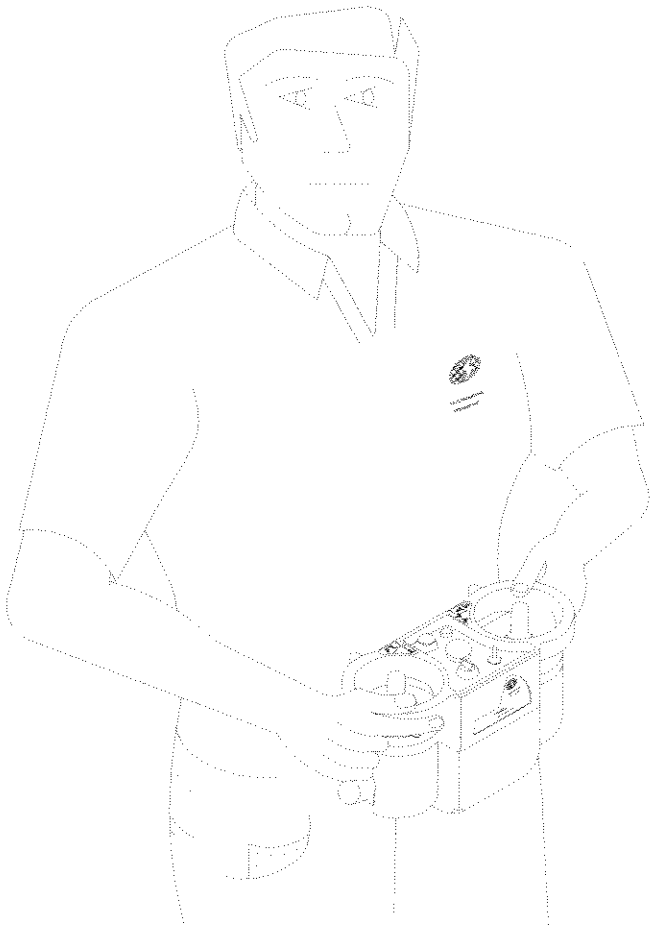


Figure 3.9: NVT Transmitter Orientation

GLT Transmitter

Please refer to Figure 3.10: GLT Transmitter Orientation on how to properly hold the GLT transmitter.

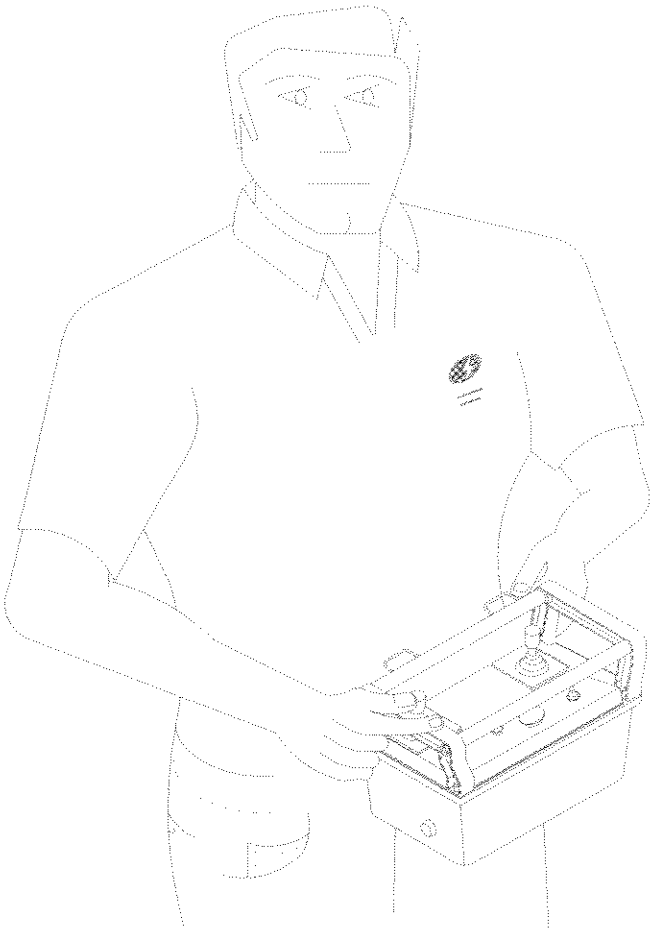


Figure 3.10: GLT Transmitter Orientation

Start-up

Refer to the appropriate transmitter layout figure shown in the PulseStar•610 Transmitters section for the location of the various functions on the PulseStar•610 transmitter. To start the PulseStar•610 transmitter:

1. Make sure that there is a charged battery in the transmitter.
2. Make sure the **Active E-STOP** push-button is pressed in.
3. Make sure all joysticks or paddle levers are in the center (off) position.
4. Insert the key into the transmitter ON/OFF key switch and turn to the ON position. The power LED flashes to indicate power is on. The transmitter will emit two sounds. The first sound indicates that the transmitter is going through the diagnostic check. The second sound indicates that the transmitter has passed the diagnostic check.
5. Pull out the **Active E-STOP** push-button and press the **START/HORN** push-button to provide power to the mainline contactor.

   The transmitter is now ready for use.

Emergency Stop

For all emergency situations, push in the **Active E-STOP** push-button. To restart, pull out the **Active E-STOP** push-button and press the **START/HORN** push-button.

When the PulseStar•610 battery voltage drops below approximately 8 volts, a buzzer will sound inside the transmitter. At the end of the 30 second period, the transmitter will automatically shut itself off and places the receiver in **Safe Mode**. This blocks all crane motion commands.

Using the Joysticks or Paddle Levers

All joysticks and paddle levers have a spring return to the center (off) position. Locate the transmitter label which corresponds to the joystick or paddle lever function you wish to operate. Deflect the joystick or paddle lever in the direction you want the crane motion to move according to the label. If the crane motion is more than one speed, the further you deflect the joystick or paddle lever from it's center position, the faster the crane motion will move. To stop the crane motion(s) simply return the joystick or paddle lever to the center (off) position.

NOTE: ***For all joysticks deflecting the joystick to the right and away from your body represents the motion in the "+" direction. For all paddle levers deflecting the paddle lever toward your body represents the motion in the "+" direction. This is important to know when wiring the receiver to the crane controls.***

Using the Option Toggle Switch

The PulseStar•610 transmitter is provided with an **OPTION** toggle switch. Turn the **OPTION** toggle switch on to activate the device, if any, which is connected to the **OPTION** relay inside the PulseStar•610 receiver. The **OPTION** toggle switch is maintained and will remain in the ON position until placed back into the OFF position.

Using the SELECTOR Toggle Switch

The PulseStar•610 transmitter is provided with a **SELECTOR** toggle switch which controls the independent or combined control of main and aux hoists, two trolley/hoists, or two cranes. When the **SELECTOR** toggle switch is set to A, the transmitter sends a signal which closes **SELECTOR** relay Select A inside the receiver. When the **SELECTOR** toggle switch is set to B, the transmitter sends a signal which closes **SELECTOR** relay Select B inside the receiver. When the **SELECTOR** toggle switch is set to A+B, both Select A and Select B **SELECTOR** relays close inside the receiver.

NOTE: ***The PulseStar•610 receiver provides an A and a B control signal the same way that a pendant station with a rotary A, A+B, B select switch does. The crane controls must have existing A, A+B, B select relay logic in order for independent/combined control from the PulseStar transmitter to work.***

Shutting Off the Transmitter

When you are finished using the transmitter, turn the key switch to OFF. The mainline contactor will drop out. Remove the key from the key switch and take it with you to prevent unintended use.

Transmitter Options

The following are some of the more common options which are available with the PulseStar•610 transmitter. If you have any questions about the functionality of your PulseStar•610 system contact Electromotive Systems.

Spare Transmitter

Spare transmitters can be used in the event that the primary transmitter becomes lost or damaged. One transmitter is used as the main crane control and the other is designated as a spare. Only one transmitter is active at any given time.

NOTE: ***If both transmitters are set to the same address code and frequency channel and both transmitters are turned on, the receiver will go into safe mode.***

Battery and Charger Information

Removing and Inserting the Battery From the NVT Transmitter

To remove or insert the battery from the NVT transmitter, refer to Figure 3.11: NVT Transmitter Battery Removal.

Removal: Push the battery toward the spring-loaded contacts. Tilt the battery away from the housing until the battery pops out of the compartment.

Insertion: Place the battery in the battery cavity at an angle, with the end containing the gold plated contacts facing the spring-loaded contacts. Push battery into the battery cavity and against the spring loaded contacts until the battery can be placed flush against the battery cavity wall. The battery should now be securely positioned inside the battery cavity.

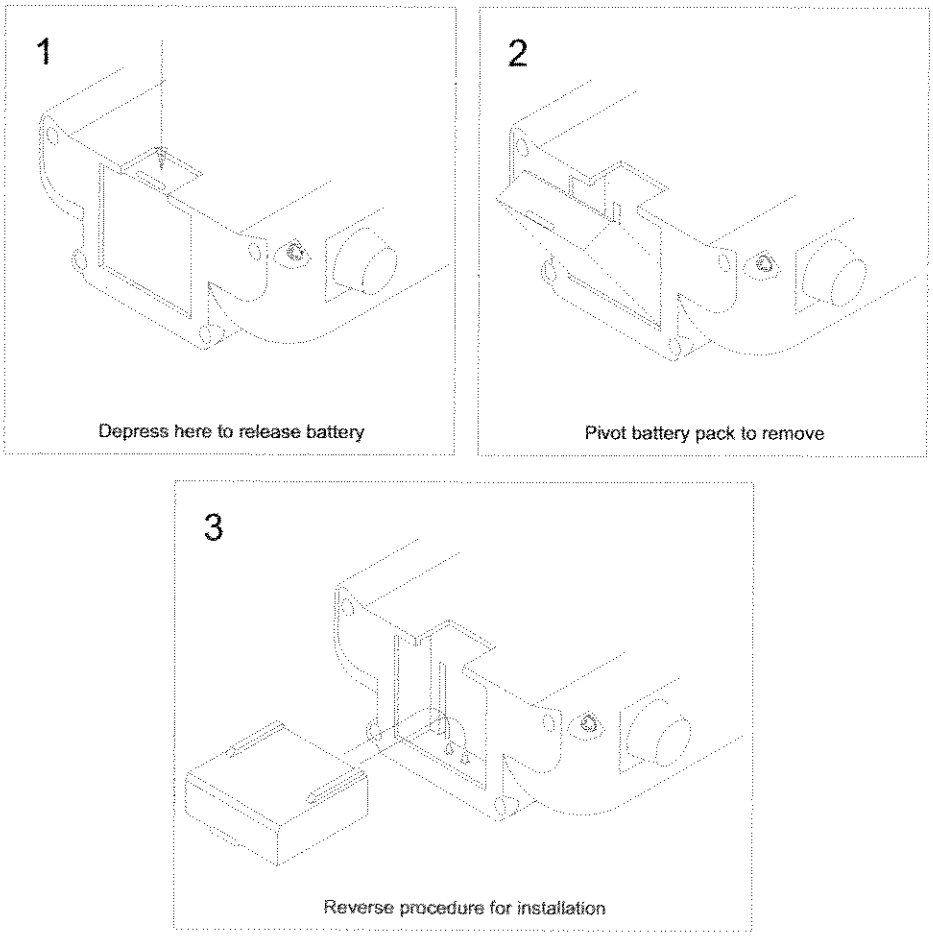


Figure 3.11: NVT Transmitter Battery Removal

Removing and Inserting the Battery From the GLT Transmitter

To remove or insert the battery from the GLT transmitter, refer to Figure 3.12: GLT Transmitter Battery Removal.

Removal: Push the battery tab toward the battery. Pivot the battery away from the housing until the battery pops out of the compartment.

Insertion: Locate the two battery hinges on the battery. They are opposite the battery tab. Line up the battery hinges with the corresponding hinge guides in the battery cavity wall of the transmitter. Place the battery, hinge side first, into the battery cavity and slide the battery hinges into the hinge guides. Slowly press downward on the battery until the battery tab locks into place.

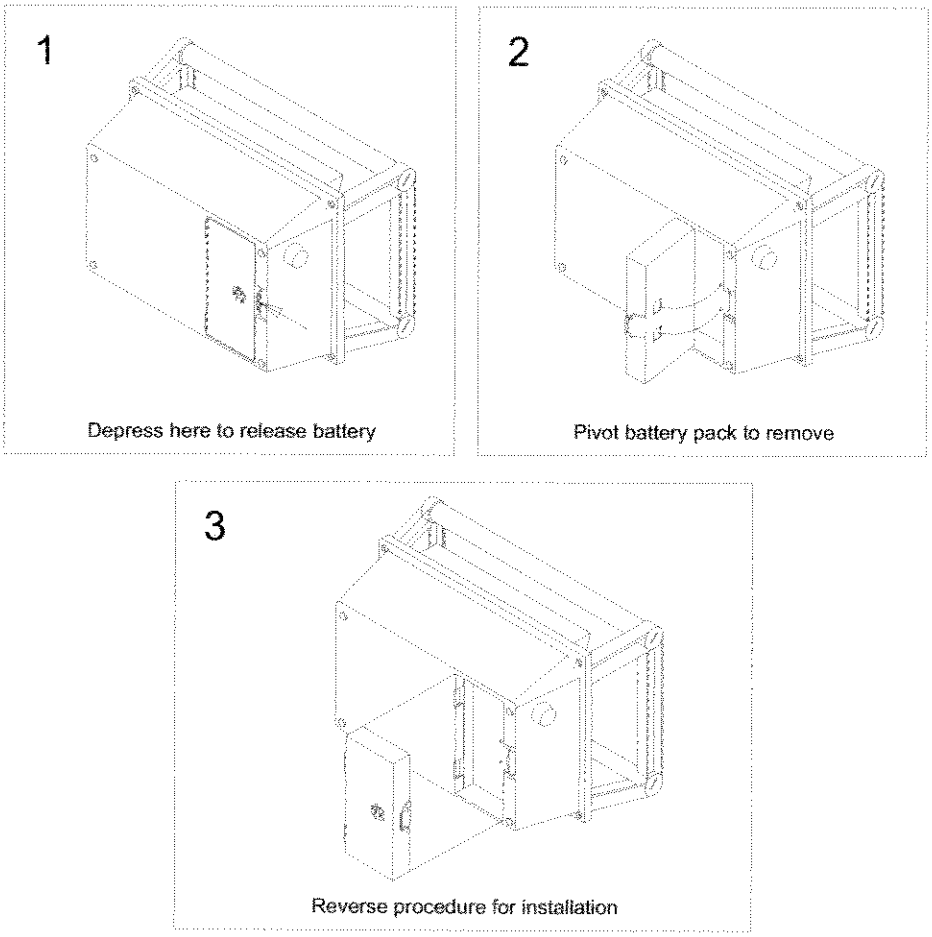


Figure 3.12: GLT Transmitter Battery Removal

Charging the Battery

The PulseStar battery charger is designed for 115/230VAC and plugs into a regular wall outlet. Please refer to Figure 3.13: Battery Charger for NVT Transmitters and Figure 3.14: Battery Charger for GLT Transmitters for charger layout.

1. Discharge Push-button
2. Discharge LED
3. Battery
4. Battery Contact
5. Power Cord
6. Battery Cavity
7. Charger
8. Charge LED

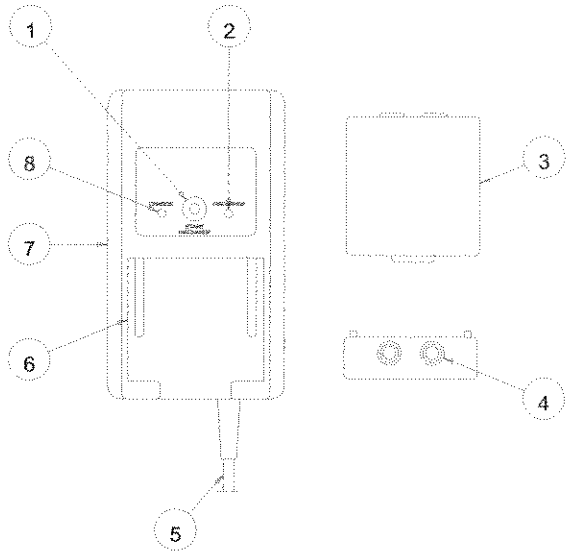


Figure 3.13: Battery Charger for NVT Transmitters

1. Discharge Push-button
2. Discharge LED
3. Battery Contact
4. Battery
5. Battery Tab
6. Power Cord
7. Battery Cavity
8. Charger Spring Loaded Contact
9. Charger
10. Charge LED

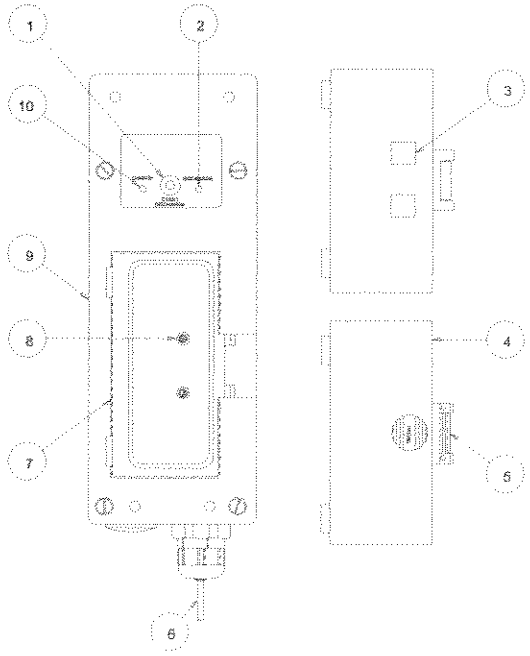


Figure 3.14: Battery Charger for GLT Transmitters

Discharge Charger

Insert the battery into the charger. The green charge LED emits a steady light to indicate that the battery is being charged. Press the red Start Discharge push-button. The green charge LED turns off, and the red discharge LED turns on. The battery will now fully discharge. Once the battery is fully discharged, the red discharge LED will turn off, and the green charge LED will turn on. The green charge LED emits a steady light to indicate that the battery is being charged.

The processor in the charger checks the capacity of the battery until the battery is fully charged. The maximum charging time is four hours. When the battery is fully charged, the green LED begins to flash. Leave the battery in the charger until needed to ensure it is fully-charged.

The following table summarizes battery information for NVT transmitters.

Charging Time	4 hours (from fully discharged)
Operation Time	7–10 hours continuous
Type	Nickel Metal Hydrite; 9.6 Volts, 750 milliampere hours
Maximum number of charges	Approximately 800 times

The following table summarizes battery information for GLT transmitters.

Charging Time	4 hours (from fully discharged)
Operation Time	12-14 hours continuous
Type	Nickel Cadmium; 9.6 Volts, 1000 milliampere hours
Maximum number of charges	Approximately 800 times

All charger and battery contacts are gold-plated to provide superior contact. Batteries and chargers are IP65-rated. The mechanical design of the battery case and the battery pocket ensures that each insertion and removal of the battery will clean the contacts. This is known as "self-cleaning" contacts.

Memory Effect

To maximize the lifetime of your battery, **only charge completely discharged batteries** whenever possible. Charging a partially discharged battery may result in a memory effect in the battery, which reduces the battery capacity, and the number of times it can be effectively charged.

RADIO CONTROL OF CRANE 5-5

CAUTION: ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS TURNED ON.

Operators should be familiar with the following rules and warnings:

1. ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS TURNED ON.

2. The range between the transmitter and receiver is between 300 and 400 feet. DO NOT operate the system outside of the working area.

3. Follow all OSHA and NASA crane operator rules and instructions for crane operation.

4. Always be aware of the crane and block location. Machines in the shop could be damaged or a collision could occur with the High Bay crane in Building 5.

The GLT Transmitter (Joy Stick Model) for Crane 5-5 consists of the following:

1. Active E-Stop Push-Button - Pressing the E-Stop Push-Button will turn off the main contactor. The button must be pulled out for the transmitter to control the crane.

2. Power LED (light) - Indicates that power is on the transmitter and is communicating with the receiver on the crane. The light will flash once and after the transmitter goes through a diagnostic check. The LED will flash green indicating that the transmitter is power up.

3. On/Off Switch on the right side - The switch turns the transmitter "on" and "off."

4. Start Button - Push the button to activate the main line contactor on the crane.

   NOTE: Two strobe lights are on the crane - the amber light indicates that the main line contactor is closed, the red light comes on when the crane is under the High Bay crane runway. (This is to make you aware of a possible collision with the High Bay crane.)

5. Joy Sticks - They provide control for each hoist and control for the bridge and trolley.

6. Back Up Pendants - The original pendant controls are on the crane as a back up in the event of radio failure. Contact RECERT Crane Technicians at 6-2583 to place the pendant in service

Crane 10-1 Flux Vector Drive and Radio Control

CAUTION - ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS "ON."

Flux Vector Drives provide the means for precise positioning of a load to enhance integration work and smooth handling.

The following terms describe some of the benefit of the system.

- Vector duty motors - 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 starts 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.

- Accel and decel ramps - the ramps have been set to minimize the load swing for the trolley and bridge. The hoist ramp is faster.

  Operators need to get accustomed or experienced with this radio control system.

- 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.) The ON-OFF switch must be in the ON position and the red E-Stop button must be pulled "UP" for crane operation. A green light indicates that the transmitter is ON.

- The operator's transmitter consists of the following:

  - ON-OFF Switch - a green light indicates that the transmitter is ON.

- Reset Button - pushing this button resets the crane control. (NOTE: Allow at least one minute between crane resets.)

- F1 function selector - sets up the radio interface and selects a speed readout in feet per minute.

- F2 function selector - also sets up the radio interface and selects a speed readout in inches per minute.

- F3 function selector - spare.

- F4 function selector - spare.

- Trolley Limit Switch By-Pass Button - provides a by-pass for the first limit at the west end of the trolley. (Protects the Vibration Lab monorails.) The second and final limit at the west end cannot be by-passed.

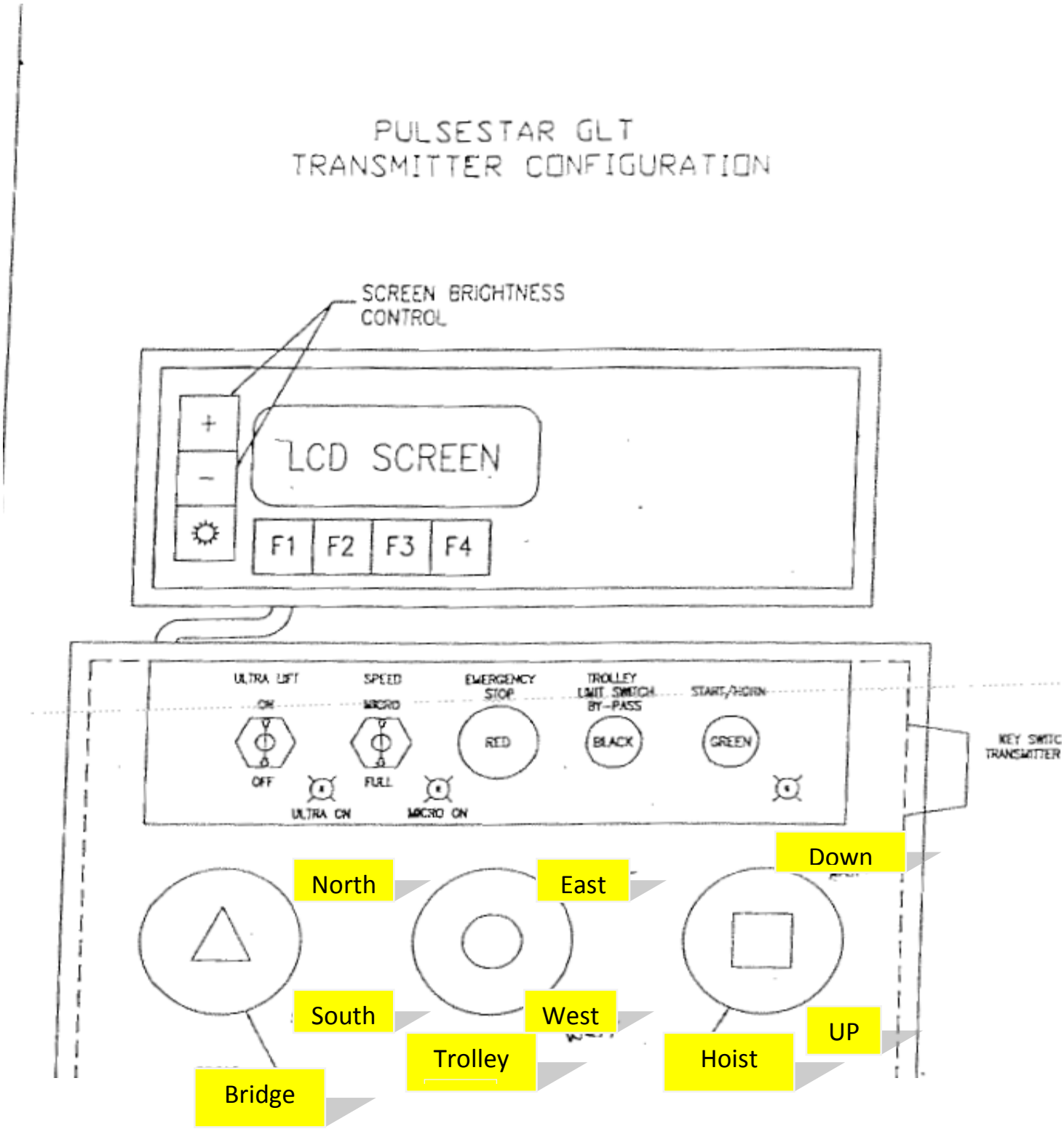
- Micro Speed selector - sets up for normal or micro speed selection for all three motions of the crane.

- Ultra Lift - provides a slightly faster than normal speed.

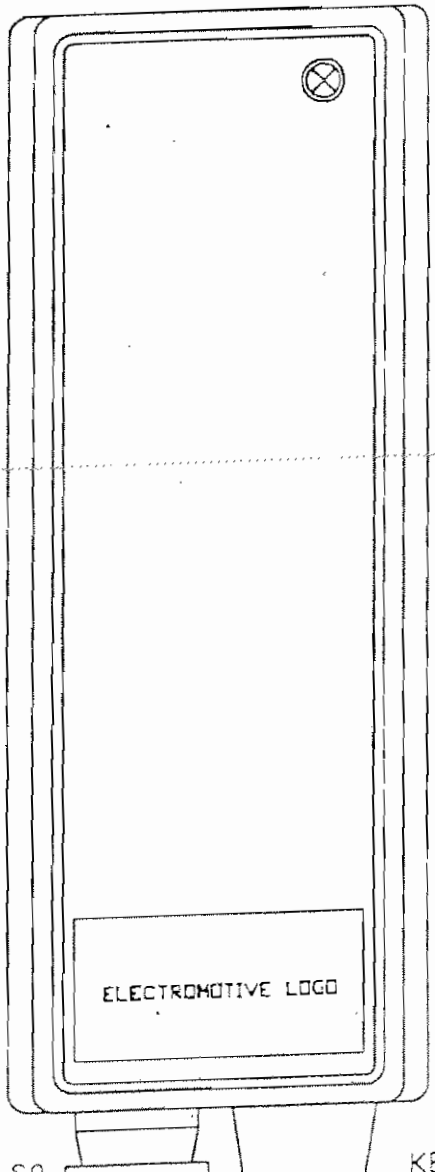
- Joy Sticks - bridge, trolley, and hoist. Provides infinitely variable speed control for each motion.

- Read-out Console - provides the percent of full load amps for the hoist and read-out of speeds for each crane motion.

- 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. See attached layout.

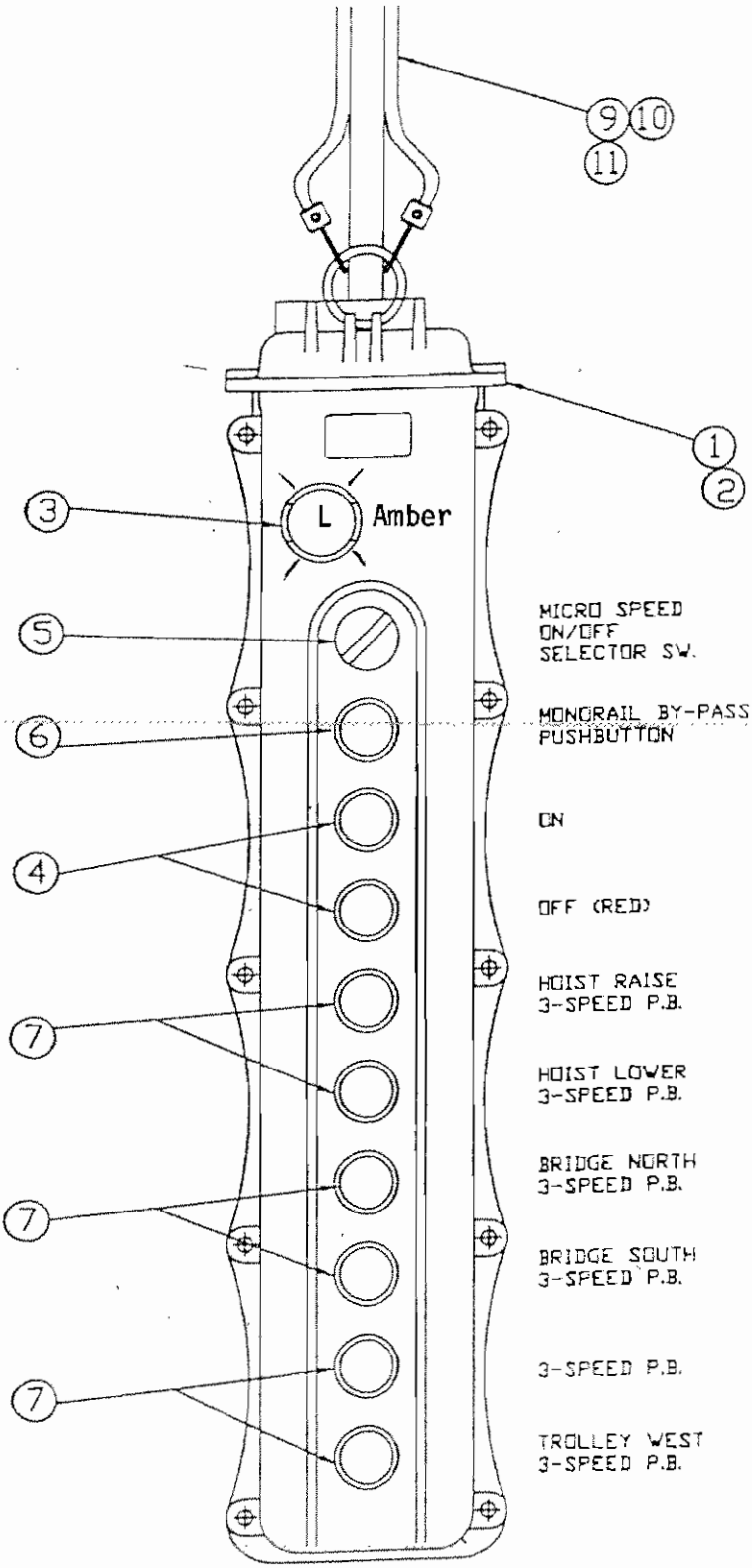

PULSESTAR GLT
TRANSMITTER CONFIGURATION
SCREEN BRIGHTNESS CONTROL
+
-
LCD SCREEN
F1
F2
F3
F4
ULTRA LIFT
ON
OFF
ULTRA ON
SPEED
MICRO
FULL
MICRO ON
EMERGENCY STOP
RED
TROLLEY LIMIT SWITCH BY-PASS
BLACK
START/HORN
GREEN
KEY SWITC
TRANSMITTER
North
South
Bridge
East
West
Trolley
Down
UP
Hoist

PULSESTAR 609 E-STOP TRANSMITTER CONFIGURATION



Crane 10-1

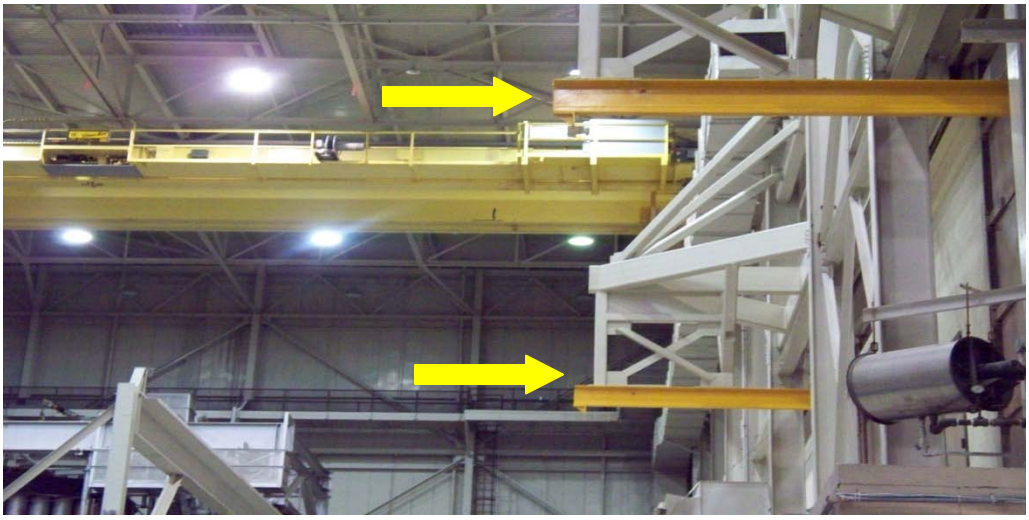
PENDANT LAYOUT



Crane 10-1 By-Pass Button Procedure and Use

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. <u>**Extreme caution should be exercised when operating in the By-Pass mode.</u>**

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**

Crane 10-1 By-Pass Button Procedure and Use

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

Crane 24-1

RADIO CONTROL OF CRANE 24-1

Operators should be familiar with the following rules and warnings:

1. ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS TURNED ON.

2. The range between the transmitter and receiver is between 300 and 400 feet. DO NOT operate the system outside of the working area.

3. Follow all OSHA and NASA crane operator rules and instructions for crane operation.

4. Always be aware of the crane and block location. The chillers in Building 24 can be damaged if caution is not adhered to.

The GLT Transmitter (Joy Stick Model) for Crane 24-1 consists of the following:

1. Active E-Stop Push-Button - Pressing the E-Stop Push-Button will turn off the main contactor. The button must be pulled out for the transmitter to control the crane.

2. Power LED (light) - Indicates that power is on the transmitter and is communicating with the receiver on the crane. The light will flash once and after the transmitter goes through a diagnostic check. The LED will flash green indicating that the transmitter is power up.

3. On/Off Switch on the right side - The switch turns the transmitter "on" and "off."

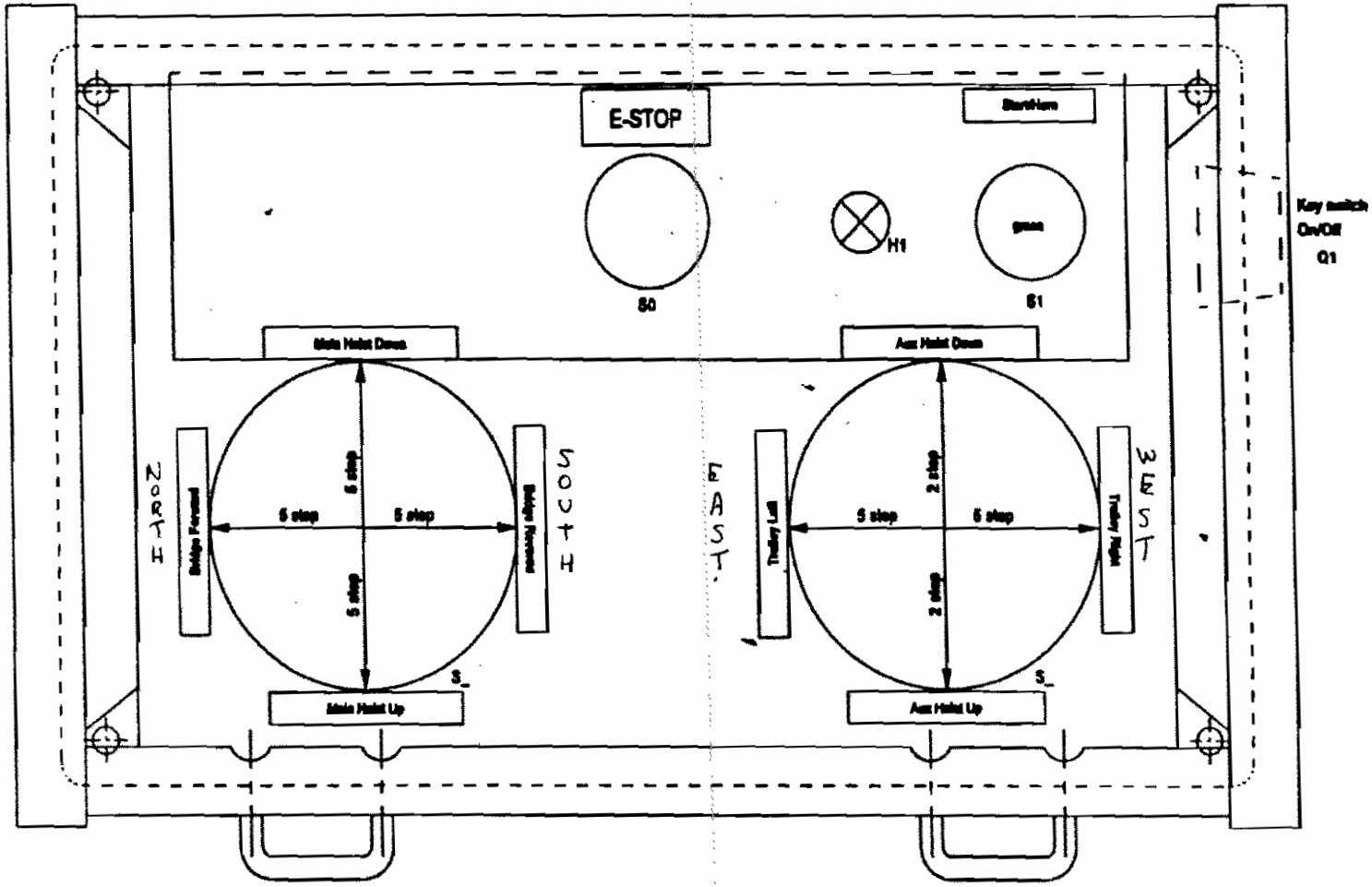
4. Start/By Pass Push Button - Push the button to activate the main line contactor on the crane. Hold the button down for "Bridge By Pass." The crane is interlocked that when the trolley is over the chillers, you must hold the By Pass button down to operate the bridge.

   NOTE: Two strobe lights are on the crane - the amber light indicates that the main line contactor is closed, the blue light comes on when the trolley is over the chiller area.

5. Joy Sticks - There are two dual axis joy sticks. They provide two step control for each hoist and five step control for the bridge and trolley. The right joy stick provides up and down control at the auxiliary hoist and east west motions of the trolley. The left joy stick provides up and down control of the main hoist and north and south motions of the bridge. See attached sketch.

CAUTION: ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS TURNED ON.

6. Back Up Pendants - The original pendant controls are on the crane as a back up in the event of radio failure. Contact RECERT Crane Technicians at 6-3403 to place the pendant in service


E-STOP
Start/Horn
S0
H1
green
S1
Key switch
On/Off
Q1
Main Hoist Down
Aux Hoist Down
Bridge Forward
Bridge Reverse
Trolley Left
Trolley Right
5 step
5 step
5 step
5 step
2 step
2 step
5 step
5 step
S_
S_
Main Hoist Up
Aux Hoist Up
NORTH
SOUTH
EAST
WEST

Cranes

29-1

29-2

29-3

29-4

OPERATING INSTRUCTIONS
RADIO CONTROL

CAUTION - ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS "ON."

- Switch on the radio remote control transmitter by turning the key switch.

  An acoustic signal, long followed by a short beep, will be emitted and, after a procedure of self-tests (max. 3 sec.), the green "power" indicator on the top of the transmitter will flash.

- Pull the Emergency Stop button "UP" to permit crane reset.

- Push the "START" button (possibly START/HORN)(29-1, -2, -3, & -4).

  The radio remote control is now operational and the desired function can be activated by levers or switches.

  NOTE:

  The function "START" is blocked as long as one of the levers is not in the neutral position. This is to avoid the unintentional activation of a crane function.

- Before working with the crane, the safety functions (e.g., Emergency Stop) have to be checked according to the requirements of the guidelines of the relevant authorities.

- When finishing work or interrupting for a long period of time, switch off the radio remote control transmitter via the key-switch. This will increase the operating period per battery charge. By the interruption of the radio communication, the radio remote control receiver is switched into a secure state.

- When pushing the "Emergency Stop" switch, the crane control is at once switched into a secure state. To re-activate the crane control, the "Emergency Stop" push-button must be pulled out and the start button re-pressed.

  NOTE:

  By pushing the "Emergency Stop" switch, the radio remote control transmitter is not switched off, but "Emergency OFF" signals are transmitted.

- After approximately 10 hours of operation, the radio remote control transmitter will indicate the discharge of the battery by an acoustic continuous beeping signal.

  CAUTION!

  The signal is emitted for about 30 seconds; during this time the crane must be driven into a secure position. After this period, the radio remote control transmitter switches off automatically.

- Switch off the radio remote control transmitter by turning the key-switch and replace the battery in the base of the housing.

- The radio remote control transmitter can be put into operation again with a charged battery.

  NOTE:

  If the radio communication is interrupted (in the case that the distance is too long, interferences caused by other transmitters), the radio remote control receiver switches into a secure state and can only be started again by pushing the "START" switch.

CHARGING THE BATTERY:

- Exchangeable battery:

  Put the discharged battery into the charger. Charge time is approximately 3 hours. A flashing green light on the charger indicates a fully charged battery. The charged battery can be left in the charger until it is needed for the running of the radio remote control transmitter.

6.0 Operating The Radio Remote Crane

6.01 The crane limit switch shall be checked at the beginning of each turn or when a new operator takes control of the crane. 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 falls, no one will be injured or no equipment will be damaged.

6.02 The limit switch shall never be used as a regular stopping device. They are intended to be protective devices only.

6.03 The bridge and trolley brakes shall be tested at the beginning of each turn or when a new operator takes control of the crane. They should be tested at low speed.

6.04 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, load shall be immediately lowered to the floor and a report made to the supervisor.

6.05 Do not make lifts in excess of the rated capacity of the equipment. Consult your supervisors for the exceptions.

6.06 When making lifts, the bridge and trolley shall be centered directly over the load to prevent swinging when the load is raised.

6.07 Side pulls shall be made only with permission of the supervisor. When such a lift is being made the operator shall not position himself in the line or path of travel of the load, but shall operate the crane from a position either to the side or to the opposite of the line of travel.

6.08 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.

6.09 Crane operator shall keep all parts of his body away from the lift and shall never position himself under the lift.

6.10 Do not make a lift or move the crane if anyone is in a position to be injured.

6.11 If the Radio Control Crane Operator is being helped, he shall not move the crane until he has received a signal from his helpers that they are in the clear.

6.0 Operating The Radio Remote Crane

6.12 Loads shall not be carried over workman's heads.

6.13 If anyone is in the path of travel, the Radio Control Crane Operator shall stop and clear the area before proceeding.

6.14 Bumping into runway stops or into other cranes on the same runway is prohibited.

6.15 When moving the crane the Radio Control Crane Operator shall be sure that the hook, block, attachment or cables will not foul on nearby equipment.

6.16 The Radio Control Crane Operator shall not drag slings, chains, etc. along the floor. They could snag something causing the cables to break and to strike the operator or a fellow workman, causing serious injury.

6.17 Where gloves are not required for more compelling safety reasons, they shall not be used when operating the radio control box.

6.18 All loose material or parts shall be removed from the load before starting lift. Such material can fall, striking people below.

6.19 The Radio Control Crane Operator shall hoist lifts high enough to clear all apparatus and workman below the crane.

6.20 Plugging shall not be used as a regular means of stopping the crane. Plugging is intended for emergency stops only, except when authorized by plant supervisor. Caution should be used when plugging with the radio control box.

6.21 If the Radio Control Crane Operator is asked to do something he believes unsafe, he shall call his supervisor for advice.

6.22 The Radio Control Crane Operator shall never permit anyone to ride on the load or hook except when authorized by the supervisor.

6.23 When another crane on the same runway is stationary, with or without a load, the Radio Control Crane Operator shall maintain a safe distance

6.24 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.

6.0 Operating The Radio Remote Crane

6.25 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 immediately.

6.26 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.

Zone Control – Collision Prevention

Of Two Tiered Cranes

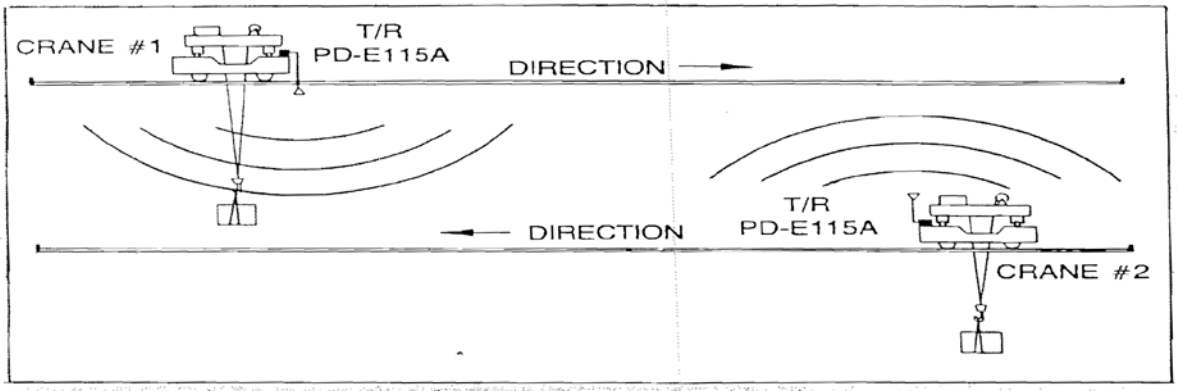


Fig. 3. TelTec being used to prevent collision of the upper crane's load with the bridge of the lower crane

COLLISION SYSTEM

1) Two transmitters, two receivers, one for each crane.
   A) Upper crane has #1 Receiver and #2 Transmitter.
   B) Lower crane has #2 Receiver and #1 Transmitter.

2) Both cranes must be energized for system to operate. SEE SIGNS ON WALL NEAR DISCONNECTS.

3) System is activated by lowering the hook on the upper crane, approx. 6 inches. This action applies power to both Transmitter and Receiver, on the upper crane.

4) System has three steps of operation.
   A) Slow down, Alarm - Approx. 30 FT. - constant bell sound.
   B) Creep Speed - Approx. 25 FT.
   C) Stop - Approx. 10 FT.
   D) These distances are not exactly the same for both cranes, due to slightly different amplifier gain, for the radio units.

5) TO RESET SYSTEM
   A) Crane can be driven in the reverse direction, to move away from the slow down and alarm settings.
   B) After stop is operated, the By-pass button should be held down, to provide Bridge operation.
   C) Opening the disconnect for the crane not being operated, will disable the entire system.

OPERATION SYSTEM
TELEMOTIVE

1) License required. Carrier signal present, whenever unit is reset.

2) Collapse of carrier frequency causes an Emergency Stop.

3) A dead battery will cause an emergency stop.

4) Blinking LED indicates charge level.

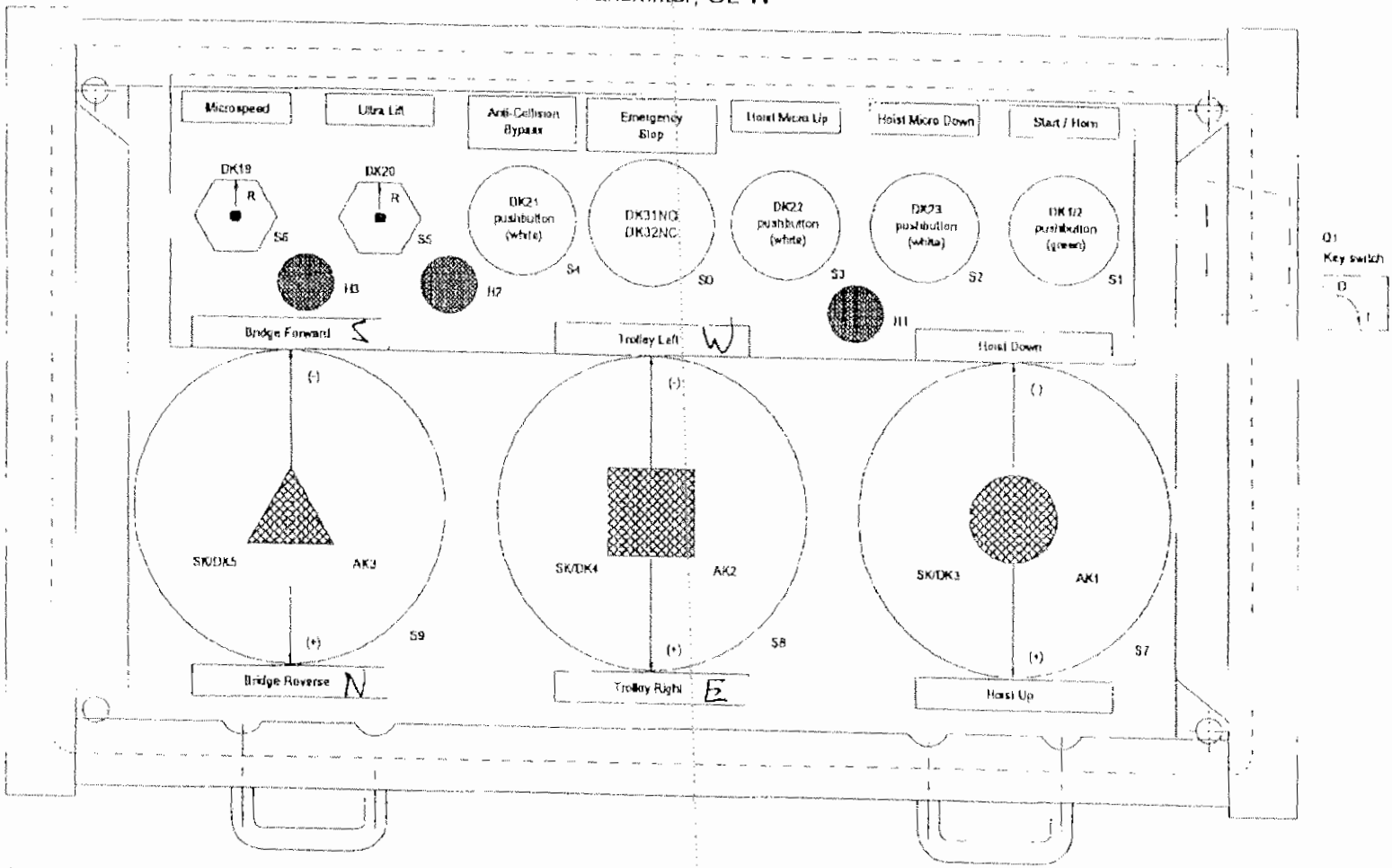
5) Battery saver in operating transmitter, but not the reset transmitter.

6) On Crane 29-1, the yellow light on the trolley with a "ding" sound indicates the crane control is reset.

7) Range is adjustable, up to 2500 FT.

8) Selector switches for speed of Bridge and Trolley, of lower crane, have been installed on the transmitter.

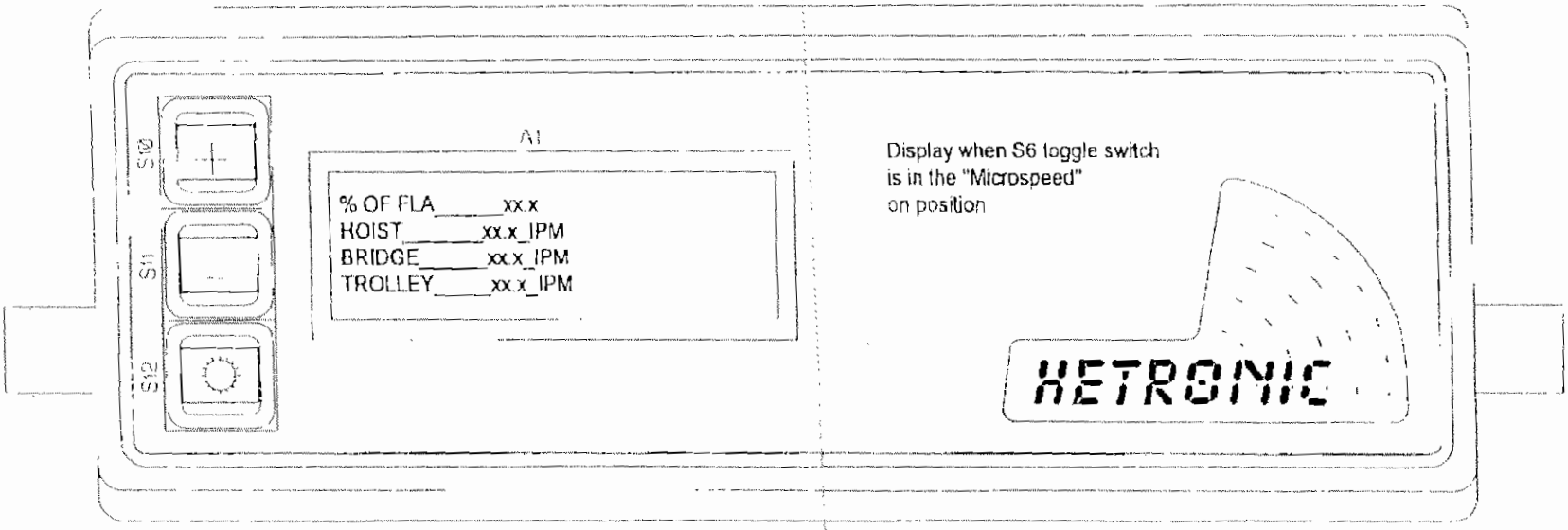
Transmitter, GL-W



T: momentary
R: maintained
S#: switch, joystick ID
H#: LED ID

CRANE 29-1

S10 & S11: Contrast control
S12 Illumination control



- The operator's transmitter consists 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 one minute between crane resets.)

  - Micro Speed selector - sets up the hoist micro speed selection.

  - Ultra Lift Selector Switch - provides a slightly faster than normal speed for the hoist

  - Normal Speed Selector - normal hoist speed.

  - 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.)

Radio Control - Crane 29-3

CAUTION - ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS "ON."

Crane 29-3 was revamped to provide radio control for the crane and Flux Vector Drive for the hoist.

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.

Radio Control - Crane 29-4

CAUTION - ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS "ON."

Crane 29-4 was revamped to provide radio control. The drive systems were not changed.

- The radio control system consists of two transmitters: the operator's transmitter and an Emergency Stop transmitter. Both must be ON to obtain a crane 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.

- The operator's transmitter consists of the following:

  - ON-OFF Switch (on the right side of the transmitter) - turn the switch "ON," a green flashing light indicates that the transmitter is in operation. Be sure to turn this switch OFF at completion of your job.

  - Reset/Horn Button - pushing this button resets the crane control and/or sounds a horn. A strobe light on the bridge indicates that the crane control is reset. (Note: allow at least one minute between crane resets.)

  - Emergency Stop Button - this is the 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.)

  - Joy Sticks - bridge, trolley, and hoist. Provides infinitely variable speed control to each motion.

  - 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.

EnRange Cranetronics Radio Remote System

Radio Training

Crane 15-4

CRANE 15-4 RADIO CONTROL
ROTUNDA (HCC) OF BUILDING 15

CAUTION - ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS "ON."

GENERAL SYSTEM INFORMATION AND OPERATION

The NASA crane control system consists of a hand held transceiver and a crane mounted transceiver. The hand held transceiver is referred to as the remote unit, and the crane mounted transceiver is the base unit. The smaller supervisor unit will be referred as the supervisor remote unit (E-Stop). All of these units exchange information between each other.

REMOTE UNIT

The remote unit is held by the crane operator. It lets the operator send manually inputted commands to the base unit. The commands could be the joystick functions or any of the push-button functions. The remote unit is turned on by a two position key switch. Once the unit is powered up, the unit goes through the initialization process. Next the main line contactor needs to be pulled in for crane operation. This is done by pushing the RESET button. For crane operation, a speed needs to be selected. The default speed mode selection is micro. Micro means the crane movements are in inches per minute (0-24 IPM). For faster crane movement, select the FULL button. The crane movements will be in feet per minute (0-21 FPM). The display on the remote unit shows the operator what speed the system is in. Other functions located on the remote are the low warning buzzer and the push/pull stop button. The stop button is pushed in to shut the system down. After a system power down, the system needs to be reset. To reset the system: 1) turn key switch to the OFF position, 2) pull the stop switch to the out position, 3) turn the key switch ON. The transmitter should start to initialize. Also shown on the display is the messages per second (M/S) readout. This is very important. Note that 3 to 8 M/S are required for communication. M/S less than 3 will not allow the E-stop transmitter to operate and will not stop the hoist.

SUPERVISOR UNIT (EMERGENCY STOP TRANSMITTER)

The supervisor remote unit is a small hand held unit that is used by the Emergency Stop Operator. This unit will have a display, a display toggle button, and a machine stop button. The display will show the same information the crane operator sees on the remote unit's display. On this unit, there is one 5/8" diameter push button. The green button will turn this unit on and changes the display to a different screen. The larger red button is the machine stop button. When this button is pushed in, it will shut down the entire crane system. The remote unit will then have to be reset (see remote unit section) for the system to work again. The operator will have to pull the stop switch out and press the green button to continue monitoring. NOTE: The supervisory unit (E-Stop Transmitter) does <u>not</u> need to be "ON" for general or noncritical lifts.

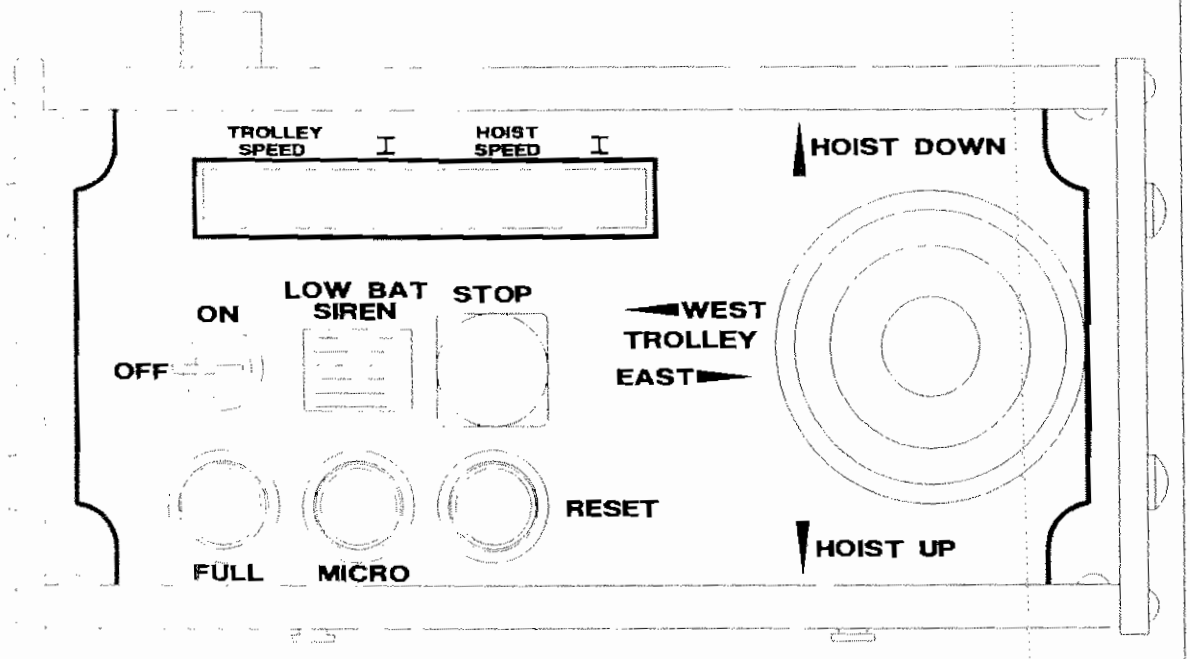
System Warnings!!!

Operators should be familiar with the following rules and warnings:

- Always be in visual contact with the crane before turning the radio ON.
- Range between the remote and the base can vary, but in ideal conditions maximum range could be 1 mile. The system could be operated outside the working area and out of sight.
- Never operate the base unit without an antenna. This could damage the output amplifier of the RF unit.
- Use supplied antenna (part no. 97115153). Any other antennae will violate Part 15 of the FCC rules.
- Make sure the Messages per Second (M/S) on the displays, both on the remote and E-stop transmitter show between 3 and 8 before operating the crane.

CHARGING THE REMOTE UNIT

- Located on the side of the remote unit is a charging jack. This jack will only mate to a connector found on the charger.
- The two battery charger connections put out 12.5VDC.
- The charger charges the remote unit at an 8 hour rate for up to 80% of the battery capacity. The remaining 20% is a trickle charge.
- When 8 hours of battery is used, the charger will take 8+ hours to recharge.
- Remote units can be left on the charger for an extended period of time (past the point where the battery is 100% recharged).



NOTE:
MESSAGES PER SECOND(M/S)
0-2 TROUBLE WITH COMMUNICATIONS
3-8 GOOD COMMUNICATION

TX STATUS DISPLAY WDG

TROLLEY SPEED	I	HOIST SPEED	I
BAT= ■■■■		M/S = 6	

MOTOR STATUS DISPLAY

TROLLEY SPEED	I	HOIST SPEED	I
000	00	000	00

COMMON POWER DOWNS

TROLLEY SPEED	I	HOIST SPEED	I
POW DOWN LOW BATT			

ACTIVITY TIMER EXPIRED

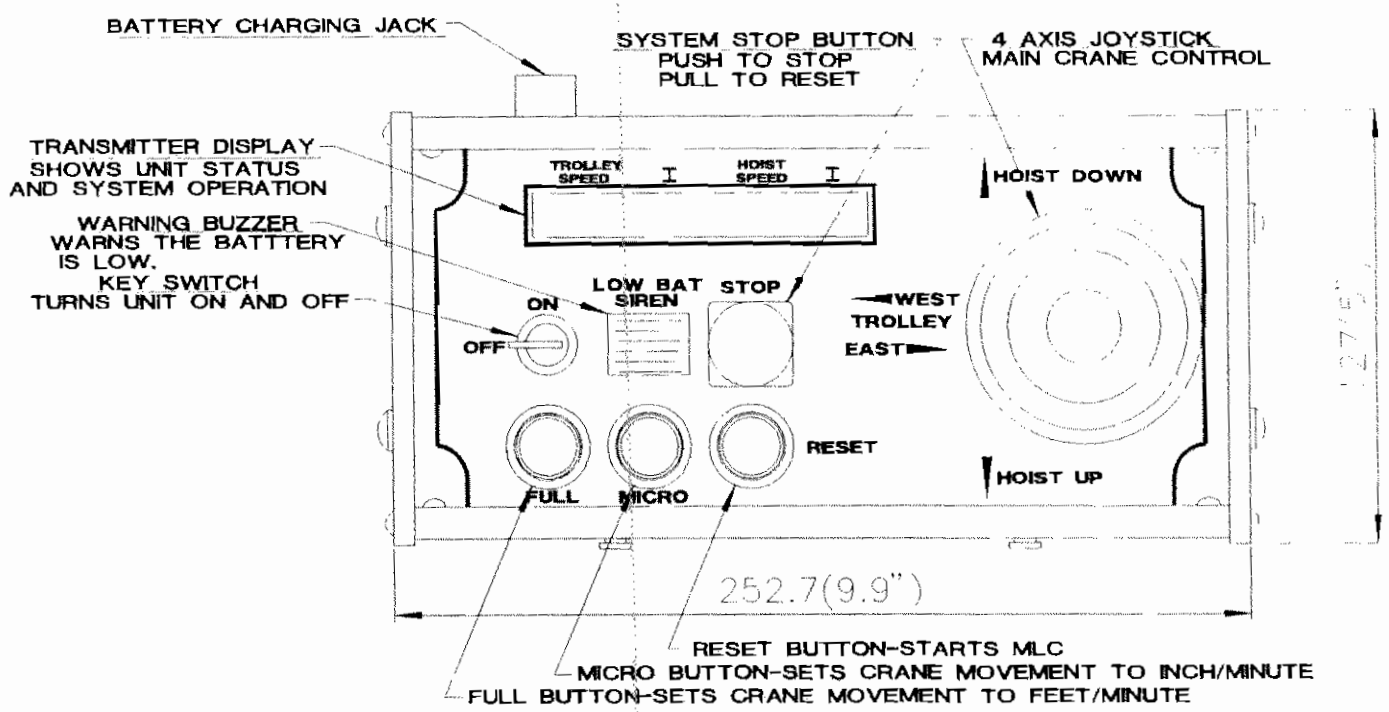
TROLLEY SPEED	I	HOIST SPEED	I
POW DOWN INACTIVE			

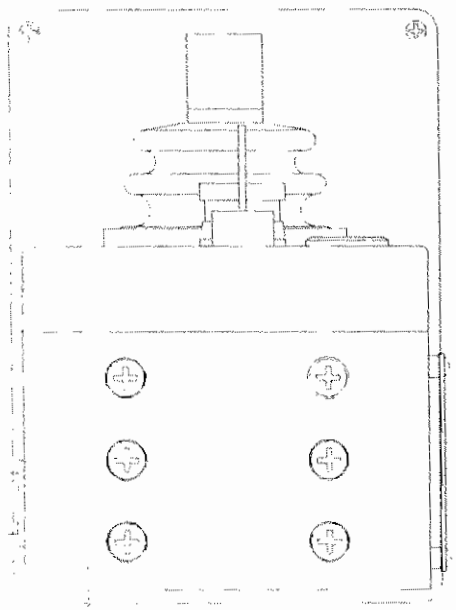
STOP BUTTON PUSHED

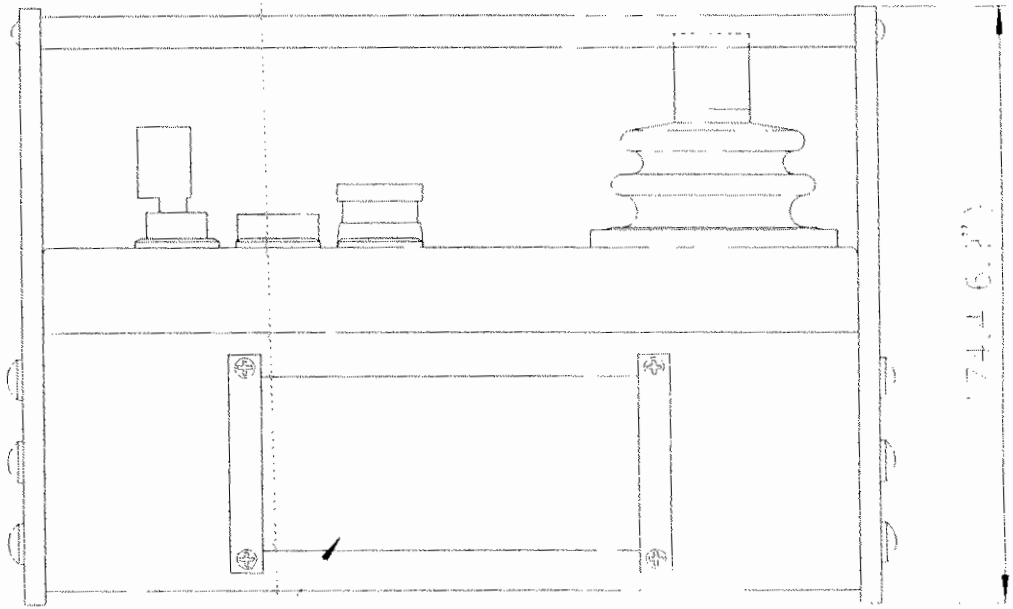
TROLLEY SPEED	I	HOIST SPEED	I
POW DOWN COMMAND			

NOTE:
-WHILE IN MOTOR STATUS DISPLAY,
I IS IN UNITS OF AMPS.
-SPEED IS IN UNITS OF IN./MIN. IN MICRO MODE
-SPEED IS IN UNITS OF FT./MIN. IN FULL MODE

TYPICAL TRANSMITTER DISPLAY

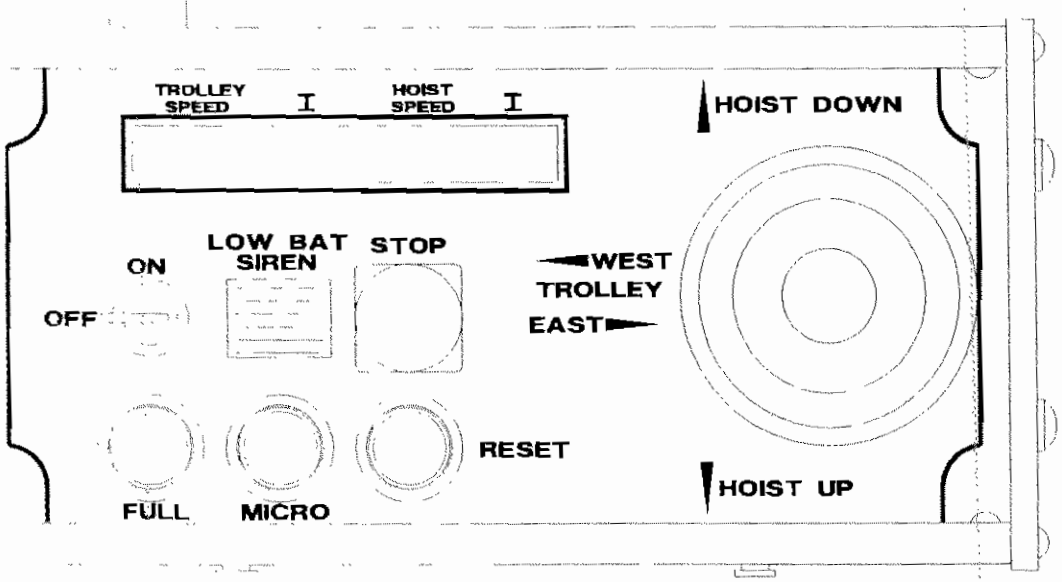






2" WAIST BELT MOUNTING

GENERAL TRANSMITTER LAYOUT
SHEET NO. 1



1.) For transmitter start up:
-To power transmitter turn key from off to on.
-Wait while the transmitter initializes. Watch the display screen for any errors.
-Verify messages per second (M/S>0)

2.) To start the main line contactor
- Press the RESET button to bring in the M.L.C..
- This will put power to the motor control drives

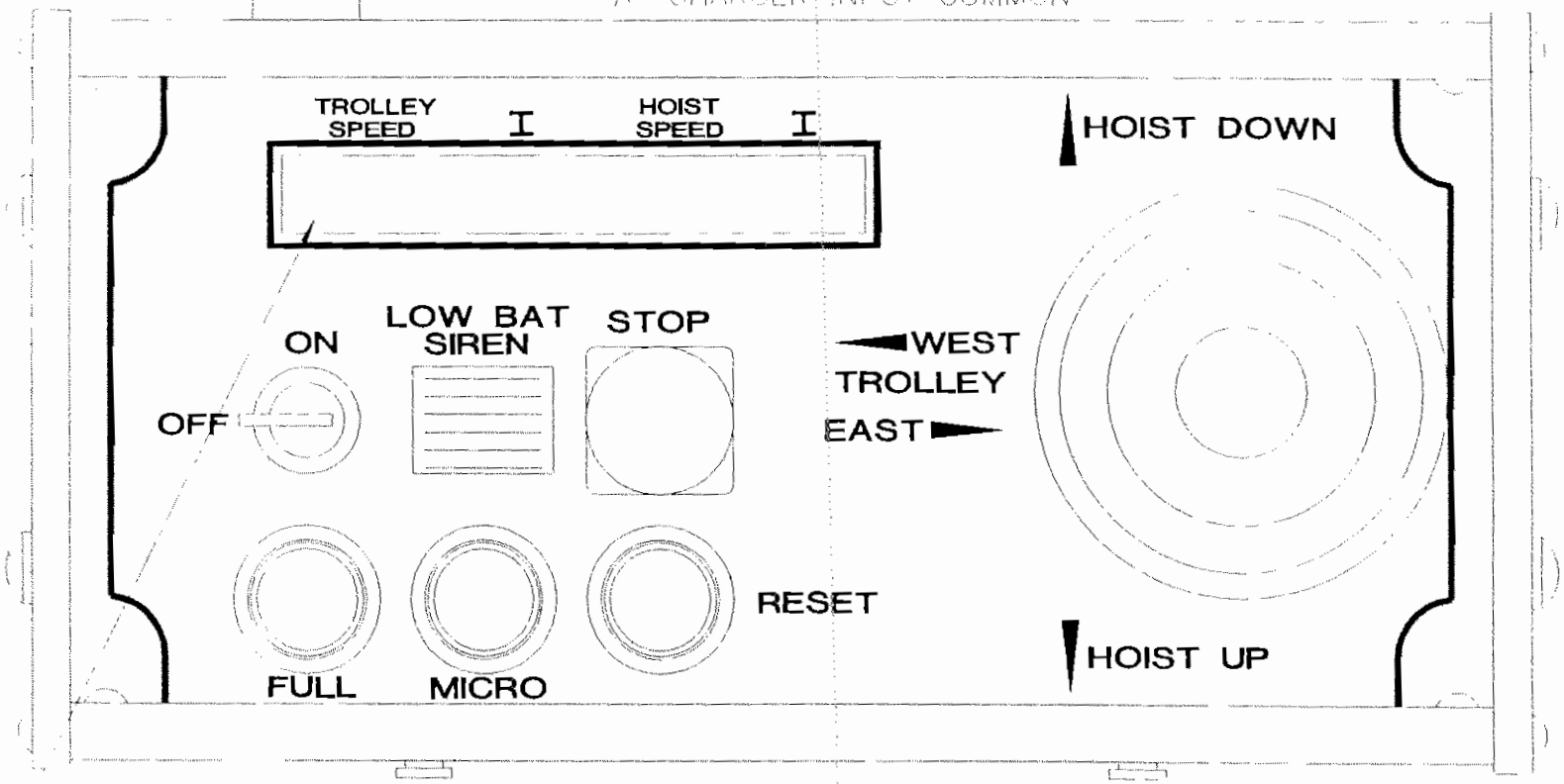
3.) Selecting a speed for operation
- Micro(in/min.) is the default setting
- Select FULL button to select full mode(ft/min.)
- Select MICRO button to go back to the micro mode.

4.) Joystick operation:
- Joystick functions are hoist up and down, trolley east and west. West is to the operators left. East is to the operators right.
- Only one direction will operate at a time. Operation will consist of a hoist operation, or a trolley operation. Not both simultaneously.

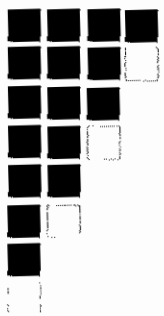
5.) The STOP button:
- Operated by pushing in. Listen for cliick. This will power down the transmitter (PWR DWN COMMAND).
- To reset: Turn key to off position. Pull out stop button. Turn key on to restart transmitter.
- This step can be used for other power down errors.

6.) Battery Note:
- Allow batteries to run out of power before recharging
- This will extend the operation life, and battery life.
- Batteries can be charged through the charging jack, or they can be removed from the bottom and replaced or charging directly.

BATTERY CHARGER CONNECTION
"B" POSITIVE CHARGER INPUT
"A" CHARGER INPUT COMMON



BATTERY DISPLAY SCREEN:
LEVELS OF BATTERY INDICATION

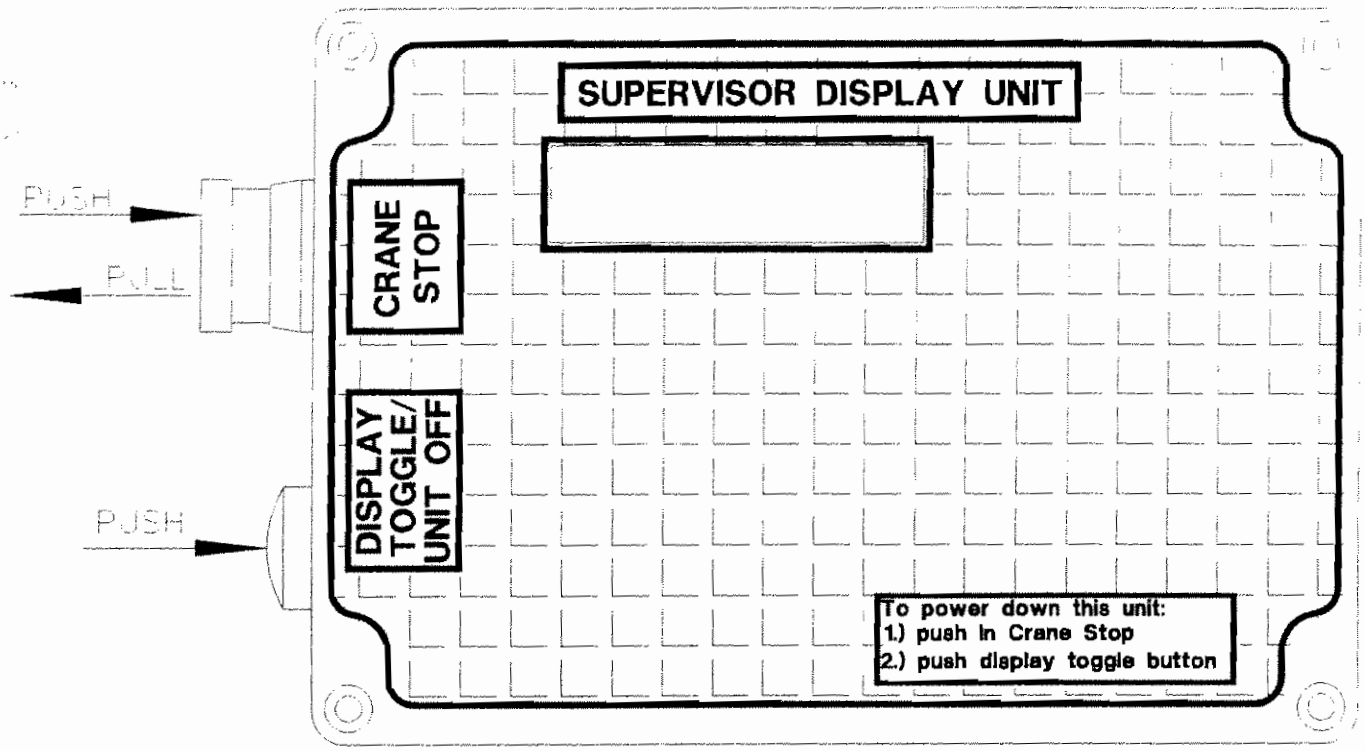


FULL POWER
7/8 POWER(LAST SQUARE BLINKING)
3/4 POWER
5/8 POWER(LAST SQUARE BLINKING)
1/2 POWER
3/8 POWER(LAST SQUARE BLINKING)
1/4 POWER
1/4 POWER(1/2 HOUR BAT. LIFE LEFT)

BATTERY STATUS SIREN:
BEEPS AT 1/4 POWER
CONTINUOUS BUZZ AT 1/8 POWER
(1/2 HOUR WARNING!!!)

BATTERY POWER INFORMATION

E-STOP TRANSMITTER



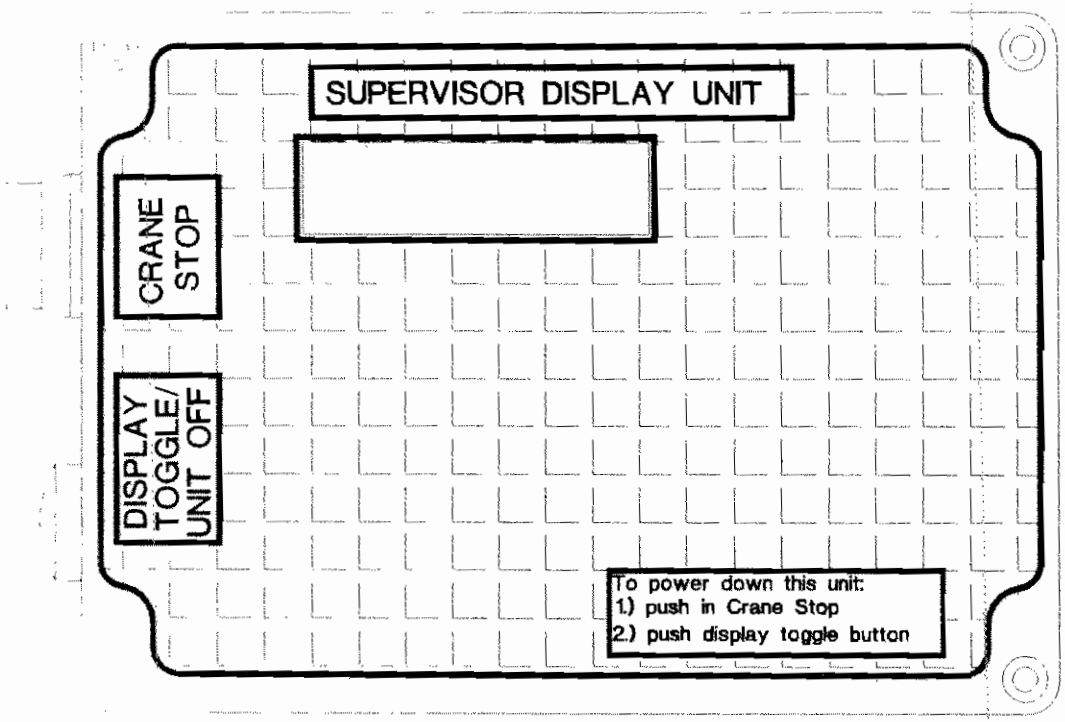
This unit is used for supervison over the base unit of the crane control system. **When necessary for critical lifts.**

To power the unit up:
1.) Pull out the CRANE STOP switch. This now allows this unit to control over the base unit.

To stop the base unit:
1.) Push in the CRANE STOP button. This will freeze the base unit operations.

To reset the system after the crane has been stopped.
1.) With the crane stop button pushed in, press the DISPLAY TOGGLE/ UNIT OFF. This will power down the supervisor unit.
2.) Pull out the CRANE STOP button.
3.) The unit will turn on.

E-STOP TRANSMITTER



Communication Notes:
Messages per second - M/S=xx
0-2 = trouble with communciations
7-8 = good communications

ONLINE W/BASE
BAT=□□□□ M/S=08

1.) Communication established with base unit
- Battery power at full strength
- communication is good with 8 messages per second

NO COMS WITH BASE
BAT=□□□□ M/S=00

2.) No communication established with base unit
- Base unit could be turned off
- Internal RF problems

TROLLEY EAST (8) □
000 FT/MIN I=1.5

WDog signal
flashing=OK
solid-Reset System

3.) Trolley east direction selected by base unit.
- 8 meassages per second
- watchdog processor indication
- speed indication in feet or inches per minute
- Current output 1.5 amps.

HOIST DOWN (8) □
000 FT/MIN I=12

4.) Hoist down direction selected by base unit
- 8 meassages per second
- watchdog processor indication
- speed indication in feet or inches per minute.
- Current output= 12 amps.

TYPICAL SUPERVISOR DISPLAYS
971b5009 ISS.1

Cattron Radio Remote System

RADIO TRAINING

Cranes 15-5 / 15-6 / 15-7 / 5-20

NO FCC LICENSE REQUIRED

CATTRON INCORPORATED

PRODUCT DATA

CAT 804 CAT 808 CAT 812 EZ™ RADIO REMOTE CONTROL SYSTEMS

HIGH PERFORMANCE, LOW COST SYSTEM FOR CONTROLLING INDUSTRIAL EQUIPMENT RELIABLY, SAFELY, EFFICIENTLY BY RADIO REMOTE CONTROL

The new EZ non-engineered off the shelf product line is EZ to install, EZ to maintain, and EZ on your budget. This group of products was taken directly from the already proven reliable CAT-800 Series of radio remote controls, packaged to allow "off-the-shelf" delivery and designed to go straight to the job with no FCC license required. All CAT-800 EZ models are micro-computer based, have high digital message security, and employ both system address and BCH error detection to assure safe, reliable control in harsh industrial environments.

KEYPAD TRANSMITTER/ ENCODER CONTROL UNIT

The Keypad control transmitter is a rugged, lightweight, ergonomically designed unit that controls four, eight, or twelve operator commanded functions any time the corresponding function pushbutton is pressed. Additionally, one ON/OFF command is sent whenever any function is active. Internally a micro-computer performs self-diagnostics and controls the RF transmitter upon demand. The rugged elastomer keypad has large keys, with tactile "feel", protected by a raised grid which helps prevent inadvertent operation. Each key is identified by function specific labels. Battery life is very long, approximately 240 hours. Nicad rechargeable batteries are optionally available with 80 hours between charges. In normal operation a green LED "winks" with each function command message and a beep is sounded when a key is pressed. When the battery voltage becomes low, the green LED will change to red, alerting the operator that approximately 30 minutes of transmit-time remains. A short external antenna connected to the pulsed RF transmitter provides the maximum FCC allowable signal strength for unlicensed operation. All commands respond within 40 milliseconds of pressing a key and are absolute functions: that is, a positive on command is sent when the key is pressed, as well as a positive off command when the key is released.

RECEIVER/DECODER

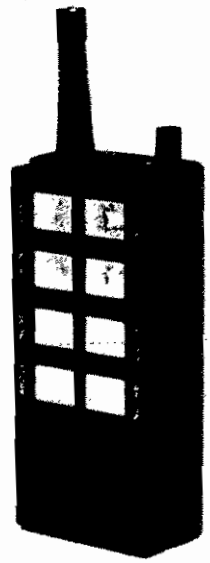
The receiving and decoding hardware, along with the relay interface, is housed within a compact NEMA 12 steel enclosure. The RF receiver, decoder, and power supply circuit boards are housed in a sub-chassis which provides EMI shielding and isolation from the output relay interface. The sub-chassis also provides an EZ way to change all of the electronics should a repair be required. The decoder makes extensive use of the micro-computer's self diagnostic capabilities by using a two character display to show system status. The output interface to the machine is handled by plug-in relays rated for heavy industrial loads, both resistive AND inductive. Each relay has two screw terminals, an output fuse, and an LED indicator showing when it is on. A secondary contact on each relay is used by the decoder to sense and verify each of the radio transmitter commands. Should a fault condition be detected, the Operate Relay and all outputs will be disabled. Automatic Safety Override (ASO) is a safety feature in all Cattron systems.

INSTALLATION

The CAT 800 EZ group is EZ to install. Each transmitter button is a function. Any or all functions can be sent at any time. Each output can go to a separate circuit or to a common circuit. Function One is connected to relay One, etc. After wiring, the transmitter is labeled as required.

FEATURES

- No F.C.C. license required
- Four, eight, or twelve output functions, plus On/Off (Operate/E-stop)
- Low cost
- High message security
- Power-on self-diagnostics
- Multiple watchdog timers
- Automatic Safety Override on every function (Output verification)
- Microcomputer-based encoder and decoder
- Proven 800-Series reliability
- Large elastomer keypads
- Made in U.S.A.



CAT-808 EZ

CATTRON INCORPORATED

CAT 804 CAT 808 CAT 812 EZ™ TAB 5 TRANSMITTER DESCRIPTIONS AND OPERATING INSTRUCTIONS

RADIO CONTROL OPERATOR'S DUTIES

THIS IS A GUIDELINE FOR RADIO CONTROL OPERATION OF A CRANE, AND IS NOT INTENDED TO SUPERCEDE ANY PLANT OPERATING PROCEDURES.

1. Prior to lifting any loads, the following should be completed:

   a. Place a fully charged battery into the control transmitter.

   b. The transmitter should be checked for obvious defects (broken case, missing parts, etc).

   c. Activate power on switch.

   d. Depress alarm/reset. (optional)

   e. Check each motor function independently in both directions to be sure the crane is responding correctly.

   f. Where a limit switch is provided, the operator will check the limit switch at the beginning of each shift.

   g. Check brake operations.

2. Persons operating this equipment must report to the foreman any defective or missing safety equipment, mechanical or electrical defects without delay. Do not continue operation until fully repaired.

3. When raising or lowering a load, proceed slowly and make certain the load is under control.

4. When lifting maximum load, the person operating the equipment shall test brakes by raising the load a few inches from the floor. If the brakes will not hold, the load shall be immediately lowered and not moved until brakes are adjusted or repaired.

5. The Trolley shall be centered directly over the load before starting to hoist.

6. Side pulls should be made only under the direction of the foreman. Since this will cause a dragging or sliding motion, the operator shall not position themselves in the line of travel.

7. Take slack out of the chains or slings gradually and make sure hands and other objects are clear before making the lift.

8. Keep all parts of the body away from the lifts. Also, do not stand under a lift.

9. Do not make a lift or move the equipment if anyone is in a position to be injured.

10. Load should **not** be carried over workmen's heads.

11. If anyone is in the path of travel, stop and sound the alarm before proceeding.

12. Do not drag slings, chains, etc. along the floor.

13. Persons operating this equipment shall not use a limit stop as a utility stopping device.

14. Bumping other cranes or run-away stops is prohibited.

15. When moving the equipment to the loading point, be sure that hook block, attachment, or cables will not fall on the adjacent equipment.

16. When leaving the crane area for any reason, be sure slings or chains are raised and the transmitter is turned off, both by the center main contact switch and the key-lock switch.

17. Do not allow any unauthorized person to operate the Radio Control unit.

18. Do not operate the Radio Control unit from a distance where the crane and all of the surrounding objects are not visible.

19. Do not place the transmitter in an area that it may be tampered with.

20. UNDER NO CIRCUMSTANCES should an operator override any of the safety features built into the Radio Control system.

21. If for any reason should anyone go aboard a radio controlled crane, the transmitter should be turned off and carried with him, or placed where no one will be able to engage the crane.

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KEYPAD TYPE HAND-HELD CONTROL TRANSMITTER
CAT-800 SERIES
MODEL 816-15

TRANSMITTER OPERATOR INSTRUCTIONS

1. INTRODUCTION

The standard control transmitter is a light-weight hand held unit with 4, 8 or 12 momentary switches on a single keypad, plus a separate emergency stop pushbutton, to provide remote control of the equipment. It contains basic control functions as well as some auxiliary functions, depending on the system application. It is hand carried with an optional belt clip, and is powered by a single disposable or rechargeable battery pack.

2. BASIC CONTROL FUNCTIONS

a. The on/off switch turns the power on and off to the control transmitter and sets the volume for the "click". No transmissions occur until a button is depressed and all transmission ceases when the button is released (5 seconds max). When transmitting with a good battery a beep will be heard any time a button is pressed, or released and the LED on top will blink green for each data transmission. If the battery goes low the green LED will switch to blinking RED for about 30 minutes before going so low that power is removed from the electronic circuits.

b. Function Control Switches are identified on the side of each keypad, and operate the functions as labeled. All operations are momentary and must be maintained by the operator. Release of the pushbutton will de-energize the corresponding function and turn off the transmitter within 5 seconds. A beep will be heard for each push of a function.

c. The Belt Clip, allows the unit to be carried at the waist of the operator.

3. ALKALINE BATTERY REPLACEMENT/BATTERY CHARGING (OPTIONAL)

A single alkaline battery pack or rechargeable Ni-Cad battery pack provides power for the CAT 816-15 keypad transmitter. This battery is located inside the transmitter housing under a removable cover for battery removal and charging. This can be accomplished by sliding two clips upward and removing the cover. Replace the pack and drop the battery into the charger and observe that charging light comes on. 16 hours charge is adequate but no damage will occur if the battery is left in the charger for a longer period.

Batteries should be charged or replaced after the low battery indicator has begun to flash red. This would be typically several days after the batteries were placed in service, because CAT 800 series greatly reduces a battery consumption by its' designed battery conservation cycle, and the automatic power off feature when left idle for 5 minutes

Battery life is normally expected to be approximately 80 hours of continuous operation with Ni-Cad's and 240 hours with disposable alkaline packs.

4. OPERATING PROCEDURE

Place the keypad type transmitter in a comfortable position in your hand and rotate the power switch. If the key "click" sound is not desired, continue rotation to the mute position. This applies power to the transmitter unit but does not send any command at this time. Next, press the alarm function or any function desired. This will send a "power up" message to the decoder. The transmitter is now turned on, as indicated by the blinking green LED. The corresponding equipment mounted decoder will respond by the main contactor of this equipment energizing. With the mainline contactor energized, operate the motor control switches and auxiliary function switches as required, remembering that the push-button must be maintained in order for the function to continue to operate. Example: if North speed 2 is desired, both North and 2 must be depressed and maintained for continued operation. Any or all functions may be operated simultaneously if the controlled machine permits such operation. The mainline contactor (OPR) will stay energized for 10 minutes after release of the last function commanded. ASO will monitor the output relays and disable the mainline contactor if an output relay fault is recognized.

Emergency stop can be commanded by pressing the emergency stop activator on the side of the keypad controller. This will drop the OPR relay instantly, which in turn should drop the equipment mainline contactor. E-Stop should be presssed before turning the transmitter power switch off at the conclusion of operation.

5. BATTERY SAVING FEATURE

The keypad controller uses a micro-computer to send digital data and control the RF transmitter as well as manage the battery consumption.

This unit will automatically turn off transmit power after all function keys are released. After this time (5 seconds) the keyboard remains alert and if a key is pressed the transmitter will turn on again. If the keyboard is inactive for more than 15 minutes a deeper "sleep" is implemented. After this time the power and on/off switch must be cycled on and off before pressing a key switch.

To store the unit the power on/off switch must be turned off.

TRANSMITTER MODEL 816-15 + 2

This model is operationally and physically the same as the standard keypad and control transmitter with one exception; the control transmitter is capable of second speed operation with a single button depressed. Here's how it works: if a forward command is

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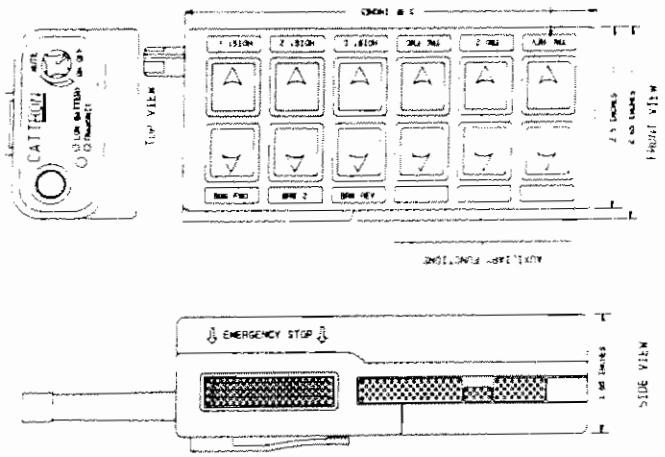
pressed, the output relay for forward is closed and the crane typically will move in first speed. If you press the speed two button for that motor, either while holding forward, or within two seconds of releasing forward, both the speed relay output and the forward output will be energized (by pressing and holding only the speed two function.) The push buttons on this transmitter have been pre-assigned for this two speed operation. Refer to the drawing below for this configuration.

Notice that while the last command direction is held "memory" for two seconds after the button is released, the direction output does not continue to run for this period. If you press speed two after waiting more than two seconds only the speed two output relay will energize.

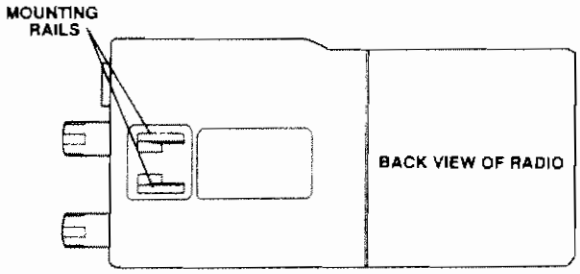


KEYPAD CONTROL TRANSMITTER DISASSEMBLY/REASSEMBLY

Refer to the accompanying diagrams while disassembling and reassembling the radio.

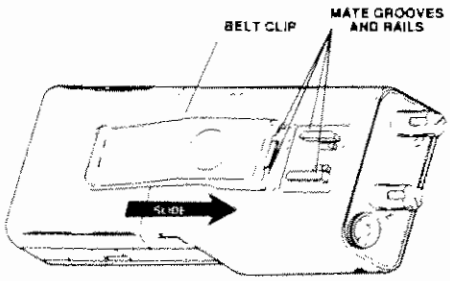
To attach the belt clip to the radio:

1. Locate the mounting rails on the back side of the radio.



(LOCATING MOUNTING RAILS)

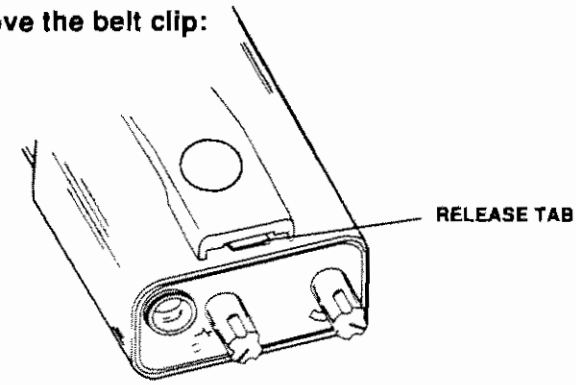
2. Position the belt clip, so the fastener end of the clip is nearest the mounting rails, and the other end of the clip is over the battery compartment.



(LOCATING GROOVES AND RAILS)

3. Align the mounting rails with the grooves in the belt clip. Slide the belt clip onto the mounting rails until it latches into place (indicated by a click).

To remove the belt clip:



(LOCATING RELEASE TAB)

1. Locate the belt clip release tab on the underside of the belt clip

2. Lift the release tab by inserting a key or coin between the release tab and the back surface of the radio.

3. While holding the key or coin firmly under the release tab, pry up until the belt clip slides slightly toward the battery compartment.

CATTRON INCORPORATED

RECOMMENDED SAFETY RULES FOR RADIO CONTROLLED CRANES

These are not necessarily intended to supersede rules or regulations of our customers, or any applicable local, state or federal government organizations. The information contained herein is based on data gathered from various users of radio crane control in this country and abroad.

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SAFETY RULES

1.00 PREFACE

1.01 Radio controlled overhead travelling cranes operate in three motions. They are large, bulky pieces of equipment that handle heavy loads efficiently at comparatively high speeds. Quite frequently they are operated in restricted areas where workmen are engaged in various tasks on the floor below. Under these conditions extreme care must be used by crane operators using radio control, and workmen must be constantly on the alert if accidents are to be avoided.

1.02 Following are rules, assembled and issued to you to indicate how your careful and thoughtful actions may save a life or prevent damage, protecting yourself and your fellow workmen.

1.03 These rules cover cranes when they are on radio control. If a radio crane is operated on cab control, special care must be taken to secure the Radio Control box (transmitter.)

2.00 PERSONS AUTHORIZED TO OPERATE RADIO CONTROLLED CRANE

2.01 Only employes designated by management shall be permitted to operate such equipment and only after they have been properly trained.

2.02 Management shall insure that the correc. transmitter to operate the crane is selected and that any spare equipment capable of crane control is secured.

2.03 Such equipment shall not be operated by any persons who cannot read and understand the signs, notices and operating instructions.

2.04 Such equipment shall not be operated by a person with seriously defective eyesight or hearing, or who may be suffering from a disease which may cause physical failure.

3.00 TRAINING CHECK LIST FOR OPERATORS OF RADIO CONTROLLED CRANE.

OPERATORS MUST:

3.01 have knowledge of hazards inherent to crane operation.

3.02 have knowledge of safety rules for radio controlled cranes.

3.03 have the ability to judge distance to stationary objects.

3.04 have knowledge of the radio control box (transmitter).

3.05 have performed limit switch test procedure.

3.06 have instructions as to plugging of crane motions where authorized.

3.07 observe signal lights on crane.

3.08 avoid striking any obstructions in the building.

3.09 check for proper clearance of lifts or hooks before moving bridge or trolley.

3.10 provide proper storage space for radio control box when not in use.

3.11 have knowledge in transferring radio control box to another person

3.12 report unsafe or unusual operating conditions.

3.13 use caution in approaching bridge or trolley bumpers.

3.14 have knowledge of the capacity of the equipment.

3.15 keep body clear of lifts, avoiding "pinch" points.

3.16 inspect cables and hooks.

3.17 be familiar with the procedure for testing hoist, trolley and bridge brakes.

4.00 THE OPERATING AREA FOR THE RADIO CONTROLLED CRANE

4.01 Unobstructed aisleways between equipment, stock, etc. should be maintained for the radio controlled crane operator's movement. These aisleways should be a minimum of 3 feet wide or per local regulations.

4.02 The radio controlled crane operator shall always position himself for the best view of the crane he is controlling. He shall never operate the crane blindly. He should always keep the crane and load in his sight and stay as close as possible to the crane load. He should never position himself or others in a "pinch" point.

5.00 THE RADIO CONTROL BOX (TRANSMITTER)

5.01 On some transmitter units the motion switches on the radio control box are spring return to off. The push-to-operate bar acts as a guard for these switches to prevent accidental movement of the switches. These switches or the PTO bar shall never be mechanically blocked in any ON position.

5.02 Using the appropriate on/off switch the radio control box shall always be turned off when the box is not in use. (When present the key lock shall also be turned off.)

5.03 A prescribed storage space shall be provided for the radio control box. The radio control box shall always be placed there when not in use. This precaution will prevent unauthorized people from operating the radio controlled crane.

5.04 Turn the transmitter off using the appropriate on/off switch when the operator is putting on or taking off the control box and belt assembly. (When present, the key lock shall also be turned off.)

5.05 The control transmitter will **always** be turned off when not in actual use.

6.00 OPERATING THE RADIO CONTROLLED CRANE

6.01 The crane limit switch shall be checked at the beginning of each turn or when a new operator takes control of the crane. While checking the limit switches, the hoist should be centered over an area free of personnel and equipment so that if the limit switches fail and the hook and block assembly falls no one will be injured or no equipment will be damaged.

6.02 The limit switch shall never be used as a regular stopping device. They are intended to be protective devices only.

6.03 The bridge and trolley brakes shall be tested at the beginning of each turn or when a new operator takes control of the crane. They should be tested with the bridge and trolley at low speed.

6.04 When lifting maximum loads or loads near maximum, the operator shall test the hoist brakes by raising the load a few inches for the floor. If brakes do not hold, load shall be immediately lowered to the floor and a report made to the supervisor.

6.05 Do not make lifts in excess of the rated capacity of the equipment. Consult your supervisors for the exceptions.

6.06 When making lifts, the bridge and trolley shall be centered directly over the load to prevent swinging when the load is raised.

6.07 Side pulls shall be made only with permission of the supervisor. When such a lift is being made the operator shall not position himself in the line or path of travel of the load, but shall operate the crane from a position either to the side or to the opposite of the line of travel.

6.08 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 chains or slings gradually. Make sure all persons are clear before making a lift.

6.09 Crane operator shall keep all parts of his body away from the lift and shall never position himself under the lift.

6.10 Do not make a lift or move the crane if anyone is in a position to be injured.

6.11 If the radio control crane operator is being helped he shall not move the crane until he has received a signal from his helpers that they are in the clear.

6.12 Loads shall not be carried over workman's heads.

6.13 If anyone is in the path of travel, the radio control crane operator shall stop and clear the area before proceeding.

6.14 Bumping into runway stops or into other cranes on the same runway is prohibited.

6.15 When moving the crane the radio control crane operator shall be sure that the hook block, attachment or cables will not foul on nearby equipment.

6.16 The radio control crane operator shall not drag slings, chains, etc. along the floor. They could snag on something causing the cables to break and to strike the operator or a fellow workman, causing serious injury.

6.17 Where gloves are not required for more compelling safety reasons, they shall not be used when operating the radio control box.

6.18 All loose material or parts shall be removed from the load before starting the lift. Such material can fall, striking people below.

6.19 The radio control crane operator shall hoist lifts high enough to clear all apparatus and workman below the crane.

6.20 Plugging shall not be used as a regular means of stopping the crane. Plugging is intended for emergency stops only, except when authorized by plant supervisor. Caution should be used when plugging with the radio control box.

6.21 If the radio control crane operator is asked to do something he believes unsafe, he shall call his supervisor for advice.

6.22 The radio control crane operator shall never permit anyone to ride on the load or hook except when authorized by his supervisor.

6.23 When another crane on the same runway is stationary with or without a load, the radio control crane operator shall maintain a safe distance between cranes.

6.24 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.

6.25 The radio control crane operator shall stop operation and turn off the appropriate on/off switch on the radio control box if his crane fails to respond correctly. He should report the condition to his supervisor immediately.

6.26 Outside cranes, subject to movement by winds, storms, etc. shall be securely anchored when left unattended. If the crane is equipped with bridge brakes, the parking brake should be set.

Radio Control of Crane #5-20
Building 5, Truck Lock

CAUTION - ALWAYS BE IN VISUAL CONTACT WITH THE CRANE WHEN THE RADIO IS "ON."

Radio Controller

The radio controller consists of an on/off switch, direction/hold push buttons, acceleration and deceleration push buttons, and an Emergency Stop push button. The on/off switch must be on for crane operation. The direction/hold button provides a direction and a speed hold function. The acceleration and deceleration button changes the speed of the motion to the desired setting. When all buttons are released, the motion will come to a stop. The Emergency Stop button on the side of the controller will stop all motions. After using the Emergency Stop button, the controls must be reset by turning the on/off switch to the off position and then back to the on position. At the end of the operation of activity, push the Emergency Stop button to deactivate the control panel, then turn the on/off switch to the off position.

Main Disconnect

The main disconnect is located in control panel P.P.G-U21 at the south side of the Truck Lock building and is labeled 5-20.

Traverse Motions

Select the direction desired and press the directional hold push button. This push button provides the direction and the hold speed function when the motor is at the speed the operator desires. To accelerate, press and hold the accelerate push button associated with the direction/hold push button. The crane motor will start to accelerate in the selected direction. (NOTE: It may be necessary to press the accelerate push button to provide enough torque to move the hoist.) When the desired speed is reached, release the acceleration push button and the crane will run at the desired speed. To increase the speed, press the acceleration push button once again. The crane motor will accelerate until full speed is reached or the acceleration push button is released. To decelerate, release the direction/hold and acceleration push buttons. The crane motor will decelerate to zero speed or will maintain a selected slower speed if the forward direction/hold push button is depressed before the motor stops.

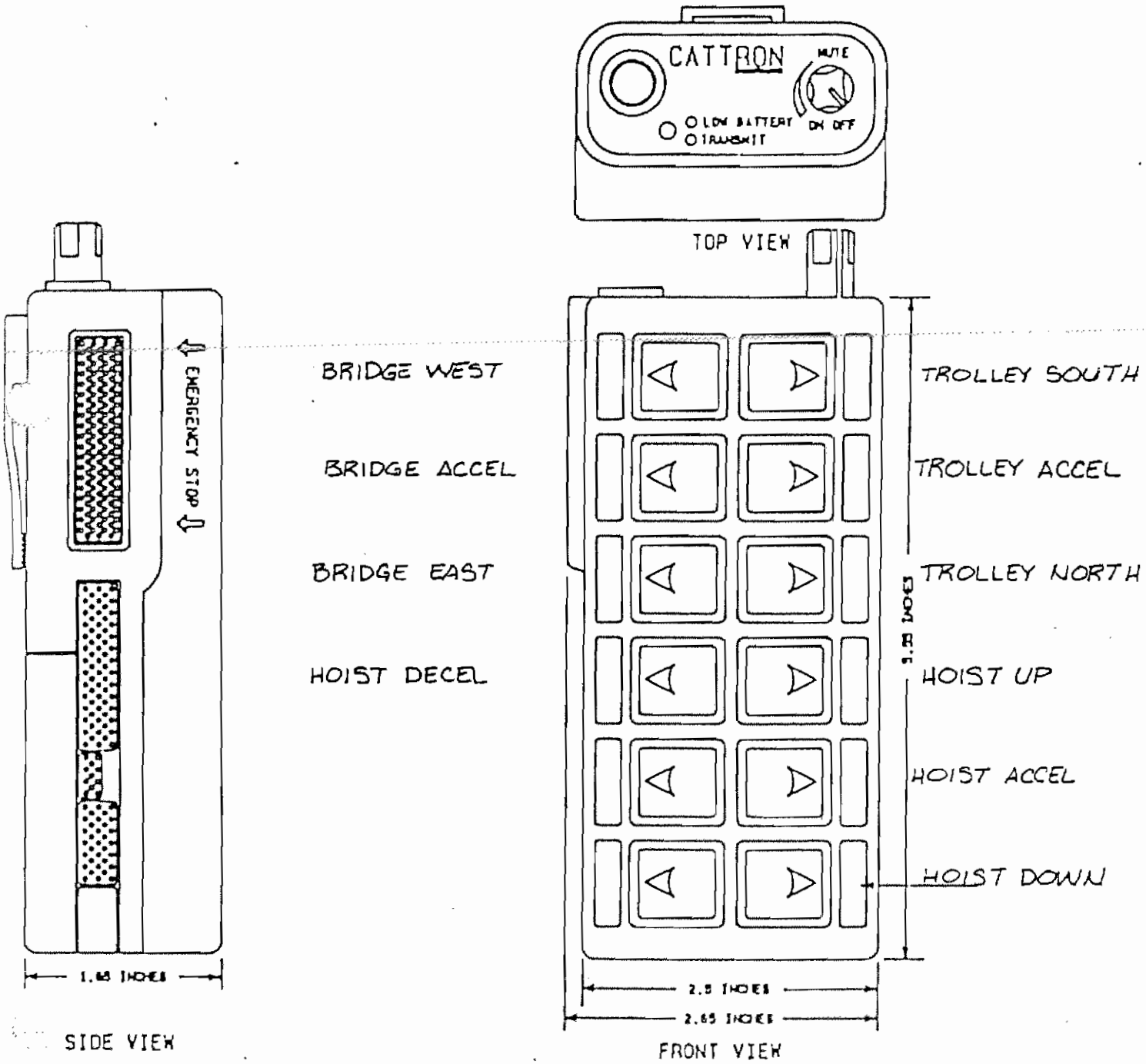
Follow the above procedure for the reverse direction.

Hoisting Motions

Select the up direction and press the up direction/hold push button. This push button provides the up direction and the hold speed function when the motor is at the speed the operator desires. To accelerate, press and hold the accelerate push button associated

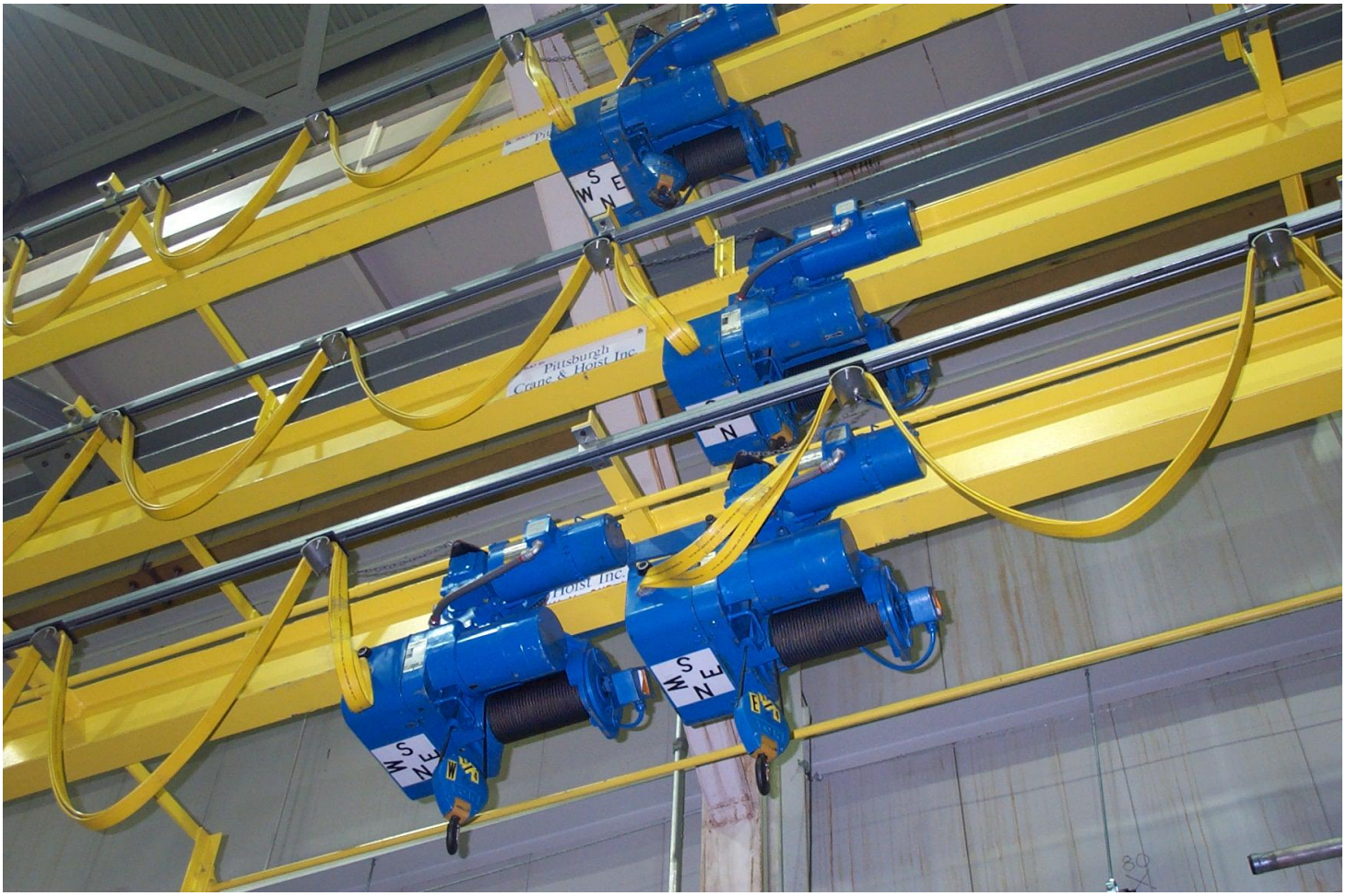
with the up direction/hold push button. The crane motor will start to accelerate in the up direction. When the desired speed is reached, release the acceleration push button. The crane motor will run at the desired speed. To increase the speed, press the acceleration push button once again. The crane motor will accelerate until full speed is reached or the acceleration push button is released. To decelerate, press the decelerate push button until the desired speed is obtained. To stop, release the up direction/hold and acceleration push buttons. The crane motor will decelerate to a Stop and the brakes will be applied.

Follow the above procedure for the down direction.


CATTRON
MUTE
LOW BATTERY
TRANSMIT
ON OFF
TOP VIEW
EMERGENCY STOP
1.65 INCHES
SIDE VIEW
BRIDGE WEST
BRIDGE ACCEL
BRIDGE EAST
HOIST DECEL
TROLLEY SOUTH
TROLLEY ACCEL
TROLLEY NORTH
HOIST UP
HOIST ACCEL
HOIST DOWN
5.25 INCHES
2.5 INCHES
2.65 INCHES
FRONT VIEW

Bldg. 15 Modal Survey

Cranes 15-5 /15-6 / 15-7



Operating Procedure for the Building 15 Modal Facility Cranes

1.0 Introduction and General Information

This operating procedure applies to the three remote cranes in the Modal Testing Facility in the northeast corner of the Building 15 high bay. The cranes are known as 15-5A & 5B, 15-6, and 15-7. For clarity, the cranes will simply be called 1, 2, & 3. Crane 1 (15A & 5B) actually has two hoists connected to the same bridge, but both are grouped together as one crane.

The main disconnect switch and documentation for all three cranes are on the north wall of the high bay. In addition, individual power switches for each crane and a selector dial are located on the northwest corner of the Modal Facility. The selector dial allows the user to choose which crane the remote control unit will operate. See Figure 1 for a top view of these locations. The operating area of the three modal cranes is outlined in dotted lines in Figure 1.

Each crane is rated to lift 1000 lbs. safely. These cranes are designated "Mission Critical" because they frequently lift critical loads.

These cranes are operated by remote control. A small hand-held control unit is used to control crane movement instead of the typical hanging pendant. The controller is stored in the cage in the southwest corner of the high bay, as shown in Figure 1. The control box operates on rechargeable batteries and will control the cranes properly from anywhere within or immediately around the Modal Facility. Figure 2 shows the layout of the remote controller for all three cranes.

2.0 Normal Operating Procedure

2.1 Personnel

There are 2 distinct types of "normal" lifts. The first is a routine lift done by a Noncritical licensed operator. For this type of lift a minimum of two licensed operators, including a Rigger and a Crane Operator, must be present. Tag Personnel are recommended as required to help handle the load. They are especially necessary when the load is lifted higher than a person can reach. One person is required to handle the electric ground line when lifting spacecraft or flammables. Other special assistants may be required according to the nature of the load or lift.

The second type of lift is a formal critical lift. This type of lift requires a Critical licensed operator, is done with a Hydra-Set.

Only the Rigger and Crane Operator(s) need to be certified crane operators. This procedure is written for their

benefit. Steps that pertain to handling the cranes apply to the Crane Operator(s). Steps that pertain to handling the load and giving directions apply to the Rigger.

2.2 Safety

Safe and effective operation of the Modal Facility cranes is the purpose of this document. Therefore, all parts of this procedure are written with safety in mind. Everyone involved in crane operations should proceed with caution and use common sense at all times. Most of the potential for injury in crane operations comes from operator error, not crane malfunction.

OSHA regulations below emphasize important safety rules (from OSHA 29 CFR 1910.179(n)):

(n) *Handling the load*—(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.

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

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

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

(3) *Moving the load.* (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.

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

(*a*) Hoist rope shall not be kinked.

(*b*) Multiple part lines shall not be twisted around each other.

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

(iii) During hoisting care shall be taken that:

(*a*) There is no sudden acceleration or deceleration of the moving load.

(*b*) The load does not contact any obstructions.

(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.

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

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

(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.

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

(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.

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

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

2.3 Startup

This section describes all the steps necessary to prepare for a lift.

1) Learn and understand all of the "Emergency Operating Procedures" described in section 3.0 of this document.
2) If the lift involves a Hydra-Set, refer to the Hydra-Set Operations & Checkout Procedure, NSI Procedure 32-01-221. The crane and Hydra-Set should only be operated alternately, never simultaneously.
3) If the lift is designated critical, a pre-lift briefing, a special procedure, records and other measures are required. Read and follow the Critical Lift Procedure developed specifically for the lift, in addition to reading this procedure.
4) Obtain the key to the main disconnect switch from the Building 15 storage cage (key #34). Obtain the remote control unit for the cranes (also in the Building 15 storage cage) and make sure that the battery is charged.
5) Perform the required daily inspection to insure that:
   a) There are no personnel on the crane bridges or on the catwalk along the north side of the cranes.
   b) There are no obvious functional discrepancies or loose items on the crane.
   c) Any discrepancies found by the operator must be entered in the log book and corrected before operations may begin.
6) Check the log book for the crane to be used (stored next to the main disconnect switch) to make sure that a frequent inspection has been performed in the same month as the lift.
7) Make sure that all of the individual crane power switches on the northwest corner of the Modal Facility are turned off.
8) Unlock the padlock on the main disconnect located on the north wall of the Building 15 high bay. Return the key to its proper storage place.
9) Standing to the right side of the disconnect switch, look away from the switch and turn on the power with the left hand.
10) Go to the individual crane power switches. Switch the selector dial to whichever crane is to be used. Then, standing to the right and looking away from the switch, turn on the individual crane power switch for the crane to be used with the left hand.
11) Read the compass printed on the underside of the cranes, and become familiar with the directions. Review the remote control and become familiar with its layout. The remote control is shown in Figure 2. The functions of each button on the remote control unit are described below:

When operating crane 1, the use of the control box is different than when operating cranes 2 or 3. For crane 1, the top row of buttons move the bridge north or south. The second row of buttons move the west hook up or down. The third row moves the west hook's trolley east or west. The fourth row hoists the east hook up or down. The fifth row of buttons move the east hook's trolley east or west. The sixth and bottom row consists of the Start and Run buttons, which serve the same purpose for all the cranes but never need to be used. For cranes 2 & 3, the top three rows of buttons move the bridge, hoist, and trolley respectively, an the fourth and fifth rows have no function.

12) Note that all three of the Modal Facility cranes have only one-speed motion on all controls.
13) Check the inspection tag on the crane to be used. If the date is more than one year old, do not operate the crane. Notify RECERT for a crane recertification.
14) Turn on the remote control unit.
15) Test all crane control functions before beginning any payload lifts. This test should include making sure that the "Emergency Stop" button on the side of the remote control unit will override all other controls.

2.4 Making A Lift

This section describes the steps involved in making a normal lift.

1) Check Storm Warning condition. Do not proceed if Storm Code 3 or 5 is in effect.
2) Clear all obstacles and hazards away from the planned path of the load movement.
3) Clear all non-essential personnel out of the crane operating range (i.e., out of the Modal Facility structure). Only those involved in the lift may be in or near the operating range of the cranes. Everyone involved in the lift must wear a hardhat an safety shoes.
4) Hook up and test the Hydra-Set if the lift requires its use.
5) Make sure each rigging component is rated for a weight greater than it must lift. Verify that the certification tags on all parts are current.
6) Rig the load and attach it to the crane hook or Hydra-Set and check the rigging to verify its integrity. The hook must be centered over the load's center of gravity, or the load will swing when lifted. Verify that the CG location is known and that the lift will be stable.

7) Start raising the load as slowly and smoothly as possible.
8) When the load has raised off the floor, stop the crane momentarily to test the holding brake an the balance of the load. Do not transport unbalanced loads.
9) Move the load to the desired location.
   a. Never lift a load higher than absolutely necessary.
   b. Do not move a load over flight hardware without obtaining prior approval from Project personnel.
   c. Remember to watch tag lines and electrical ground lines to make sure they don't get tangled or caught during the lift.
10) Lower the load at the desired location as slowly and smoothly as possible.
11) Depending on the configuration of the rigging, either remove the hook from the rigging or the rigging from the load, whichever is appropriate.
12) Move the crane away from the load and into a safe location.
13) Detach the rigging from the crane and/or load and return it to its proper storage place.
14) Go on to the next list or secure the crane as described in Section 2.5 of this document.

2.5 Securing The Crane

Once operations are complete, the crane must be properly secured for safe storage until next use.

1) Raise the empty hook to just below the upper limit switch.
2) Move the crane to a position where the hook, bridge and trolley are not likely to interfere with other operations (such as maneuvering a tall ladder into position in the Modal Facility).
3) Push the "Emergency Stop" button on the remote control unit, and then turn the unit off.
4) Turn off the individual power switch, and ***then*** the main disconnect. Be sure to stand to the side and face sway from the switches.
5) Lock the main disconnect with the padlock.
6) If any crane malfunctions occurred during the lift, record it in the log book and notify the RECERT Crane Inspection group of the malfunction.
7) Return the remote control unit to its proper storage location and make sure it gets recharged.

MODAL CRANE REMOTE CONTROL UNIT

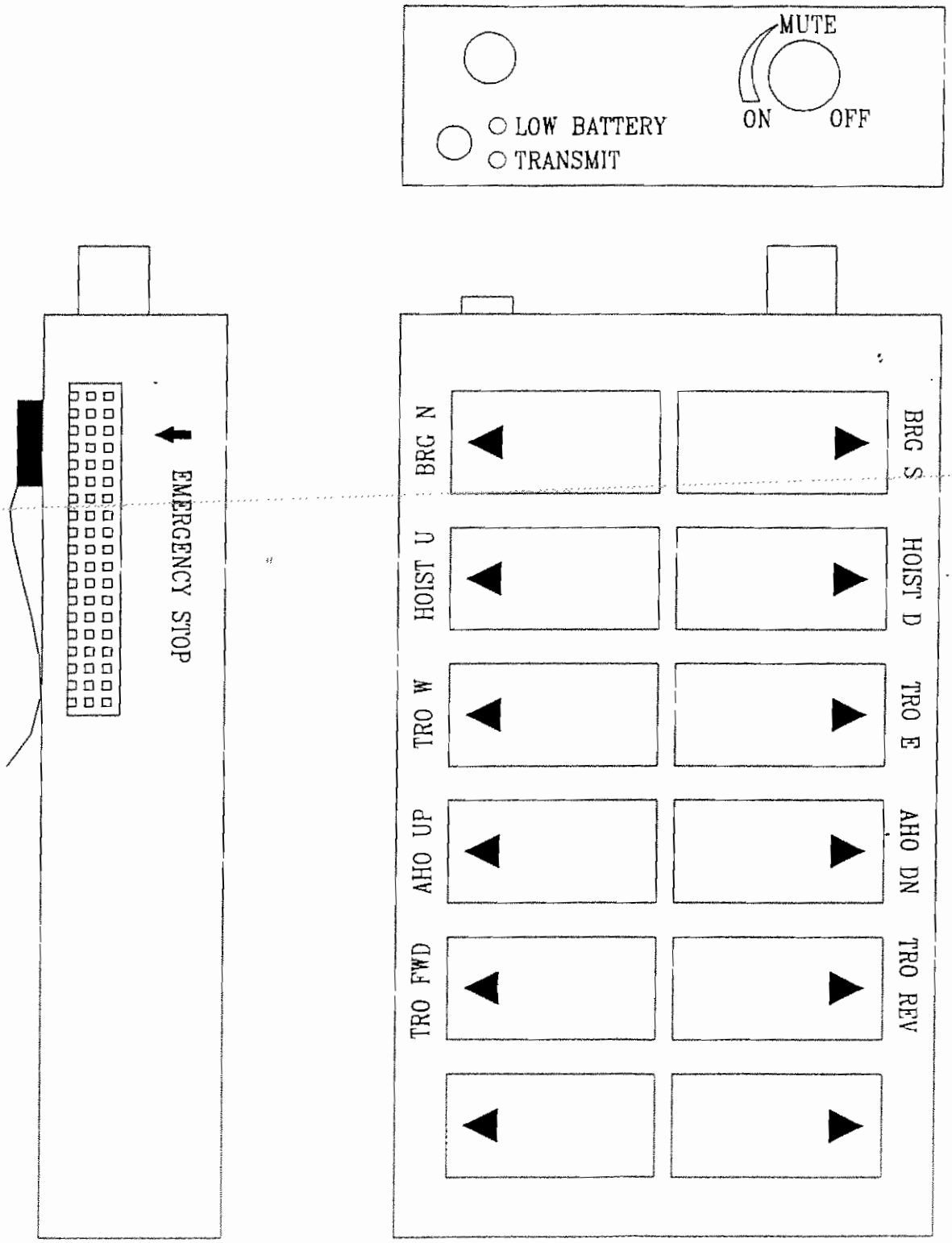
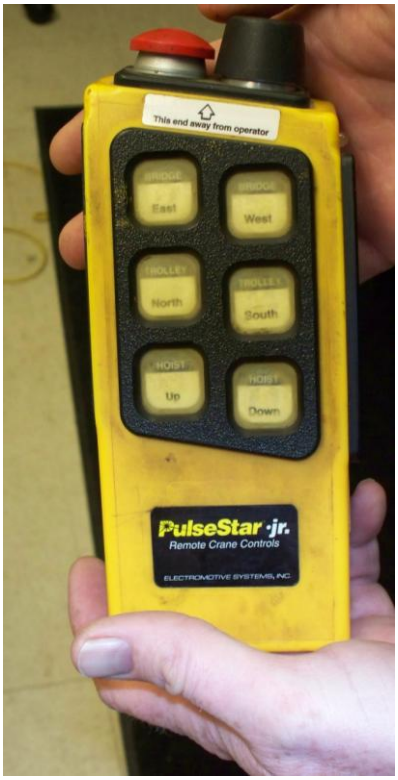


FIGURE 2

RaCon Series II
Radio Remote System



Radio Training For Crane 10-2

RaCon Series II

Radio remote control

EN DOCIKA40100-0 - 4 PS03841 Rev:5.1.2004

Read the instructions supplied with the products before installation and commissioning.

Keep the instructions in a safe place for future reference.

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1 Description

The RADS11 (**RaCon II**) and RADF13 (**RaCon II Plus**) push-button transmitter type, radio remote control systems, are designed for the remote control of hoists and cranes, and are particularly suitable for applications when the operator needs to be able to choose the best location from which to carry out an operation.

The system consists of a transmitter for selecting commands and a receiver that is connected to the electrical system of the machine to be operated. The system also comes with a battery charger and two rechargeable batteries.

The main specifications for RADS11 / RADF13 systems are:

RADS11 / RADF13 Systems		**In EU countries**	**In North America**
	Frequency band	869.7 to 870MHz	902 to 928MHz
	Baud rate	7200 bps	
	Channel separation	12.5 KHz	25 KHz
	Channel Occupation	7.2 KHz	
	Modulation	FM (GMSK)	
	Response Time	100 ms	
	Temperature range	-20ºC to +65ºC	-4F to 150F
The RAD-TS and RAD-TF transmitters			
	Transmission power	<5 mW	
	Protection	IP65	NEMA 4
The RAD-RS and RAD-RF receivers			
	Power supply	48 Vac, 115 Vac, 230 Vac ± 10%, 50/60 Hz	48 Vac, 115 Vac ± 10% 50/60 Hz
	Consumption	30 W	
	Relays	230 Vac/8 A	
	Protection	IP55	NEMA 12
	Communication	CL20mA (RAD-RF only)	
	Protection against electric shock	Class II according EN50178 (1997)	
The BC60K battery charger			
	Power supply (± 10%)	230 Vac 50/60Hz	115Vac, 50/60 Hz
The BT06K batteries			
	Voltage	4.8 V	
	Capacity	700 mAh, NiMH	
	Charging temperature	5ºC to 35ºC	41F to 95F
	Operating Time	12h at 50% RAD-TS model.	
		8h at 50% RAD-TF model.	

2 Safety Precautions

These instructions must be read carefully in order to install and use the radio control system properly and to keep it in perfect working condition and to reduce the risks of misuse.

Do not use this system on machines for the lifting of persons or in potentially explosive atmospheres.

Any use other than that specified in this manual is dangerous. The following instructions must be strictly adhered to.

Important note: To comply with FCC RF exposure compliance requirements, this device and its antenna must not be operating in conjunction with any other antenna or transmitter.

2.1 What you must do

- Strictly adhere to the instructions for installation contained in this manual.
- Make sure that professional and competent personnel carry out the installation.
- Ensure that all site and prevailing safety regulations are followed.
- Make sure that this manual is permanently available to the operator and maintenance personnel.
- Keep the transmitter out of reach of unauthorised personnel.
- Remove the transmission key when the system is not in use.
- At the beginning of each work shift, check to make sure that the STOP button and other safety measures are working.
- When in doubt, press the STOP button.
- Whenever several systems have been installed, make sure the transmitter you are going to use is the correct one. Identify the machine controlled on the label for this purpose on the transmitter.
- Service the equipment periodically.
- When carrying out repairs, only use spare parts supplied by the manufacturer dealers.
- Use only battery pack BT06K 4.8V 700mAh.

2.2 What you must not do

Never make any changes to the radio control system, which have not been engineered and approved by the manufacturer.

Never power the equipment other than with the specified power supply.

Never allow unqualified personnel to operate the equipment.

After use, never leave the equipment ON-state. Always use the transmission key or the STOP button to avoid accidentally activating functions.

Do not use the radio control system when visibility is limited.

Avoid knocking, bumping or dropping the transmitter.

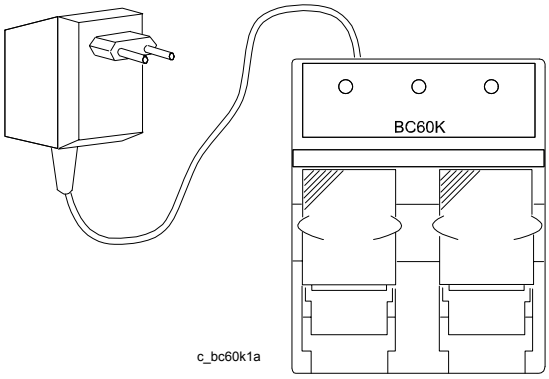
Do not use the equipment if failure is detected.

3 Installation

3.1 The BC60K battery charger

Connect the charger to the power source using the power source and the cable supplied. The red LED, in the middle, should light up indicating power ON.

When installing the battery charger, bear in mind that the batteries must be charged at temperatures over 5ºC (41F) and that the power supply must be left on all night. Also remember that the charger must not be left in direct sunlight, as the batteries may not become fully charged at temperatures exceeding 35ºC (95F).



Place the batteries in the charger. There is green LED on top of each battery. Each LED should light up, indicating that recharging is in process. Complete recharging takes approximately 12 hours. After charging process is finished, the green LED is turned OFF. The batteries may remain in the charger for an unlimited period of time.

☞ The capacity of the batteries decrease(s) with use. Their life span is estimated to be 500 recharging cycles, but this depends largely on the conditions of use, for which the following is recommended:

✋ **Do not recharge the battery until it is completely empty. The transmitter will indicate this when to recharge the batteries.**

✋ **Always charge the batteries at temperatures between 5ºC (41F) and 35ºC (95F).**

✋ **Avoid short-circuits between the battery contacts. Do not carry charged batteries in toolboxes or next to other metal objects (keys, coins, etc.).**

✋ **Always keep contacts clean.**

✋ **Never leave batteries in direct sunlight.**

4 Use

To ensure correct use of the equipment, follow the instructions below:

- Make sure the transmitter you are going to use is the correct one, identifying the machine on the identification label.
- Attach the strap to the transmitter unit. Its use is recommended to prevent the equipment from falling.
- Install a charged battery, turn the key-switch and activate the transmitter.
- To activate the system, you must first pull out the STOP button (1), the transmitter LED should then give a yellow-green pulse; then press the START button (9). If you find that the STOP button has already been pulled out, it is necessary to push it in and then pull it out again, as this sequence will allow the checking of the STOP circuit. If the unit has experienced a time-out auto-disconnection, it is not necessary to repeat the STOP button procedure, simply push the START button for 1 second.
- The transmitter LED should light up in green, indicating that the transmitter has started transmitting. From now on, if any of the transmitter's command buttons are pressed, the corresponding motion will be activated.
- To be able to start up the transmitter, all the command pushbuttons must be in the neutral position (not activated). This is not the case for the Hoist Selection functions.
- When 4 minutes have passed and no active motion command have been activated, the transmitter automatically switch OFF. To start it up once more, press the START button (9).
- The transmitter is equipped with a circuit for monitoring the battery level. When this level drops below a pre-established limit, the transmitter LED starts to flash in red; 5 minutes later the transmitter switches off, and the machine's main contactor is deactivated. During this time, the load has to be located in a safe position.
- The LCD display of the RAD-TF (**RaCon II Plus**) transmitter also shows the battery level of charge: Three dots for charge bigger than 50%, two dots when 50% or less, one dot when 10% or less, none when 5% or less.
- To switch OFF the transmitter, press the STOP button or turn OFF the key -switch

Remember that you are going to control remotely a moving piece of machinery. The safety instructions described in chapter 3 of this manual must be strictly adhered to.

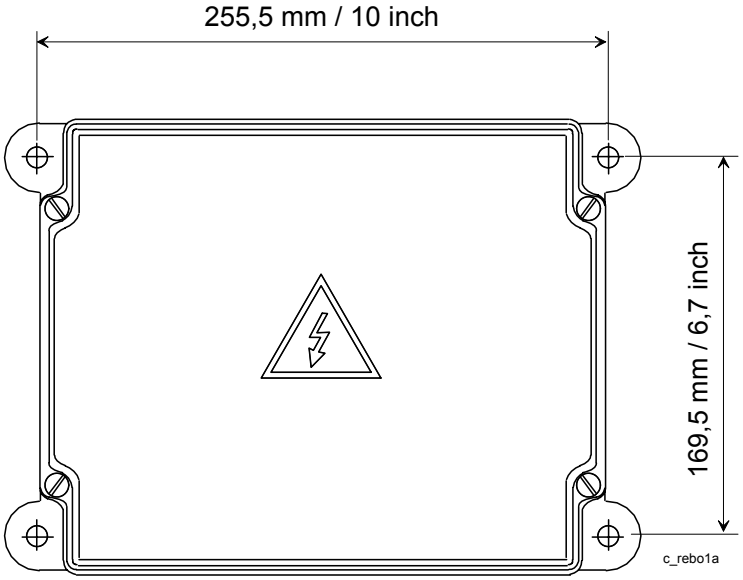
4.1 Receiver

Make sure that the crane is stopped for the entire duration of the installation process, keep the work area free and wear protective clothing.

Park the crane and position at end stop, (if these are not available use appropriate signs), at a suitable distance so that other cranes do not hit it on the same runway.

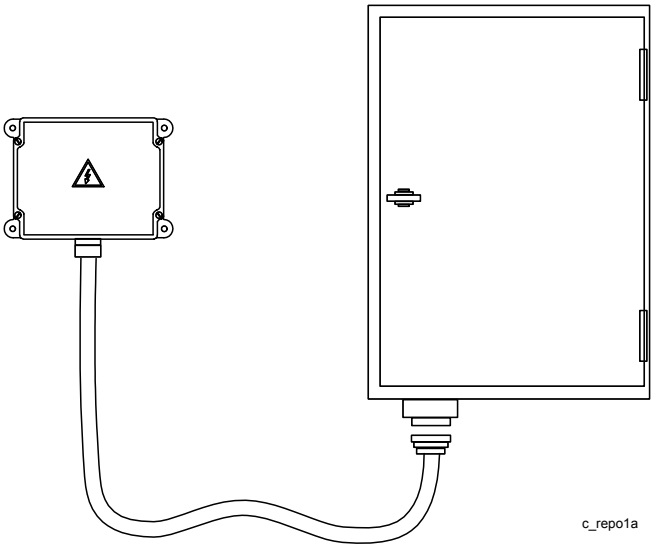
Check the power-supply voltage and turn off the main switch.

Find a suitable location for the receiver, away from any intense radioelectric disturbance sources and install the receiver using the 4 elastic rubber absorbers, (M8) supplied with the set.



The receiver must be placed free of shielding. Metal parts that could obstruct reception of the radio signal must be avoided.

The best way to connect the receiver box to the crane's electrical installations is using a cable with a terminal multiple-pole connector:



The contacts of KSTOP1 and KSTOP2 (KSTOP1+KSTOP2=STOP) relays are in series and must be connected to the main contactor coil circuit.

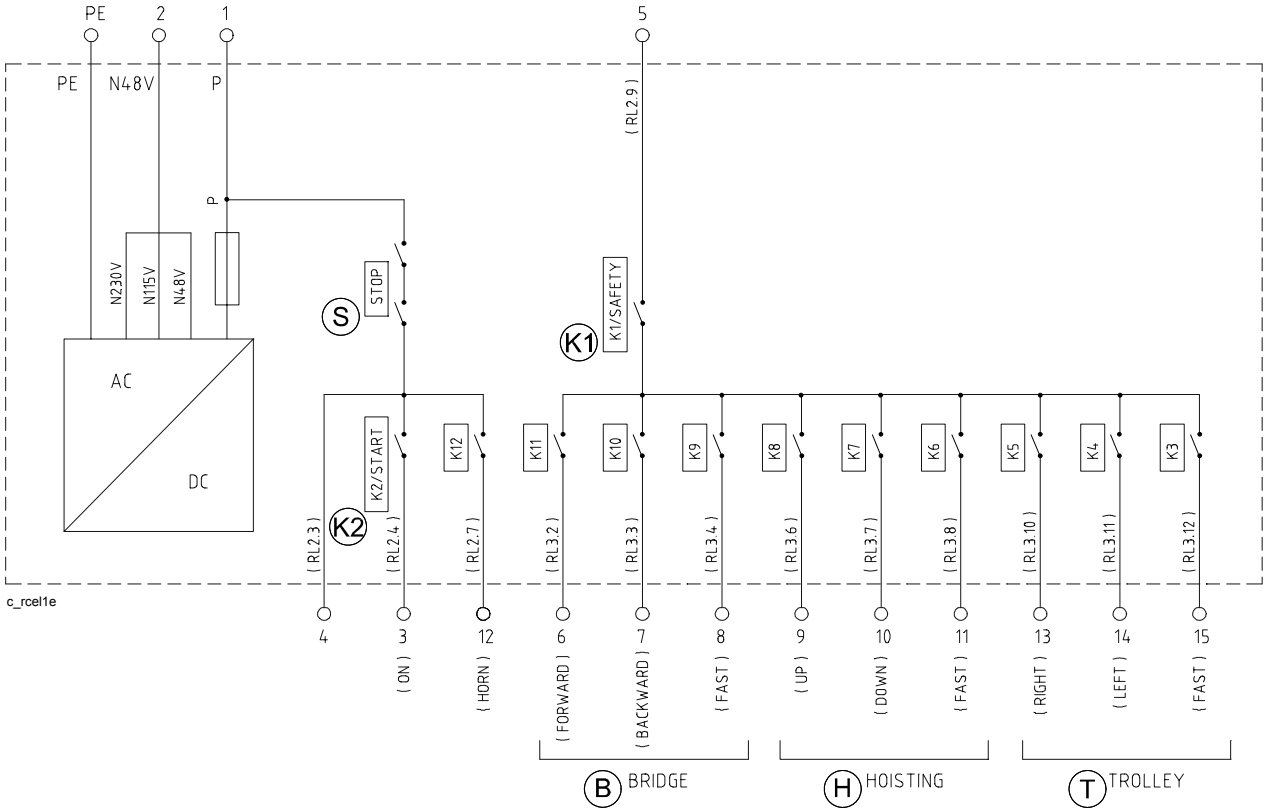
The K2/START is activated once the start-up command is held down.

The K1/SAFETY relay is a security relay which is activated when any of the other function control relay are activated.

The receiver is a class II device, according EN50178, containing a functional earth connection. A (in Europe green-yellow) ground cable is not recommended for this earth connection.

The power supply and relays must be protected against current overload with convenient electric devices, limiting the maximum input/ output current to their limits: 1A fuse is provided in the receiver circuit board for power supply. 8A fuse(s) has to be provided in the crane control panel for the for the output relays.

4.2 Receiver's RAD-RS outputs



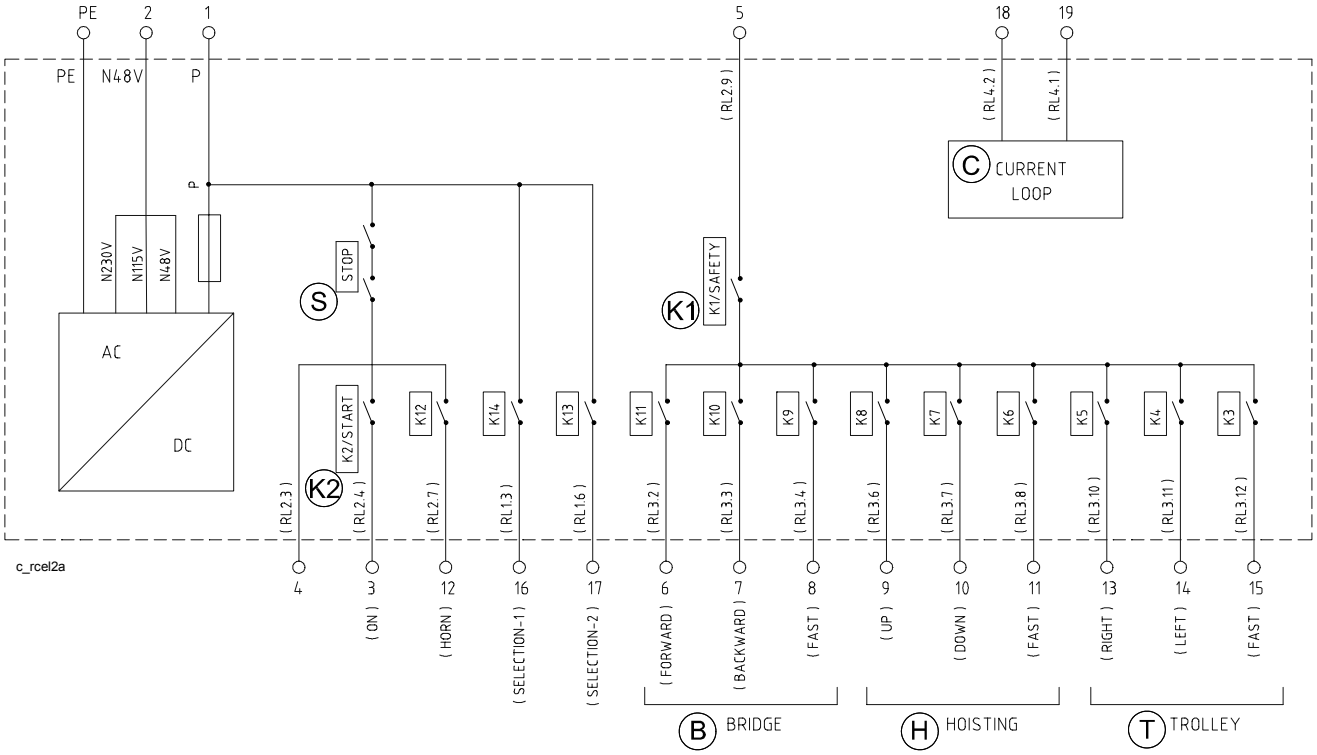
S. Stop
K1. Safety
K2. Start
B. Bridge
H. Hoisting
T. Trolley

Remember to connect the ground cable.

Use only the approved cables.

Select the appropriate voltage on the receiver, (115 or 48 Vac). (See above picture from pin number 2 to the circuit board AC connection.)

4.3 Receiver's RAD-RF outputs



C. Current Loop
S. Stop
K1. Safety
K2. Start
B. Bridge
H. Hoisting
T. Trolley

Remember to connect the ground cable.

Use only the approved cables.

Select the appropriate voltage on the receiver, (115 or 48 Vac). (See above picture from pin number 2 to the circuit board AC connection.)

4.4 Starting-up

Proceed with caution; Incorrect connections may lead to unforeseeable movements on starting-up.

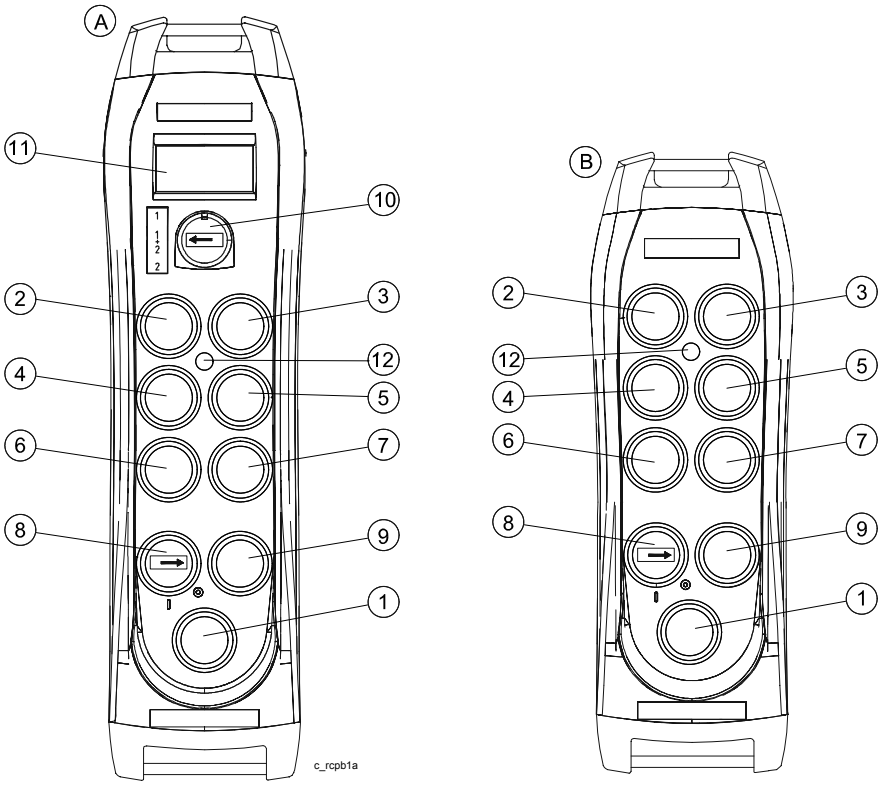
Remember that the receiver has several voltage-powered circuits. Even when the receiver's power supply has been cut off, there is still a risk of electrical shocks.

Once the receiver has been connected, disconnect the power supply to the motors (if possible), for example, by removing the fuses and power on the receiver. The receiver will enter into the SCANNING mode while the transmitter is off. The following receiver LEDs should now light up:

POWER	ON, indicating that the power supply is correct.
HARDOK	ON, indicating the absence of defects on the board.
SIGNAL	OFF if all radio channels in the band are free.
	Flashing ON if the receiver is finding channels with RF signals.
DATA	OFF if none of the radio channels contains signals belonging to a RADF13 or RADS11 radio remote control system in the area. Flashing ON if some do.
ID	OFF.

On receiving a signal from the transmitter, the receiver will enter into the WORKING mode. The following LEDs will light up on the receiver:

POWER	ON, indicating that the power supply is correct.
HARDOK	ON, indicating the absence of defects on the board.
SIGNAL	Flashing ON, indicate that it is receiving a RF signal at the working frequency.
DATA	Flashing ON each time a good frame is received without caring about ID. This means that the data received has a correct format.
ID	Flashing ON (quickly) each time a good frame is received with ID correct. This means that the receiver has recognised the transmitter's identification code



A. Rad – Tf (**RaCon II Plus**)
B. Rad – Ts (**RaCon II**)
1. Stop
2. Down
3. Up
4. Left
5. Right
6. Reverse
7. Forward
8. Key
9. Start/Horn
10. Hoist Selector
11. Display (optional)

To enter into Normal Working mode follow the sequence:
1. Put a charged battery in the transmitter.
2. Turn on the key-switch
3. Push down STOP pushbutton (1) (if the button was in up position)
4. Pull up STOP (1) pushbutton. The transmitter LED should flash yellow-green for a second.
5. Press START (9) The transmitter LED should light up green indicating that the transmitter is transmitting.

After pushing the START button (9), STOP relays will be activated. K2/START and K12/HORN relays are activated only when the start button is pushed.

Relays K13 and K14 on RADF13 system will be activated to the corresponding state of the Hoist Selector.

Push any of the transmitter's motion buttons and its corresponding relay should be activated. The safety relay K1/SEC will also be activated.

Check to make sure all other motions work in this way.

Turn OFF the transmitter using the STOP (1) button, and make sure the relays are deactivated and the DATA, ID and SIGNAL LEDs light corresponding to the SCANNING mode.

Reconnect the power supply to the motors, move to the usual work position and check to see if all the motions and the STOP (1) button are functioning correctly.

4.5 Spurious Disturbance

The receiver has designed to become blocked if there is intense spurious disturbance arising from galvanic, inductive, or capacitive coupling, thus preventing unwanted movement.

As a precautionary measure, it is recommended that spurious-preventing devices (diodes, capacitors, RC circuits) be fitted at the source of the disturbance. These devices should be connected directly to the contactor coil terminals, etc. and can be obtained from the usual contactor suppliers.

If the equipment is installed on a crane with a friction power supply, where electric arcs are produced as a result of defective contact, an RC circuit should be fitted between each phase and earth.

5 Service Mode - How To Access to the HoistMonitor in RADF13 (RaCon II Plus) System.

5.1 General Description of Service Mode

For RADF13 systems, there is a special “Service Mode” of operation for maintenance and set up of the HoistMoinitor via radio.

This unit is connected to the receiver RAD-RF by a serial data communication CL20mA.

When in Service mode, the transmitter RAD-TF (**RaCon II Plus**) is able to act as a data console for the HoistMonitor, sending commands and receiving information, using the radio link and the appropriate software in the transmitter RAD-TF and in the receiver RAD-RF.

During the Service Mode of operation, due to the amount of data being sent in the reverse link, the amount of frames per second in reverse mode is increased such that the feedback in the display is fast enough. The movements of the crane in this mode of operation are inhibited, this is, there are no movement orders being sent by the transmitter or acknowledged by the receiver. The Stop relays are activated.

☞ It could be too slow to enter in service mode by the receiver if the transmitter and the receiver are in different channels. Whenever possible, avoid the scanning of radio channels.

5.2 Entering the Service mode.

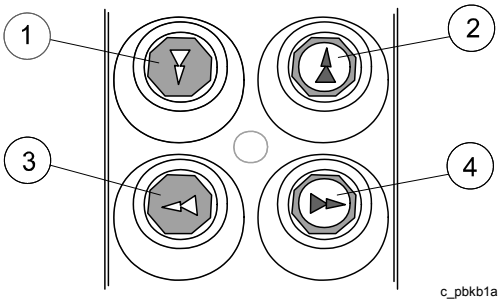
To access the HoistMonitor mode follow the sequence:

1. Install a charged battery in the transmitter.
2. Move close to the receiver.
3. Turn on the key-switch.
4. Push down STOP pushbutton (If it was in UP position.
5. Pull up STOP pushbutton.
6. Press Pushbutton UP in second speed, and then, START. The system enters in Service Mode.

While the system is in service mode the “envelope” icon in the display will be switched ON.

5.3 Keys for moving within the Menus.

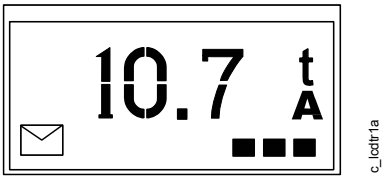
The keys for moving within the menu are the following:



1	Button that simulates the **Down** Key	Down button	▼
2	Button that simulates the **Up** Key	Up button	▲
3	Button that simulates the **Esc** Key	Left button	◄
4	Button that simulates the **Enter** Key	Right button	►

5.4 Switching from Tared Load to Actual Load.

The actual load is shown in the display unit as the Tared Load, but an “A” is shown below the “t” in the bottom right hand side of the display unit. In order to switch from Tared Load to actual load, this is performed by pressing UP and/or DOWN. Pressing ENTER, the password is requested.



5.5 Resetting the Tared Load.

Pressing the ESC button for several seconds performs the reset of the Tared Load.

5.6 Exiting Service mode.

There are two ways of exiting this mode.

Pressing the STOP button
(The transmitter will be switched OFF and the receiver will switch to standby mode). If the system is switched ON again and the system was switched OFF in a menu within the service mode, when receiving the new frames in normal operation, first of all the following message may appear: “EXITING SERVICE MODE”. The receiver will send as many Escape messages as needed to return to the load message.

Pressing the START button for 3 seconds
The transmitter will switch from Service Mode to Standard mode of operation while the receiver will go to Standard mode passing through the Standby status. The STOP relays are deactivated and activated again. If you exit service mode within a menu in the Hoist Condition Monitoring Unit, the system will exit to the Load status. This may take several seconds where the message “EXITING SERVICE MODE” will be ON.

5.7 Messages originated in the receiver.

There are three possible messages that may appear apart from the messages originated by the HoistMonitor. These are:

"EXITING SERVICE MODE"
This message is originated when the HoistMonitor is in Service mode within the menus and the transmitter is in Normal mode of operation. This message will appear prior to show the Load or Fault messages while exiting the Service mode. The receiver will send the HoistMonitor as many Escape messages as needed to return to Normal mode.

"RECEIVER FAULT"
This message will appear whenever the receiver RADF13 is not able to open the current loop communications channel. There will be a problem in the receiver.

"CURRENT LOOP FAULT"
This message will appear whenever the receiver RADF13 is not able to read any data frame from the Hoist Condition Monitoring Unit. This message can be seen when switching the unit to display mode or by unplugging HoistMonitor from the receiver. There is an error in the connection between both systems.
If the transmitter does not receive a valid frame from the receiver within 2.5 seconds, the display will erase the data being displayed. This means that there is faulty link between transmitter and receiver.

6 Maintenance

6.1 Precautions

This equipment is designed for use in an industrial environment. However, we recommend you follow the instructions below to extend the life span of your remote control set:

☞ Use the strap provided with the transmitter to prevent the transmitter from falling.

☞ Do not clean the transmitter with solvents or pressurised water. Use a damp cloth or soft brush.

☞ Use and recharge the battery regularly.

☞ Check every day that the STOP button is working.

☞ Disconnect the receiver cables if soldering/welding work is going to be carried out on the crane.

6.2 Preventive maintenance

A few simple checks can show certain defects which can later be the cause of subsequent break-downs and which can be readily rectified. We recommend the following checks to be made from time to time:

Transmitter

- Check the transmitter's closing screws to make sure they are securely tightened.
- Check the rubber protection seals on the transmitter's command buttons from time to time. Replace them if they are found to have deteriorated. This will protect the unit's water tightness.
- Keep the battery contacts clean.

Receiver

- Check to make sure the cable fixture screws are tight.
- Check the contacts on the fuses and the fuse-holders.

Battery charger and batteries

- Keep all contacts clean.

6.3 Locating Break-downs

The transmitter and receiver both have status monitoring LEDs that help to identify irregularities. The most common signals are contained in the tables below:

6.3.1 Transmitter

LED	MEANS
Green double flashing	Transmitter ready for start-up
Solid green	Transmitter transmitting normally
Red flashing	Battery level low
Red double flashing	Transmitter cannot start up because a manoeuvre command is present
Solid red	Transmitter failure

6.3.2 Receiver

In WORKING mode, the 5 green LEDs should light as described in Starting-up procedure. If this is so, press the transmitter motion buttons and observe the response of the output relays. If the response is normal, the problem is not related to the remote control equipment and the installation must be checked. If any of the relays is not activated, the problem is associated with the remote control equipment.

LED	COLOUR	ON	FLASHING ON	OFF
SIGNAL	Green	-	Own or more Radio Systems sharing the own channel	Receiver doesn't receive any RF signal.
POWER	Green	Power supply OK	-	Power supply NOTOK
HARD OK	Green	Board OK	Slow: Failure in board. Fast: EEPROM error	Failure in board
ID	Green	-	ID Code OK	Not recognised ID Code
DATA	Green	-	Own or other valid messages are presents	No correct messages are being received.

If the problem is associated with the equipment, please send both the transmitter and the receiver to the your Technical Assistance Service, together with a description of the problem and the status of the LEDs.

Operating Instructions For Radio Control for Crane 5-4 & 31-1

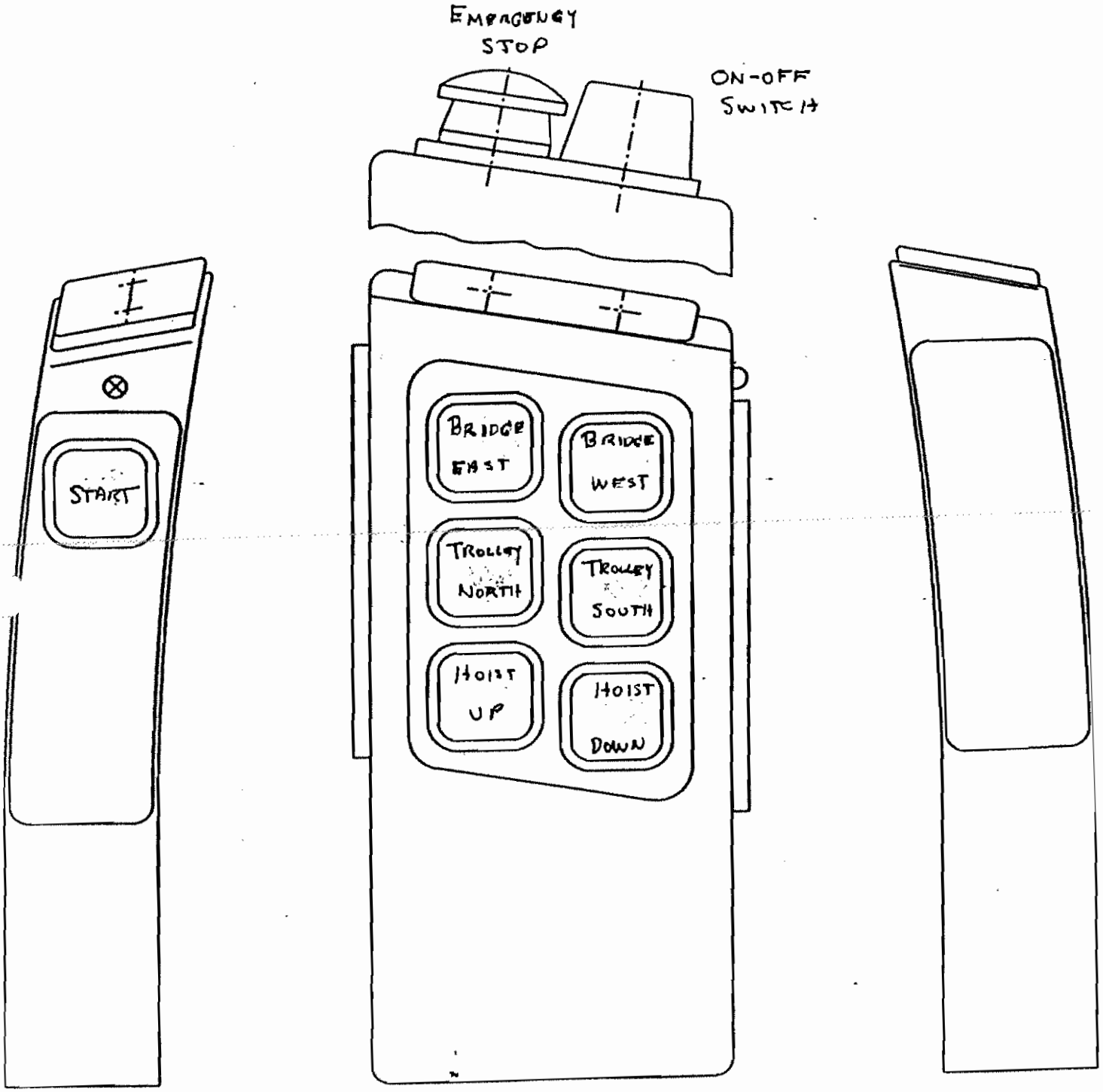
PulseStar®•Jr

PulseStar®•Jr. is a low cost, stand-alone, radio remote control system, designed to serve the common three-motion, two-speed overhead crane or monorail hoist.

This value-packed remote crane control system features the same state-of-the-art technology as our other systems.

Each system includes:

- Receiver in IP65 enclosure
- Ergonomic hand held transmitter
- Holster with belt clip
- Two rechargeable batteries
- Battery charge


EMERGENCY STOP
ON-OFF SWITCH
START
BRIDGE EAST
BRIDGE WEST
TROLLEY NORTH
TROLLEY SOUTH
HOIST UP
HOIST DOWN

PulseStar•jr. Transmitter

The JRT-5 transmitter is a hand-held radio control device with push-buttons used to control crane motions. The JRT-5 transmitter can control up to three crane motions with single speed control, or two motion with two speed control.

NOTE: The Start/Horn push-button is not used with JRT-206, JRT-206-2 or JRT-306 systems.

JRT-5 Transmitter Components

The JRT-5 transmitter has the following components. Refer to Figure 3.1: JRT Transmitter Layout and to identify parts of the JRT transmitter.

1. Key Switch
2. Key Cap
3. Right Side Bezel and Membrane
4. START/HORN Push-button (not used)
5. Housing
6. Battery
7. Motion Push-button
8. Power LED
9. Top Bezel with Membrane
10. Active E-STOP Push-button

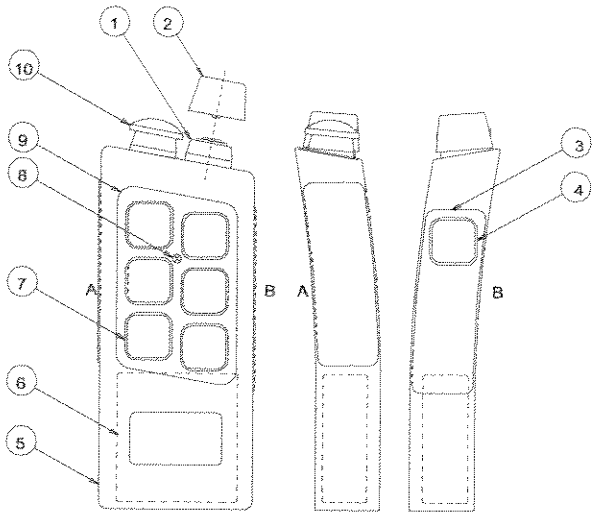


Figure 3.1: JRT Transmitter Layout

1. Key Switch
2. Key Cap
3. Active E-STOP Push-button
4. JRT Coder Board
5. Active E-STOP Push-button Contact Element
6. Frequency Channel Jumper Block
7. RF Module
8. Battery
9. Housing
10. Fuse
11. Internal Antenna
12. Address Code Switch Block
13. Key Switch Contact Element

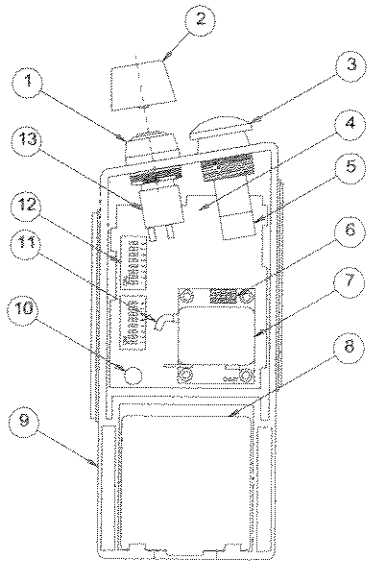


Figure 3.2: JRT Transmitter Layout Backside

JRT-5 Transmitter Functions

The following describes the basic functionality of the JRT transmitter. Please reference Figure 3.1: JRT Transmitter Layout for the location of these functions.

Active E-STOP Push-button. Pressing the **Active E-STOP** push-button will place the receiver in **Safe Mode**. The **Active E-STOP** push-button must be pulled out for the transmitter to control the crane motions.

NOTE: ***The* Active E-STOP *push-button is for emergency situations only. Do NOT use it as an OFF switch. Use the key switch to turn the transmitter on and off.***

Power LED. As soon as the JRT transmitter is turned on, this LED will emit a flashing red light. The transmitter performs a self-test to check the JRT software. If it passes, the LED changes to flashing green and continues flashing green until the transmitter is turned off. This LED changes to flashing red when the battery is low.

Key Switch. The key switch turns the transmitter on and off. It only works with the key cap inserted, and the key cap can only be removed while in the OFF position.

Motion Push-buttons. These push-buttons control the various crane motions and are labeled accordingly.

Start-up and Operation

Holding the Transmitter

Before using the PulseStar•jr. transmitter, refer to the following information on how to hold the PulseStar•jr. transmitter the correct way.

WARNING

To make sure that you are oriented correctly in relation to the directional push-buttons. Hold the transmitter as shown.

Please refer to Figure 3.8: JRT Transmitter Orientation on how to properly hold the JRT transmitter.

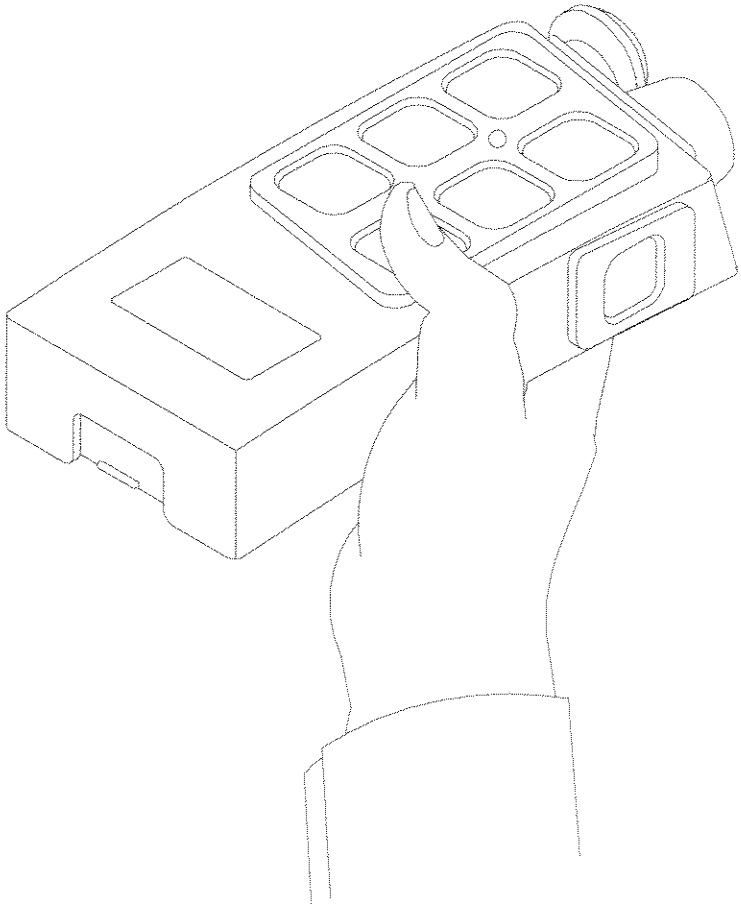


Figure 3.8: JRT Transmitter Orientation

Start-up

Refer to Figure 3.1: JRT Transmitter Layout section for the location of the various functions on the PulseStar•jr. transmitter. To start the PulseStar•jr. transmitter:

1. Make sure that there is a charged battery in the transmitter.
2. Make sure the **Active E-STOP** push-button is pressed in (activated).
3. Make sure no motion push-buttons are depressed.
4. Insert the key into the key switch and turn to the ON position. The power LED flashes red to indicate power is on, and the transmitter is going through a self-check. If the transmitter passes the self-check, the power LED flashes green.
5. Pull out the **Active E-STOP** push-button to provide power to the mainline contactor.

   The transmitter is now ready for use.

Emergency Stop

For all emergency situations, push in the **Active E-STOP** push-button. To restart, pull out the **Active E-STOP** push-button.

When the PulseStar•jr. battery voltage drops below approximately 8 volts, the power LED on the transmitter will begin flashing red for about 30 seconds. At the end of the 30 second period, the transmitter will automatically shut itself off and places the receiver in **Ten Minute Time-out Mode**. This blocks all crane motion commands.

Using the Motion Push-buttons

The JRT transmitter can control up to three crane motions. Each pair of push-buttons corresponds to one crane motion. The push-buttons are "interlocked," which means that only one push-button in each horizontal row is operational at a time. In other words, if you press a push-button, the crane function corresponding to that push-button will be activated. If you then press the other push-button in the same row while still holding down the first push-button pressed, the receiver will ignore the crane motion corresponding to the second push-button pressed.

Shutting Off the Transmitter

When you are finished using the transmitter, turn the key switch to Off. The receiver will go into the **Ten Minute Time-out Mode**. After the **Ten Minute Time-out Mode** expires the receiver will go into **Safe Mode** and the mainline contactor will drop out. Remove the key switch and take it with you to prevent unintended use.

Transmitter Options

The following are some of the more common options which are available with the PulseStar•jr. transmitter. If you have any questions about the functionality of your PulseStar•jr. system contact Electromotive Systems.

Spare Transmitter

Spare transmitters can be used in the event that the primary transmitter becomes lost or damaged. One transmitter is used as the main crane control and the other is designated as a spare. Only one transmitter is active at any given time.

NOTE: ***If both transmitters are set to the same frequency and address, and both transmitters are turned on, the receiver will go into*** **Safe Mode.**

Battery and Charger Information

Removing and Inserting the Battery From the Transmitter

To remove or insert the battery from the JRT transmitter, refer to Figure 3.9: JRT Transmitter Battery Removal.

Removal: Push the battery toward the spring-loaded contacts. Tilt the battery away from the housing until the battery pops out of the compartment.

Insertion: Place the battery in the battery cavity at an angle, with the end containing the gold plated contacts facing the spring-loaded contacts. Push battery into the battery cavity and against the spring loaded contacts until the battery can be placed flush against the battery cavity wall. The battery should now be securely positioned inside the battery cavity.

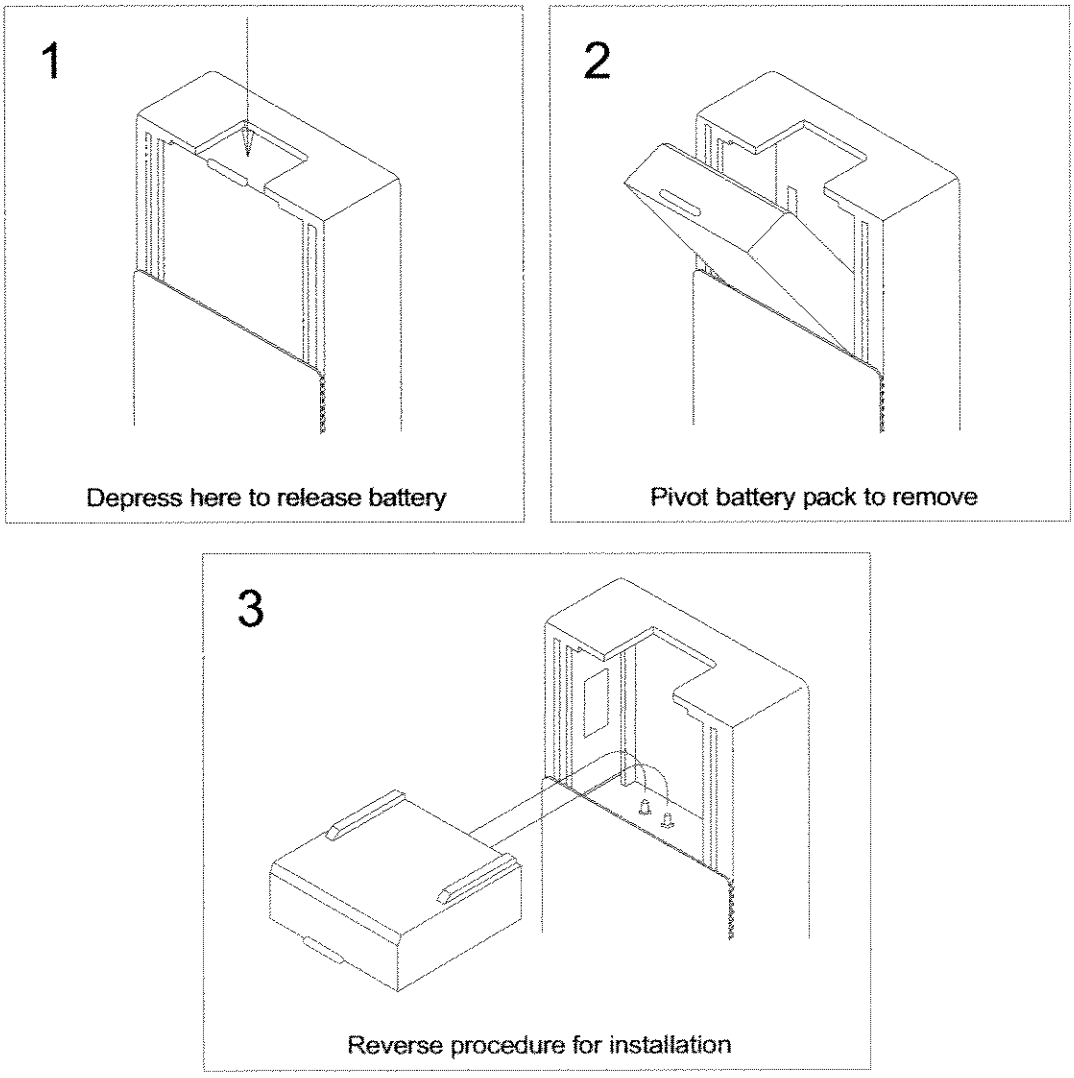


Figure 3.9: JRT Transmitter Battery Removal

Charging the Battery

The PulseStar battery charger is designed for 115/230VAC and plugs into a regular wall outlet. Please refer to Figure 3.10: Battery Charger for JRT Transmitters for charger layout.

1. Discharge Push-button (Discharge charger only)
2. Discharge LED (Discharger charger only)
3. Battery
4. Battery Contact
5. Power Cord
6. Battery Cavity
7. Charger
8. Charge LED

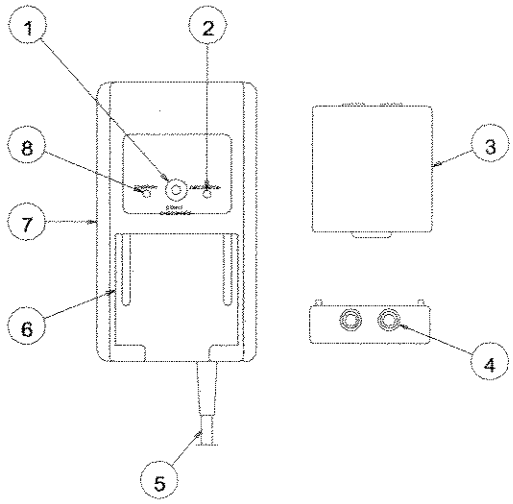


Figure 3.10: Battery Charger for JRT Transmitters

Standard Charger

Insert the battery into the charger. The green charge LED emits a steady light to indicate that the battery is being charged.

The processor in the charger checks the capacity of the battery until the battery is fully charged. The maximum charging time is four hours. When the battery is fully charged, the green charge LED begins to flash. Leave the battery in the charger until needed to ensure it is fully-charged.

If the power supply to the charger is interrupted, or the battery is removed and then reinserted into the charger (before the battery was fully charged), the charger detects how much charge the battery has left and resumes the charging process.

Discharge Charger

Insert the battery into the charger. The green charge LED emits a steady light to indicate that the battery is being charged. Press the red Discharge push-button. The green charge LED turns off, and the red discharge LED turns on. The battery will now fully discharge. Once the battery is fully discharged, the red discharge LED will turn off, and the green charge LED will turn on. The green charge LED emits a steady light to indicate that the battery is being charged.

The processor in the charger checks the capacity of the battery until the battery is fully charged. The maximum charging time is four hours. When the battery is fully charged, the green LED begins to flash. Leave the battery in the charger until needed to ensure it is fully-charged.

The following table summarizes battery information for JRT.

Charging Time	4 hours (from fully discharged)
Operation Time	7–10 hours continuous
Type	Nickel Metal Hydrite; 9.6 Volts, 750 milliampere hours
Maximum number of charges	Approximately 800 times

All charger and battery contacts are gold-plated to provide superior contact. Batteries and chargers are IP65-rated. The mechanical design of the battery case and the battery pocket ensures that each insertion and removal of the battery will clean the contacts. This is known as "self-cleaning" contacts.

Memory Effect

To maximize the lifetime of your battery, **only charge completely discharged batteries** whenever possible. Charging a partially discharged battery may result in a memory effect in the battery, which reduces the number of times it can be effectively charged.

RADIO CONTROL OF CRANE 5-4

Caution: DO NOT TURN THE RADIO TRANSMITTER ON IF YOU ARE NOT IN VISUAL CONTACT WITH THE CRANE

Radio Control Transmitter - The radio transmitter consists of an on/off switch, start push button, Emergency Stop push button, six directional Two-Step push buttons, an indicating LED light, and a rechargeable battery.

On-Off Switch - Switch on the radio control transmitter by turning the switch clockwise. A short noise will be emitted to indicate that the transmitter has power.

Indicating LED - When the transmitter is turned on the LED will light up red, then change to a flashing green light. If the LED indicates a continual red light, then the battery needs to be replaced.

Emergency Stop Push Button - Pull the button up to permit crane reset. Push the button down to send a stop signal to the crane. Note: to reactivate the crane, the "Emergency Stop" button must be pulled up and the start button repressed.

Start Button (on the side of the transmitter) - After the Radio Switch is on and the Emergency Stop Button is pulled up, press the start button to reset the crane. A light on bridge of the crane will come on indicating that the crane is ready for operation.

Directional "Two-Step" Push Buttons - Push the desired motion push button to the 1st position - that motion is now selected, push the button to the second position and drive will begin to accelerate, come back to the first position to "Hold" the desired speed.

Battery - Place a fully charged battery in the radio before beginning operations. After approximately 7 hours of operation, the LED light will turn red indicating a discharged battery. Put the discharged battery into the charger. Charge time is approximately 3 hours. A flashing green light on the charger indicates a fully charged battery. The charged battery can be left in the charger until it is needed for the next job.

NOTES:

To shut down the crane, push the E-Stop button, turn off the radio switch, open and lock the crane disconnect.

To start up the crane, unlock the crane disconnect, be sure the E-Stop button on the disconnect panel is pulled "out" and close the disconnect. Then follow the radio control instructions.

A back-up pendant is stored on the crane bridge. The controls function similar to the radio control. If necessary, the pendant can be placed in service by calling the crane Technicians at ext. 6-2583.

RADIO CONTROL OF CRANE 31-1

Caution: DO NOT TURN THE RADIO TRANSMITTER ON IF YOU ARE NOT IN VISUAL CONTACT WITH THE CRANE

Radio Control Transmitter - The radio transmitter consists of an on/off switch, start push button, Emergency Stop push button, six directional Two-Step push buttons, an indicating LED light, and a rechargeable battery.

On-Off Switch - Switch on the radio control transmitter by turning the switch clockwise. A short noise will be emitted to indicate that the transmitter has power.

Indicating LED - When the transmitter is turned on the LED will light up red, then change to a flashing green light. If the LED indicates a continual red light, then the battery needs to be replaced.

Emergency Stop Push Button - Pull the button up to permit crane reset. Push the button down to send a stop signal to the crane. Note: to reactivate the crane, the "Emergency Stop" button must be pulled up and the start button repressed.

Start Button (on the side of the transmitter) - After the Radio Switch is on and the Emergency Stop Button is pulled up, press the start button to reset the crane. A light on bridge of the crane will come on indicating that the crane is ready for operation.

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Battery - Place a fully charged battery in the radio before beginning operations. After approximately 7 hours of operation, the LED light will turn red indicating a discharged battery. Put the discharged battery into the charger. Charge time is approximately 3 hours. A flashing green light on the charger indicates a fully charged battery. The charged battery can be left in the charger until it is needed for the next job.

NOTES:

To shut down the crane, push the E-Stop button, turn off the radio switch, open and lock the crane disconnect.

To start up the crane, unlock the crane disconnect, be sure the E-Stop button on the disconnect panel is pulled "out" and close the disconnect. Then follow the radio control instructions.

A back-up pendant is stored on the crane bridge. The controls function similar to the radio control. If necessary, the pendant can be placed in service by calling the crane Technicians at ext. 6-3403.

Control Chief

Crane 7-30 Acoustic Chamber

CONTROL CHIEF®

WIRELESS SOLUTIONS

Summit Series
SK1500 / SK2500

Owners Manual

Failure to return the Warranty Registration document (enclosed) to Control Chief within 30 days of purchase will void any warranty responsibilities on behalf of Control Chief Corporation

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95-00-0-092 Rev 002

CONTROL CHIEF

WIRELESS SOLUTIONS

Control Chief Corporation, a world leader in wireless radio and infrared remote control products has, developed and expanded upon this powerful technology. More than three decades of experience in designing, manufacturing, and installing state-of-the-art remote communication systems emphasize Control Chief's mission.

Our systems are tailored to virtually any environment or application. Control Chief provides training, technical support, and comprehensive system design to maximize performance. It is our honor to uphold this reputation of innovative engineering and superior product performance.

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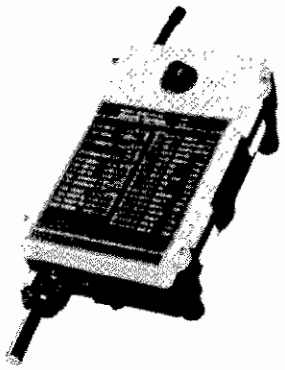
Telephone: (814) [illegible]-6811, FAX: (814) 368-4133

3.0 Standard Components

A standard and full set of SK1500/SK2500 wireless pendant consists of:
700SK3 and 700SK4 Kits include a single (1) transmitter
700DK3 and 700DK4 Kits include two (2) transmitters.

NOTE: Upon receipt of the radio kit, please identify and verify the following components are included as listed.

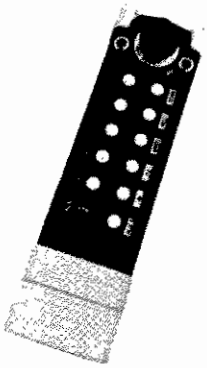
3.1 Receiver



SK1500 Single Speed Receiver Part Number = 701K-52539

SK2500 Two Speed Receiver Part Number = 701K-52540

3.2 Transmitter



SK1500, Single Speed Transmitter, Part Number = 701K-52530

SK2500, Two Speed Transmitter, Part Number = 701K-52531

3.3 Accessories

3.3.1 Accessories Per Radio Kit

1. Owners Manual (1 pc.)
2. 701D0023 - Spare Key (1 pc.)

3.3.2 Accessories Per Radio Transmitter

1. 0100-0230- Alkaline batteries for transmitter (6 batteries required)
2. 701K-52489 - Strap for transmitter (1 pc.)
3. 701K-52484 - Battery Holder
4. 701K-52767 - Button legend sheet for transmitter (1 pc.)

5.0 Operation

NOTE: For the following procedures, the buttons on the transmitter will be referred to as noted in Figure 4.3

5.1 General Precautions

1. After operating, please press the Red Mushroom Pushbutton to shut off main power in the receiver. Remove transmitter key.
2. Stop operating if irregular response occurs due to insufficient transmitter power, operating beyond the remote control range, or severe interference.
3. Remove the batteries when the equipment is not going to be used for a long period of time.
4. Operators must be properly trained and certified, understanding safe operation of the crane /machine and this radio control.
5. Operator must be familiar with emergency procedures before operating (See Section 5.4).
6. Transmitter is durable and weather-resistant, but care should be taken not to subject it to severe impacts or undue abuse.
7. This product is suitable for use in industrial environments. Proper care and maintenance will extend system's life.
8. Check the Red Mushroom Pushbutton and the other security functions of the entire system before daily operation, including (but not limited to) switch operation, etc.
9. Stop operating if the operator's view is not clear of crane/machine or load.
10. Press Red Mushroom Pushbutton when malfunctions or abnormal conditions occur.

5.2 Standard Operation

5.2.1 Default Power-On Procedure

1. Rotate Red Mushroom Pushbutton clockwise and pull out.
2. Turn rotary key switch clockwise to "ON" position.
3. Depress the "START" button in order to turn on power.

5.2.2 Transmitter Power Indication

1. Transmitter has a power indication function with an LED indicator.

- "*Green Color*" Sufficient power to operate transmitter (In order to save power, one can program to turn off LED display when power level is sufficient).
- "*Yellow Color*" Power is depleting The operator has a short time to finish his task (for example, lower the hoist, remove load) but then needs to replace batteries.
- "*Red Color*" Insufficient Power. Transmitter is no longer functional. Transmitter will send out an emergency stop signal to the receiver due to insufficient power. Operator should avoid this situation in order to maintain operation safety.

5.3 Emergency Shutdown Procedure

1. Press Red Mushroom Pushbutton.
2. Turn the rotary key to the "OFF" position.
3. Remove the rotary key.
4. Open the battery compartment and remove the transmitter's batteries.
5. Shut off the main power of the crane and discontinue operation until the problem is resolved.
6. Contact your distributor or Control Chief to diagnose the problem.

6.0 Basic Troubleshooting and Maintenance

6.1 General Precautions

Daily inspection is important and will ensure safety of operation. Inspection should include testing the "Red Mushroom Pushbutton" and other safety devices and functions. If there is any doubt, operation must be stopped immediately and problems must be corrected before operation is resumed.

6.2 Transmitter Malfunction Detection

If the transmitter's LED is rapidly flashing red, the following may have occurred:

1. Pushbutton(s) may be jammed
2. Red mushroom Pushbutton may be Depressed
3. The correct "power on" procedure may not have been properly executed.

6.3 Receiver Malfunction Detection

The receiver is equipped with simple self- diagnosing circuits and indicators. If a malfunction is detected during operation, self-diagnosing circuits will illuminate the indicators in the following sequence:

G1	R1	G2	R2	Malfunction Type
			On	MCU1 Fault
Blinks w/ R1	Blinks w/ RG1			DB1 / DB2 Relay Fault
Alternates w/ R1	Alternates w/ G1			Relay Driver Buffer Fault
	Blinking			Jammed relay

If the system is demonstrating improper operation, the following chart may help determine the cause of the malfunction:

Symptom	Possible Cause
Receiver relay does not activate when associated transmitter pushbutton is depressed	1. Button may be faulty or jammed
	2. Transmitter and/or receiver may be improperly coded
	3. Receiver may be experiencing interference
	4. Receiver may not have sufficient operating power
	5. Transmitter's Red Mushroom Pushbutton may be depressed
Intermittent operation	1. Receiver may be experiencing interference
Decreased range	1. Receiver antenna may be damaged or incorrectly installed
Transmitter does not start	1. Keyswitch may not be in the "On" position
	2. Red Mushroom Pushbutton may be depressed
	3. "Start" pushbutton may be defective
	4. Button may be faulty or jammed

If the receiver or any of its relays fail to respond to the transmitter, the following checks may be preformed:

1. Ensure the "power on" indicator located on the front of the receiver is illuminated. If this light is off, the mainline circuit is not active.
2. Press each button on the transmitter and confirm that its associated relay's LED is illuminated. If an LED does not illuminate, its relay is not receiving a command from the transmitter.
3. Be sure "LED 1 is illuminated. This LED is active when the "Jammed Relay Detect" circuit is working properly.
4. Be sure "LED 2" and ""LED 3" are illuminated. These LEDs are active when the receiver is getting the proper operating voltages.
5. Check fuse "F1". This fuse is rated at .5a @ 250VAC (5x20mm)
6. Check fuses "F2-F5". These fuses are rated at 6.3a @ 250VAC (5x20mm)

Energizer® recharge™

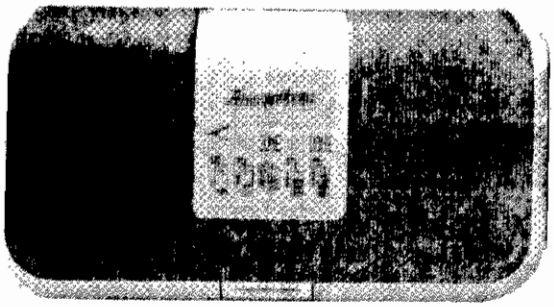
Energizer® Recharge™ Universal Charger

Please read this manual before you use the charger, and save it for reference.

Batteries: Nickel Metal Hydride (NiMH) Rechargeable batteries

Sizes: AA, AAA, C, D, 9V

Recommended: Energizer® NiMH Batteries

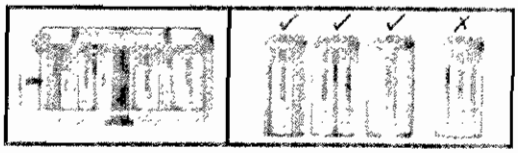


Best used with Energizer® NiMH batteries
Utilisation optimale avec les piles NiMH Energizer®
Mejor si se usa con pilas NiMH Energizer®
Melhor se usado com baterias Energizer® NiMH

CHARGING

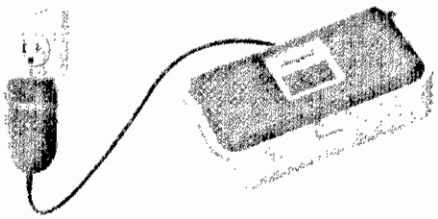
1. Load Batteries into Charger

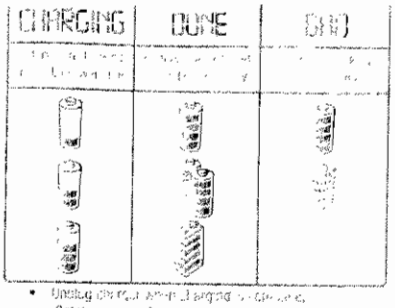
- Open lid and place batteries in charger, matching the polarity marks (+ and -).



- Close the lid, which moves the charger contacts into place for charging.

2. Plug transformer into a standard AC outlet.





- Unplug charger when charging is complete.
- Safety feature: Power to contacts is shielded when charger is not in use.

CHARGING TIMES

Battery Size (NiMH)	Rated Capacity (mAh)	Number of Batteries	For Charger
AA	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
AAA	[illegible]	[illegible]	[illegible]
C, D	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
9V	175	1-2	[illegible]

*When using two bays only

SPECIFICATIONS

Model: CHFC

Charges: AA NiMH batteries up to 2650mAh
AAA NiMH batteries up to 1000mAh
C, D NiMH batteries up to 2500mAh
9V NiMH batteries up to 175mAh

Input Voltage: 100-240V AC

Charging Current: 1/2pcs **9V:** 30mA
2/4pcs **AA:** 1100mA, 6/8pcs **AA:** 550
1/2pcs **C/D/AA:** 1100mA, 3/4pcs C/D
2/4/6/8pcs **AAA:** 450mA, [illegible]

WARNING

To avoid personal injury and property damage from, but not limited to, the risk of electric shock or fire:

- Charge only Nickel Metal Hydride (NiMH) rechargeable batteries. Charging other types of batteries may cause them to leak, rupture or explode.
- Do not open battery, dispose of in fire, put in backwards, mix with used or other battery types or short circuit – may ignite, explode, leak or get hot causing injury.
- Use the charger only in dry locations. Keep away from rain, snow or excessive moisture.
- Never plug battery chargers into an extension cord.
- Do not operate the charger if damaged.
- Do not disassemble, modify any part of the charger, or attempt to use the charger as a power source.
- Unplug before attempting maintenance or cleaning.
- For use in other countries beyond USA, attach the proper plug adapter.
- This charger is not a toy and should not be used by children or infirmed persons without adequate training or supervision.

LIFETIME LIMITED WARRANTY

Lifetime Limited Warranty: Warranty covers any defect in material or workmanship. It excludes damage caused by normal wear and tear, misuse, modification. Warranty lasts for as long as the original United States or Canadian purchaser owns this Energizer Battery Charger and uses Energizer Nickel-Metal Hydride Rechargeable Batteries. Warranty terminates if you sell or transfer them. Energizer will repair or replace at its option. Call 1-800-383-7323 for warranty service. Warranty [illegible] EXCLUDES ALL INCIDENTAL AND [illegible] DAMAGES. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM JURISDICTION.

IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS. DANGER - TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, CAREFULLY FOLLOW THESE INSTRUCTIONS.

IMPORTANTES CONSIGNES DE SÉCURITÉ – CONSERVEZ CES INSTRUCTIONS. DANGER – POUR RÉDUIRE LE RISQUE D'INCENDIE OU DE SECOUSSES ÉLECTRIQUES, SUIVEZ ATTENTIVEMENT CES INSTRUCTIONS.

IMPORTANTES INSTRUCCIONES DE SEGURIDAD – GUARDE ESTAS INSTRUCCIONES. PELIGRO – PARA REDUCIR EL RIESGO DE INCENDIO O CHOQUE ELÉCTRICO, SIGA ESTAS INSTRUCCIONES CUIDADOSAMENTE.

IMPORTANTES INSTRUÇÕES DE SEGURANÇA-GUARDE ESTAS INSTRUÇÕES PARA FUTURAS PESQUISAS. PERIGO - PARA REDUZIR O RISCO DE INCÊNCIO OU CHOOUE

Merci d'avoir choi
Chargeur Unive

Veuillez lire ce manu
conserver pour référe

Piles : [illegible]

Formats : [illegible]

Recommandation : [illegible]

CHARGE

1. Placez les piles d

- Ouvrez le couver
en faisant corres

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2. Branchez le trans

Communication
Standard Hand Signals

OVERHEAD CRANE HAND SIGNALS

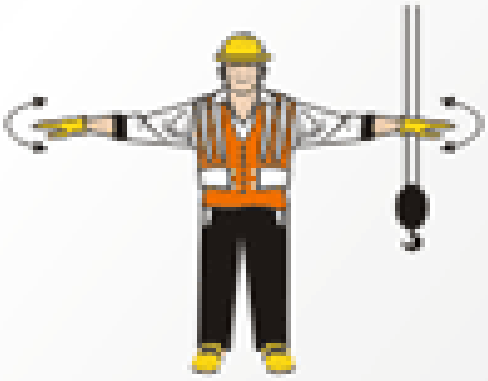
HOIST

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

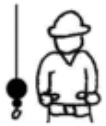
STOP – With arm extended horizontally to the side, palm down, arm is swung back and forth.

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.

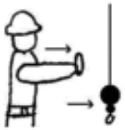
RAISE THE BOOM AND LOWER THE LOAD – With arm extended horizontally to the side and thumb pointing up, fingers open and close while load movement is desired.

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.

Emergency Operating Procedures

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.

•OSHA 29 CFR 1910.184

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 -- 90° loading	Double sling vertical angle (1)			Triple and quadruple sling (3) vertical angle (1)		
		30° (60°)	45° (45°)	60° (30°)	30° (60°)	45° (45°)	60° (30°)
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		Rated capacities, tons (2,000 lb)		
		2-Leg bridle slings		
Dia [in.]	Constr	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

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		Rated capacities, tons (2,000 lb)		
		3-Leg bridle slings		
Dia [in.]	Constr	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]

				Eye and eye sling			
Rope dia. nominal in inches	Nominal wt. per 100 ft in pounds	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	Endless sling: Choker hitch	Endless sling: 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	Eye and eye sling: Choker hitch	Eye and eye sling: 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	Vertical hitch	Choker hitch	Endless sling: 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)

Regulations (Standards - 29 CFR) - Table of Contents

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200 Constitution Avenue, NW
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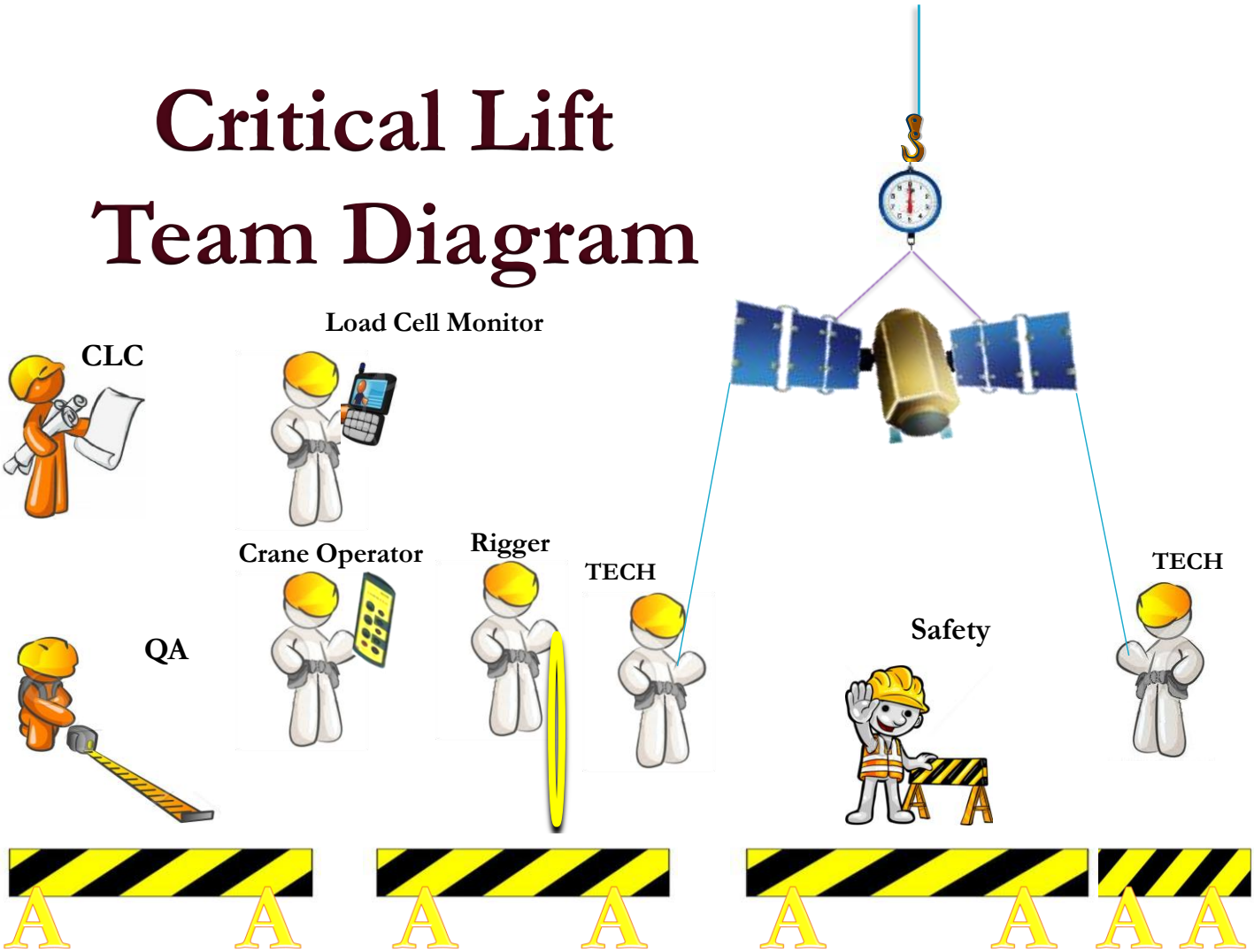
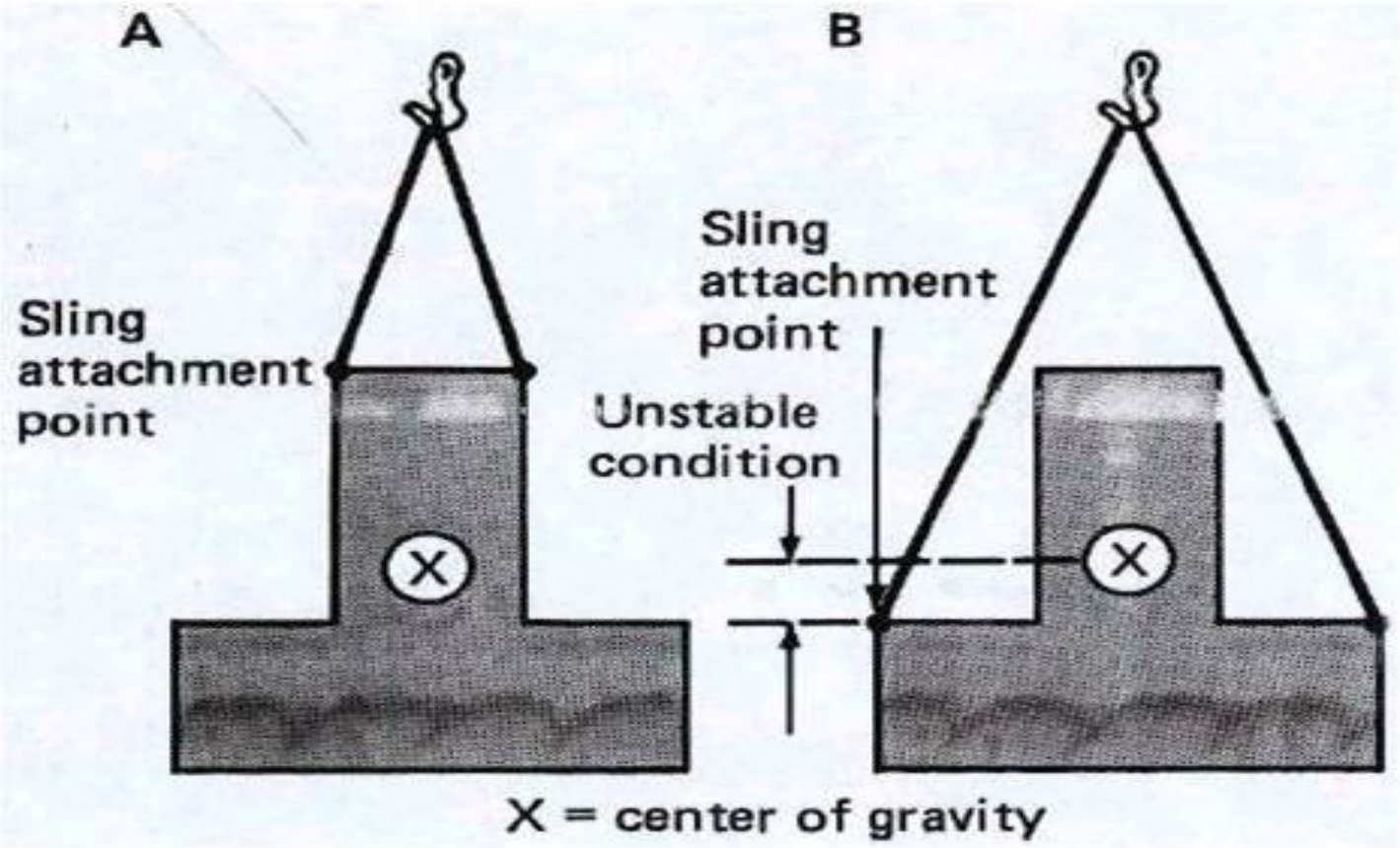
CRITICAL LIFT TEAM

Critical Lift Team Diagram



RIGGERS WORKSHEET



Rigger's Worksheet

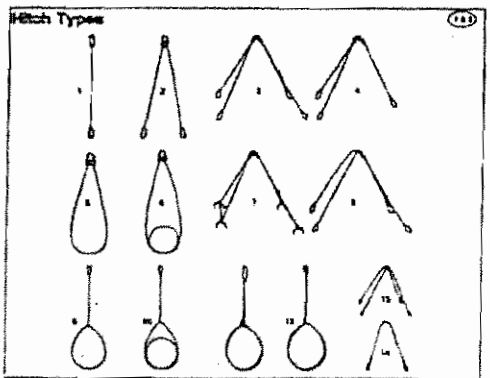
WRRC: We Rig It Right!

When we first start out as riggers, we are fascinated—and perhaps overwhelmed—by the variety of rigging methods "out there." But once we've been out there a while, we realize that some techniques are acceptable, while others can be hazardous.

In this "worksheet" you will find six different rigging techniques for each load type(1, 2 and 3). Under each item, there is a label and a number. To find out more about that hitch type, look for the corresponding number in the "Journeyman Rigger's Reference Card" below. After studying each of the six choices (1A-1F) for load shape 1, identify four that represent reasonable load control and two that show unsafe rigging technique. Repeat for 2 and 3.

Once you have identified four "Acceptable" and two "Unacceptable" hitch types for each of the three loads, check your choices against the Answer Key on page 65. ■

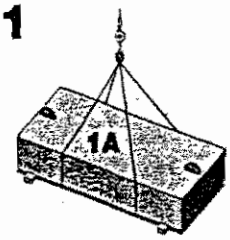
The Rigger's Worksheet is designed to be a personal challenge of your rigging knowledge. It is not to be used as a formal examination for the purpose of certification or qualification. The publishers of CraneWorks *do not accept responsibility for the misuse of this worksheet.*



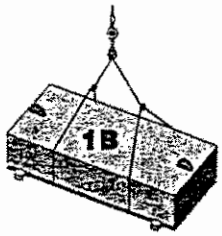
	Hitch Type	Load Control	Line Effectiveness	Load Control	Load Control Rating
1	Single Vertical	Above	One	Poor	1
2	4-Leg Bridle	Both	Two	Excellent	3
5	Single Wrap Basket	Both*	Two	Average	5
	Two Single Baskets	Both**	Four	Poor	7
	Single Wrap Choker	Both*	Single	Average	9
11	Double Choker Sight -up	Both*	Two	Good	11
13	Double Inverted Baskets	Above	Four	Poor	13

* (never use as single hitch below DS) **(compounds loading at pick points)

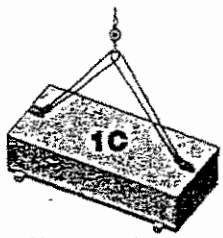
1



2ea Single wrap baskets (#5)

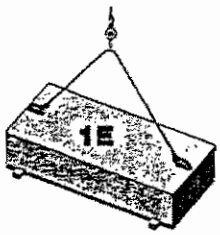


2ea Single wrap chokes (#9)

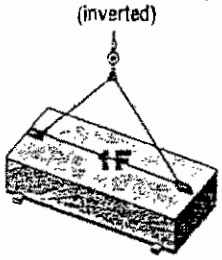


2ea Single wrap baskets (#5) (inverted)

2-leg bridle (#2)

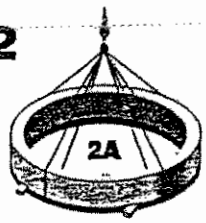


Single inverted basket (#14)



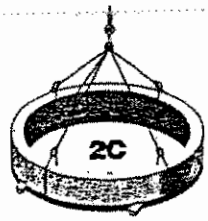
Single basket (#7)

2



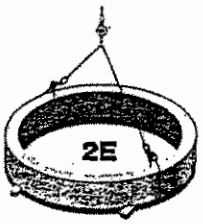
4ea single wrap baskets (#5)

3ea single wrap chokers (#9)

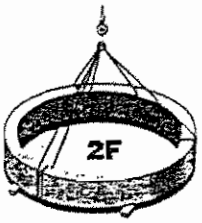


4ea single wrap chokers (#9)

2-leg bridle (#2) + 2ea single wrap baskets (#5)

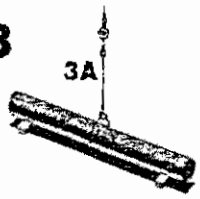


Single inverted basket (#14) + 2ea single wrap baskets (#5)

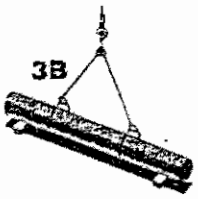


3ea double wrap baskets (#6)

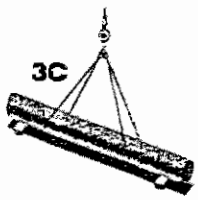
3



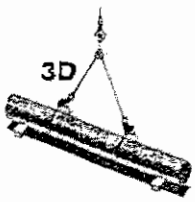
single wrap choker (#9)



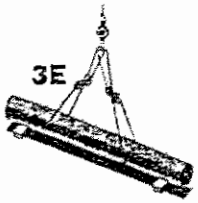
2ea single wrap chokers (#9)



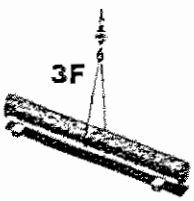
2ea single wrap baskets (#5)



2-leg bridle (#2) + 2ea single wrap baskets (#5)



2ea single inverted baskets (#14) + 2ea single wrap baskets (#5)



1ea single wrap basket (#5)

The Rigger's Worksheet is sponsored by Wire & Rigging Consultants Inc., of Woodland, Wash.
For more information call (800) 727-6355 Fax: (360) 225-1122

Rigging Safety Volume 1

Rigging Safety Volume 1

Name: _____

Employee ID#: _____

Date: _____

MULTIPLE CHOICE (Circle One Answer Only)

1) Name three (3) types of slings currently in use?
   A) Wire Rope, Chain, neoprene
   B) Synthetic Link, Mesh, Steel Rope
   C) Chain, Metal Mesh, Wire Rope
   D) Neoprene, xylene, and Polyester

2) Which of the following OSHA standards regulates slings?
   A) 29 CFR 1910.179
   B) 29 CFR 1910.180
   C) 29 CFR 1910.184
   D) 29 CFR 1926.550

3) Which of the following ASME standards regulates slings?
   A) ASME B30.2
   B) ASME B30.5
   C) ASME B30.9
   D) ASME B30.10

4) What is the minimum diameter to diameter (D/d) ratio that should be used in the body of a mechanically spliced wire rope sling?
   A) 2:1
   B) 5:1
   C) 10:1
   D) 20:1

5) Which of the following sling types is least subject to stretch?
   A) Chain
   B) Wire Rope
   C) Synthetic Web
   D) Synthetic Round

6) What are the three (3) most common materials used for synthetic web slings?
   A) Nylon, Polyester, and Polypropylene
   B) Nylon, Orlon, and Polyester
   C) Nylon, Dacron, and Polyester
   D) Nylon, Dacron, and Orlon

7) What are the OSHA broken wire criteria for a wire rope sling?
   A) More than 1 broken wire next to and end fitting and more than 2 broken wires in rope lays beyond the end fitting
   B) 6 broken wires in one rope lay or 3 broken wires in one strand of one rope lay
   C) 10 broken wires in one rope lay or 5 broken wires in one strand of one rope lay
   D) 12 broken wires in one rope lay or 4 broken wires in one strand of one rope lay

8) What are the three (3) basic hitches used in rigging?
   A) Choker, Eye to Eye, Basket
   B) Vertical, Eye to Eye, Bridle
   C) Vertical, Basket, Slip Hitch
   D) Basket, Choker, and Double Wrapped Vertical

9) When must damaged slings be removed from service?
   A) At the end of the shift
   B) At the end of the day
   C) Immediately
   D) At the next periodic inspection

10) How many basic web sling types are there?
   A) 3
   B) 4
   C) 5
   D) 6

11) Which of the following sling angles to the horizontal would result in the greatest amount of stress on the sling?
   A) 30°
   B) 45°
   C) 60°
   D) 90°

12) When using a choker hitch, when the angle of choke falls below how many degrees will the capacity of the choker be reduced?
   A) 45°
   B) 60°
   C) 90°
   D) 120°

13) Within how many degrees from vertical must the legs of a basket hitch be kept to have the full capacity of the hitch?
   A) 5°
   B) 10°
   C) 15°
   D) 45°

14) What is the lowest angle of pull to the horizontal recommended for shouldered eye bolts?
   A) 90°
   B) 60°
   C) 45°
   D) 30°

15) Which of the following hitches provides the least amount of capacity?
   A) Vertical
   B) Choker
   C) Basket
   D) Double wrapped Basket

16) Which type of sling is only flexible in one plane?
   A) Wire Rope
   B) Chain
   C) Metal Mesh
   D) Synthetic Round

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17) Which type of sling is most susceptible to damage from ultraviolet radiation?
   A) Synthetic Round
   B) Synthetic Web
   C) Wire Rope
   D) Chain

18) What two (2) grades of steel are used for alloy steel chain slings?
   A) Grades 30 and 40
   B) Grades 40 and 60
   C) Grades 60 and 80
   D) Grades 80 and 100

19) Which sling type is best suited for use when lifting delicate equipment or finished items where load damage is a concern?
   A) Synthetic Web
   B) Wire Rope
   C) Metal Mesh
   D) Chain

20) Which sling type is required by OSHA to have a periodic inspection performed on it?
   A) Chain
   B) Wire Rope
   C) Metal Mesh
   D) Synthetic Web

Wire Rope Information Packet

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 important.

Basic Types

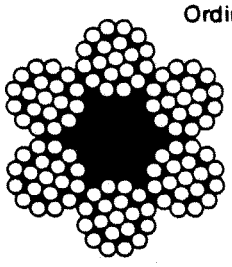
The four basic constructions are illustrated in Figure 1 :

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.

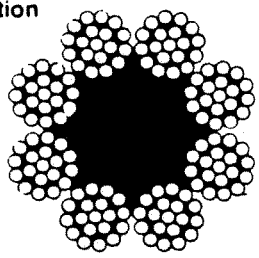
On ropes of **Ordinary** construction the strands are built in layers. The basic seven-wire strand consists of six wires laid around a central wire. A nineteen-wire strand is constructed by adding a layer of twelve wires over a seven-wire strand. Adding a third layer of eighteen wires results in a 37-wire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

Ordinary Construction

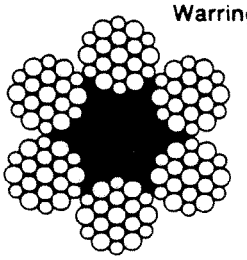


6x19 Ordinary, Fibre Core

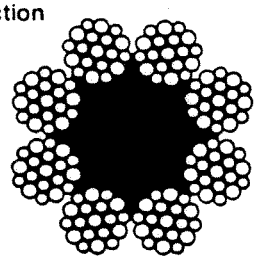


8x19 Ordinary, Fibre Core

Warrington Construction

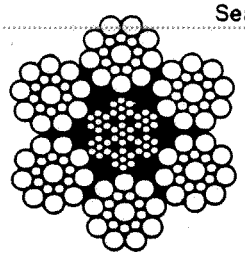


6x19 Warrington, Fibre Core

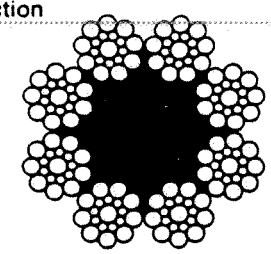


8x19 Warrington, Fibre Core

Seale Construction

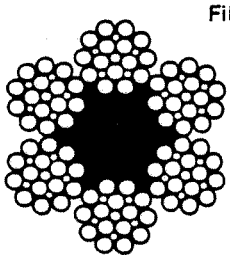


6x19 Seale IWRC

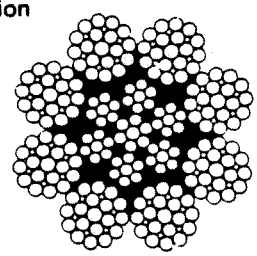


8x19 Seale, Fibre Core

Filler Construction



6x21 Filler, Fibre Core



8x25 Filler, IWRC

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.

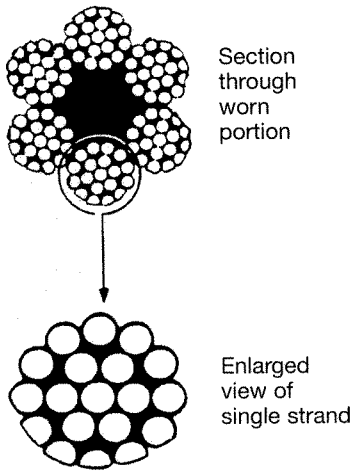
Construction regulations under The *Occupational Health and Safety Act* establish criteria for retiring a rope based on the number of wire breaks.

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.

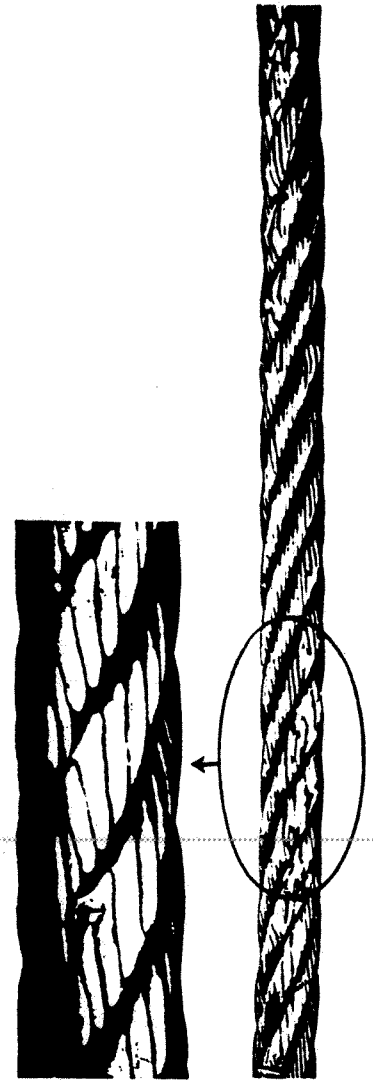
Figure 2

Snagged wires resulting from drum crushing

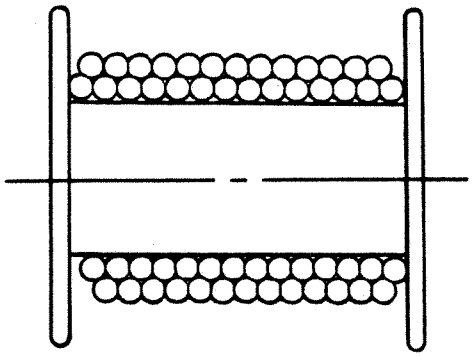
Rope that has been jammed after jumping off sheave

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.

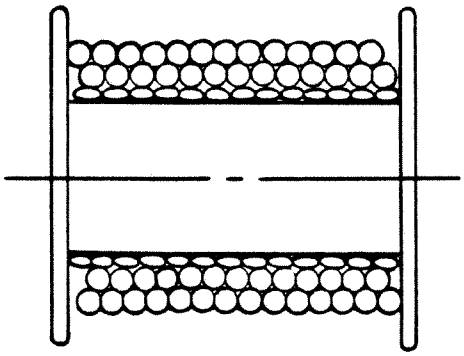
Localized crushing of rope



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 condition is permanent. It results when wires in the strands and strands in the rope seat themselves under load. Rope stretch can be recognized by increased lay length. Six-strand ropes will stretch about six inches per 100 feet of rope while eight-strand ropes stretch approximately 10 inches per 100 feet. Rope stretched by more than this amount must be replaced.

Corrosion

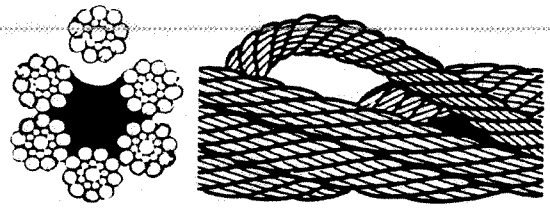
Corrosion is a very dangerous condition because it can develop inside the rope without being seen. Internal rusting will accelerate wear due to increased abrasion as wires rub against one another. When pitting is observed, consider replacing the rope. Noticeable rusting and broken wires near attachments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

Crushed, Flattened or Jammed Strands

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

High Stranding and Unlaying

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

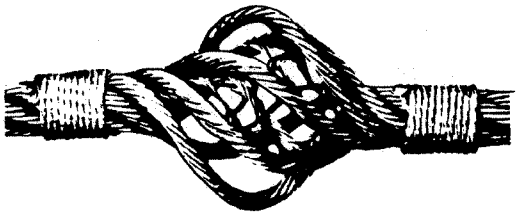


HIGH STRANDING
Figure 4

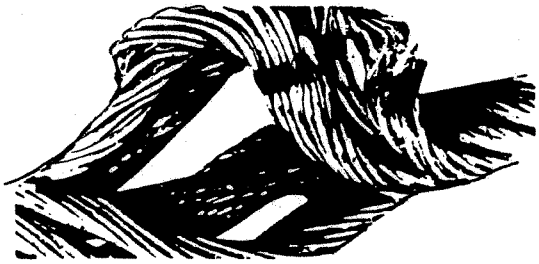
Bird Caging

Bird caging is caused by the rope being twisted or by a sudden release of an overload (Figure 5). 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

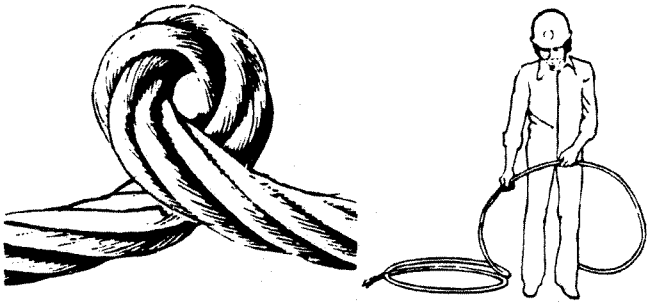
Kinking is caused by loops that have been drawn too tightly as a result of improper handling (Figure 6). Kinks are permanent and will require that the rope, or damaged section, be taken out of service.

Core Protrusion

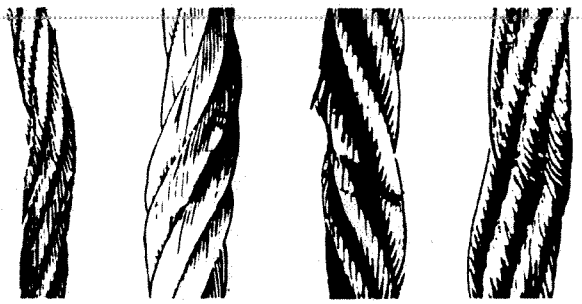
Core protrusion can be caused by shock loads and/or torsional imbalance (Figure 7). This condition requires that the rope be taken out of service.

Electrical Contact

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

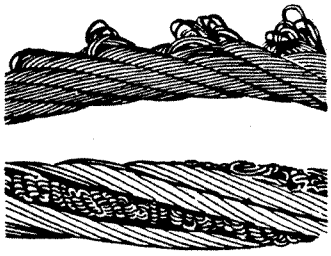


An open kink like this is often caused by improper handling and uncoiling as shown.



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.

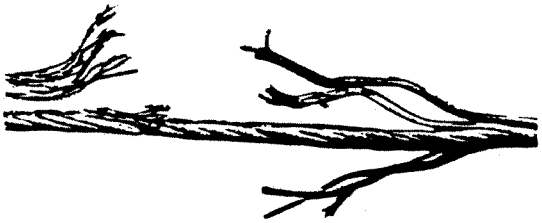
Fatigue failure of wire rope subjected to heavy loads over small sheaves. In addition to the usual crown breaks, there are breaks in the valleys of the strands caused by strand nicking from overloading.

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.

Wear and damage on one side of rope.

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.

TYPICAL ROPE DAMAGE
Figure 8 (continued)

TABLE 6

FAULT	POSSIBLE CAUSE	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	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.
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 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 Broken Off Square	Overload, shock load. Kink. Broken or cracked sheave flange.	Rope Chatters	Rollers too small.
Strand Break	Overload, shock load. Local wear. Slack in 1 or more strands.	Rope Unlays	Swivel fittings on Lang Lay ropes. Rope dragging against stationary object.
		Crushing and Nicking	Rope struck or hit during handling.
Corrosion	Inadequate lubricant. Improper type of lubricant. Improper storage. Exposure to acids or alkalis.	High Stranding	Fittings improperly attached. Broken strand. Kinks, dog legs. Improper seizing.
Kinks, Dog Legs, Distortions	Improper installation. Improper handling.	Reduction in Diameter	Broken core. Overload. Corrosion. Severe wear.
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.	Bird Cage	Sudden release of load.
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.	Strand Nicking	Core failure due to continued operation under high load.
Stretch	Overload. Untwist of Lang Lay ropes.	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.
- Inspect 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

Chain Use, Care and Inspection

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.

CARE

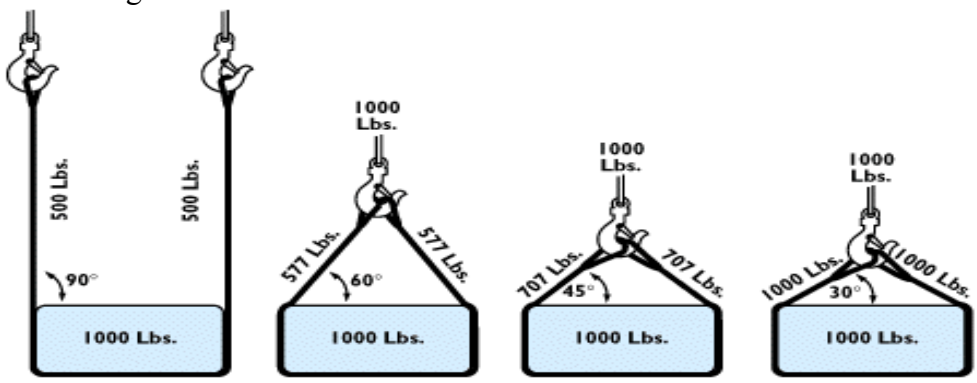
Chains require careful storage and regular maintenance.

- 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.

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
    - Acceleration in rate of load application can produce dangerous overloading.
    - Variations in the angle of the load to the sling as the angle decreases, the working load of the sling will increase.



    - Twisting, knotting or kinking subjects links to unusual loading, decreasing the working load of the sling.
    - Use for purposes other than those for which slings are intended can reduce the working load of the sling.
- 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.

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 here 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.

Nylon Sling Use Care and Inspection

CERTEX

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

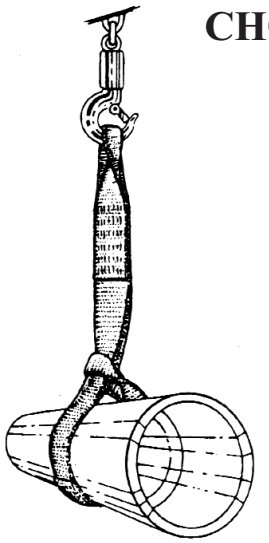
- Any single hitch shall **NEVER** be used to transport a load that is not balanced

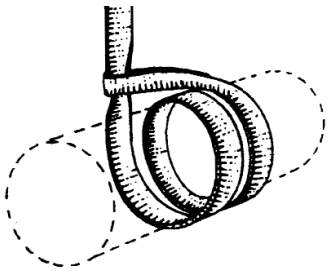
WARNING

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

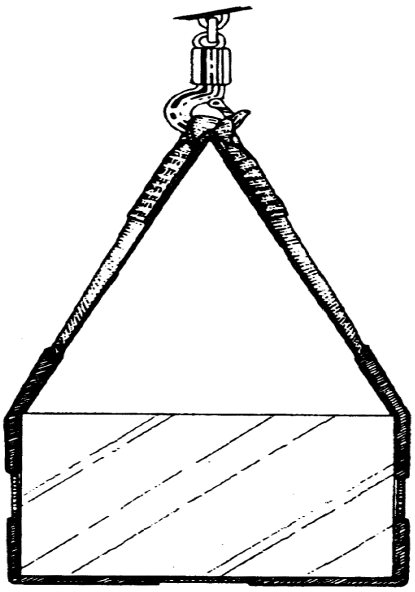




The double wrap hitch or the double wrap choker hitch provides full 360 degree contact with the load.

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.

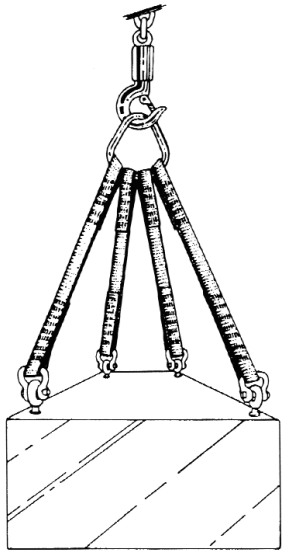
BASKET HITCH



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.

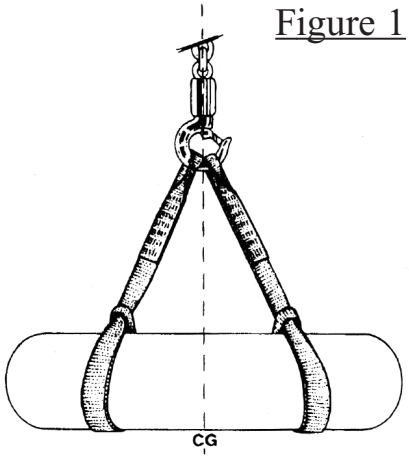
FOUR LEG BRIDLE SLING



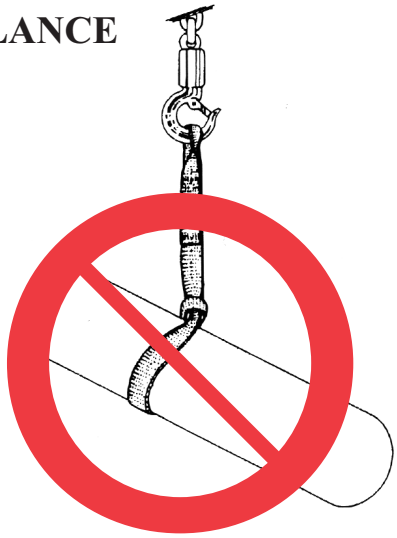
Four Leg Bridle Sling – Each leg length must be the proper length if the object is to hang level. If the hook up is such that two or even three legs are taking the load, the design factor is reduced.

CONTROL & BALANCE

Figure 1



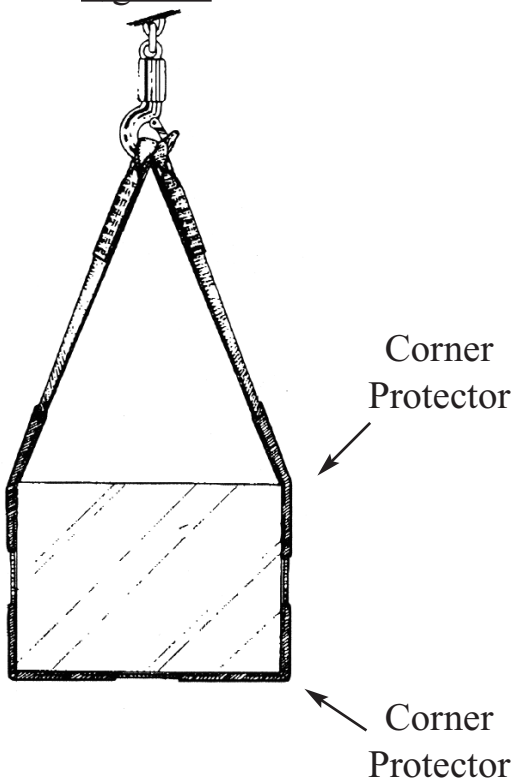
RIGHT WAY



WRONG WAY

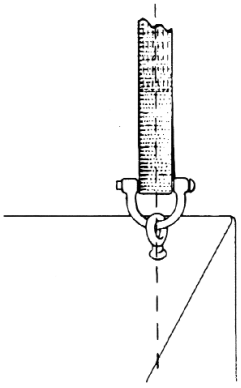
PREVENT DAMAGE

Figure 2

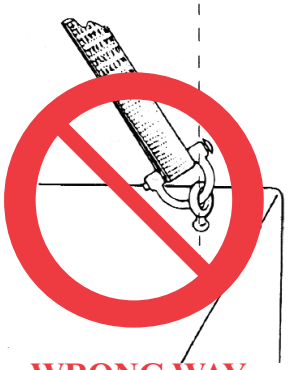


USE OF LIFTING LUGS/EYE BOLTS

Figure 3



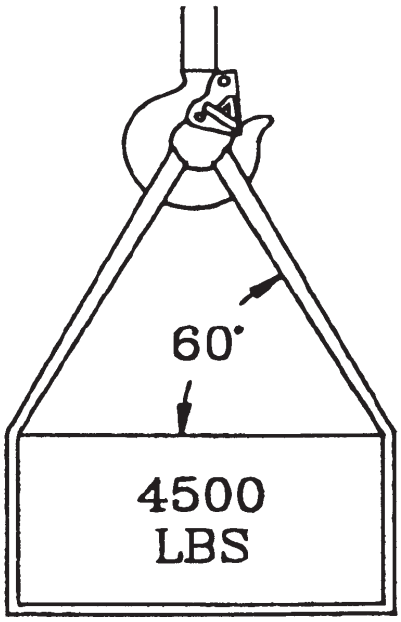
RIGHT WAY



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

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:

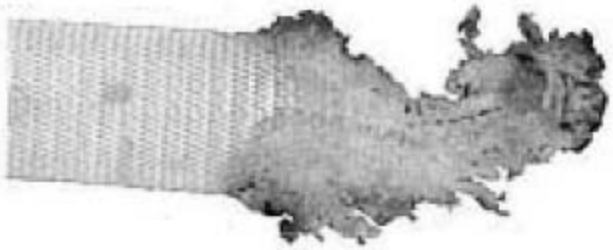
- If sling rated capacity tag is missing or not readable
- Acid or alkalis burns
- Melting, charring or weld spatter on any part of the sling
- Holes, tears, cuts, snags or embedded particles
- Broken or worn stitching in load bearing splices
- Excessive abrasive wear
- Knots in any part of the sling
- 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.)

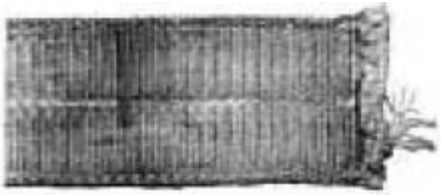
Nylon & Polyester Sling Abuse

Acid Damage

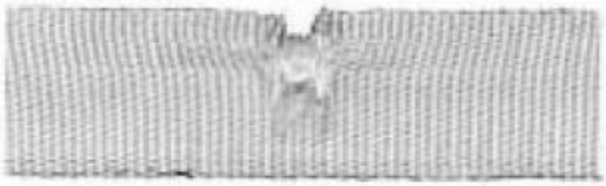


Heat Damage

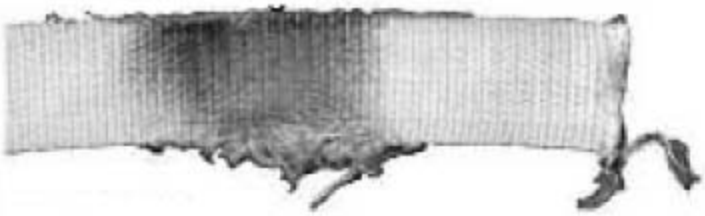
Cuts



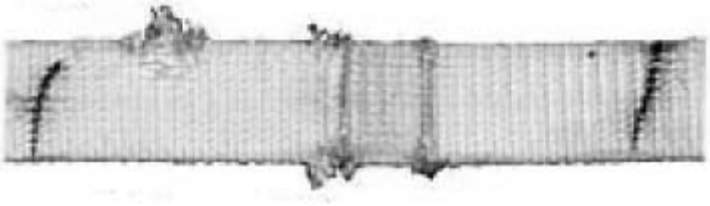
Cut & Tensile Damage



Abrasion Damage

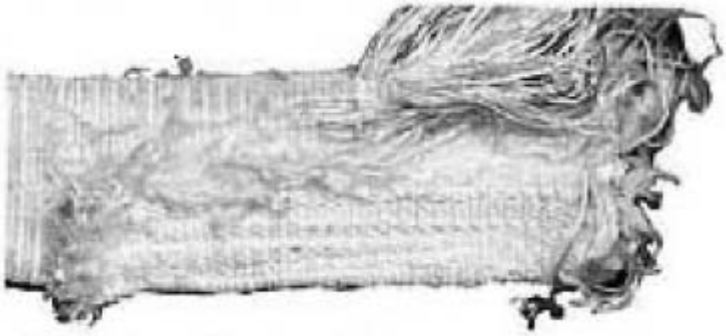


Face Cuts



Punctures & Snags

Tensile Break



Illegible or Missing Tag

Sling Wear Pads

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:

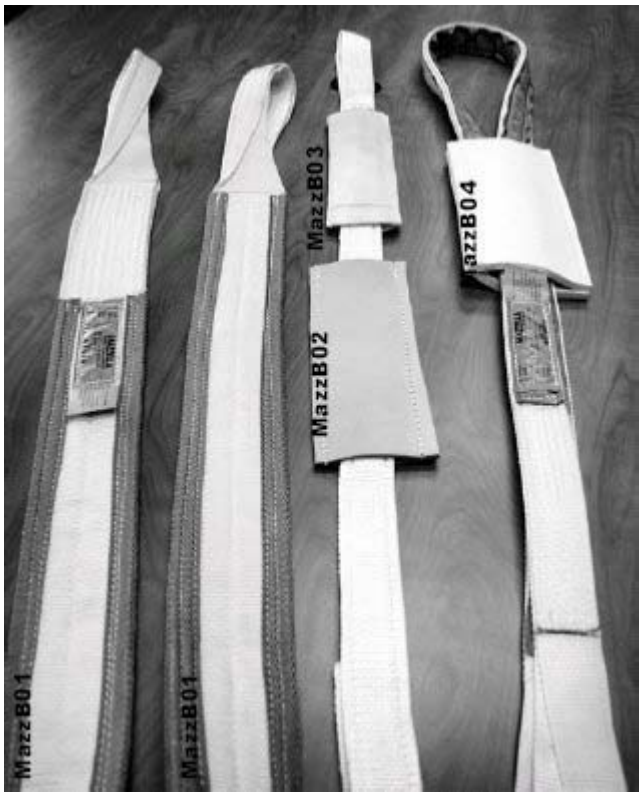
Wire Rope Slings

- Broken wires
- Kinking

- Abrasive wear

Chain Slings

- Abrasive wear
- Nicks, cracks.
- Gouges, stretch



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

Abrasion Protection Pad

DO NOT USE this Pad to protect sling from cutting on load edges, corners or protrusions. This Pad **WILL NOT** adequately prevent damage or failure of sling if used for cut protection. Only Pads which are tested and rated for cut protection are to be used to protect sling from cutting. **DEATH** or **INJURY** can occur from improper use or maintenance. Sling users shall be trained.

Web Slings

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

Nylon & Polyester Web Slings

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.

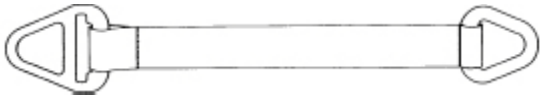
Damaged or misused protection can result in damage or sling failure. Inspect before each use. Inspect for cuts, tears or damage that may prevent protection of the sling. Ensure protection is the correct size and type to protect the sling. *Prevent pads and sling from slipping or sliding across load edge.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

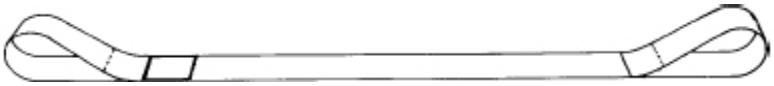
Basic Sling Types

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.

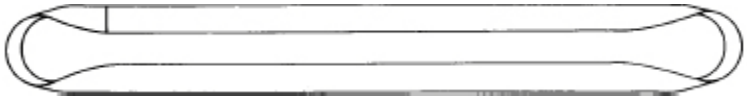
Type III—Web sling made with a flat loop eye on each end with loop eye opening on same plane as sling body. This type of sling is sometimes called a flat eye and eye, eye and eye, or double eye sling.



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:
    1. Frequency of web sling use
    2. Severity of service conditions
    3. Experience gained on the service life of web slings used in similar applications
    4. 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.

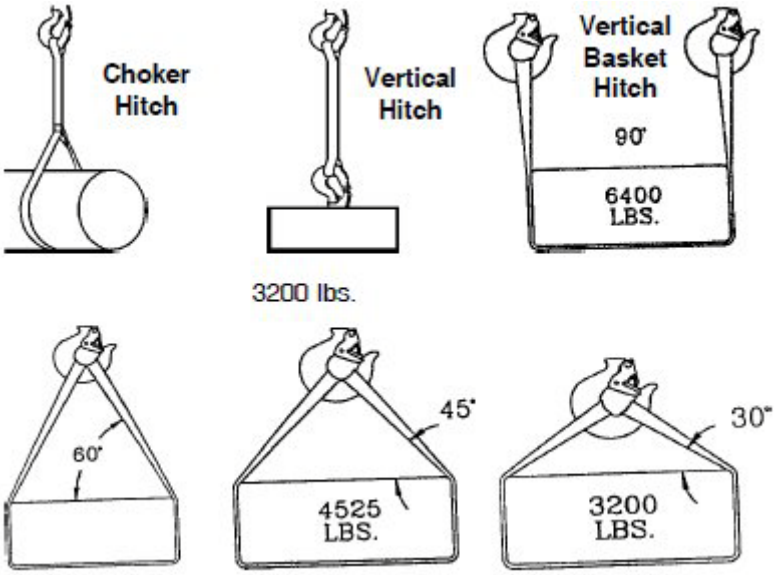
Effect of Angle

Rated capacities are affected by angle of lift (sling to load) measured from the horizontal when used with multi-legged slings or chocker/basket hitches. To determine the actual sling capacity at a given angle of lift, multiply the oringinal sling rating by the appropriate loss factor determined from the table on the right.

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



Angle/Degrees Horizontal	Loss Factor
7/16	0.40
90	1.000
85	0.996
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

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.

To calculate the load on a particular sling leg proceed as follows:

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 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.

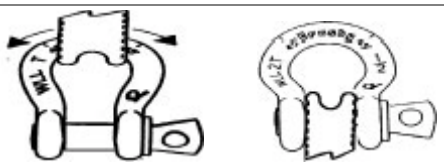
Hooks available in sizes 1- 1/2, 3 and 5 tons.

Shackles available in both a Screw Pin and Bolt,

Nut and cotter pin configuration.

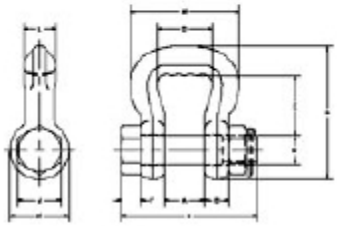
- Bolt (pin) has a larger diameter that provides better load distribution.
- All Alloy construction.

Sling Saver®

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

Load Rated®

Fatigue Rated®



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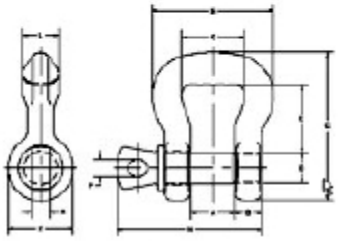
"QT" QUENCHED & TEMPERED

Look for the Red Pin ®
... the mark of genuine
Crosby Quality.

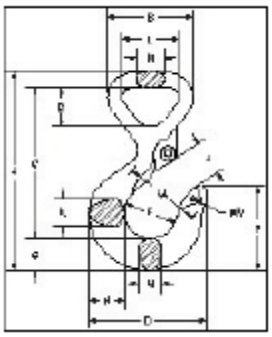


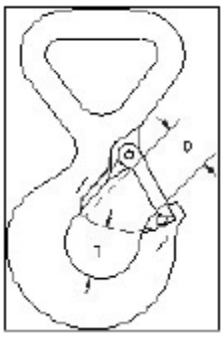
S-253

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)	Dimensions (in) 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

* 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 A S. C.	WSL-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

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.

Campbell Operations
45 Cleveland Street
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
Product Design Engineer

Campbell Operations
45 Cleveland Street
Cortland, NY 13045
Phone: (607) 756-2821
Fax: (607) 753-1722

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

DETERMINING WEIGHT

Objective: To learn how to determine the weight of a load.

Definition: Weight is the amount of force that gravity exerts on an object.

Formula:

Weight = Volume X Density

In order for a lifting device to hold a load, it must exert at least as much force upward as gravity exerts downward.

If the capacity of a lifting device is exceeded, there is a great danger that the lifting device cannot exert enough upward force, and gravity may bring the load crashing down.

For this reason it is extremely important, in fact mandatory, that an operator know the weight of the load. The closer the weight is to the rated capacity of the lifting device, the more accurate the weight determination must be.

Quite often, the weight will be provided by the people in charge of the load. Flight hardware, for instance, coming from another code or agency will have the weight documented. Project management will want to take responsibility for determining the weight of its critical load.

In less critical cases, the weight might be stenciled or marked somewhere on the object to be lifted. Or the weight may be found in documents. It pays to look around first.

But if the information is not provided, it must be obtained otherwise.

The load can be weighed on a floor scale if it is already mounted on a dolly or truck and the weight of the vehicle is known. Then, after rolling the load onto the scale, the weight of the vehicle can be subtracted from the total weight.

If the load is not already on a vehicle, you can't lift it to a floor scale because it hasn't been weighed yet. And it can't be lifted without knowing the weight first. So you need another way to determine the weight.

Using a Hydra-Set to weigh a load is the best idea if qualified operators are available. Hydra-Sets have weight dials built in.

A Hydra-Set lifts so slowly that it gradually removes the weight of an object from the floor. The slow motion allows an operator to stop lifting before the capacity of the crane is exceeded.

Sometimes the weight of a load has to be calculated. To calculate weight, the operator must be able to determine volume and understand density.

First, let's look at volume.

Two standard units of volume are commonly used in the United States: gallons (gal.) and cubic feet (cu.ft.). These are the units that will be used in this lesson.

Liquids are normally measured in gallons. The operator should rely on container labels to find the number of gallons. Add up a separate volume total for each different kind of liquid on the load.

In case a label gives volume in some other units, the following conversion table can be used to switch the numbers into gallons.

VOLUME CONVERSIONS

1 quart (qt.)	=	.25 gal.
1 liter (l.)	=	.26 gal.
1 cubic centimeter (cc.)	=	.00026 gal.
1 cubic yard (cu.yd.)	=	67 gal.
1 cubic inch (cu.in.)	=	.0043 gal.

Solids are normally measured in cubic feet. After measuring an object, convert all measurements into feet using decimals before beginning a calculation. In other words, get rid of the inches. For example:

5 ft. 6 in. becomes 5.5 ft.
4 in. becomes .33 ft
and 3 1/2 yd. becomes 10.5 ft.

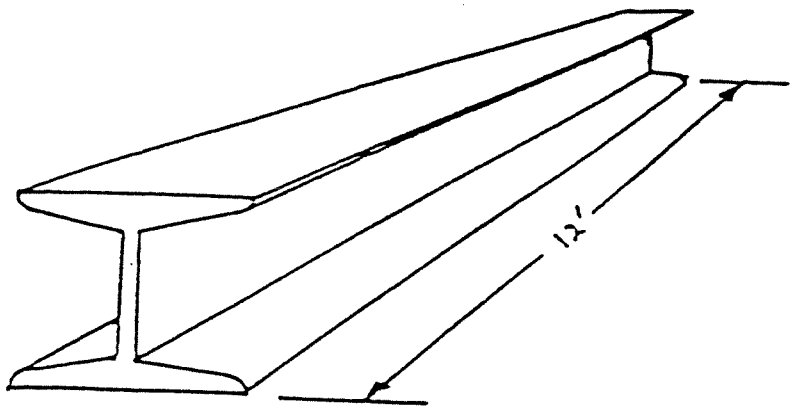
To determine the volume of a box-shaped object, multiply the length times the width times the height. This is the simplest volume formula:

Volume: of a box = Length X Width x Height

Quite often complex shapes can be broken down into several simple shapes. Then the volumes of the simple shapes can be added to get the total.

Example:

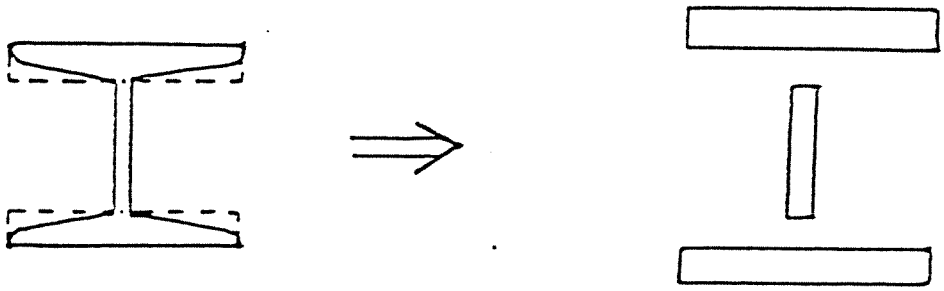
You have to lift a 12 ft. I-beam. Nobody seems to know what it weighs, and the weight charts for I-beams have all been lost. (Typical situation.) So the first step is to determine the volume.



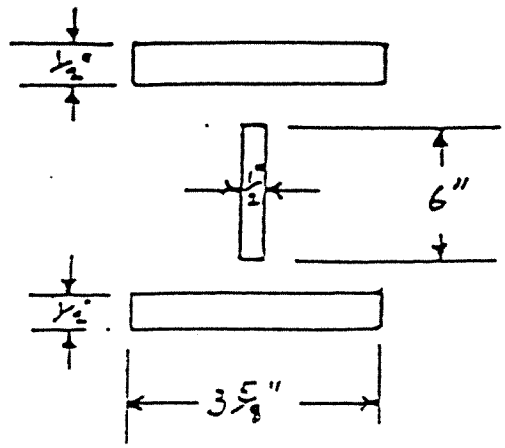
Solution >>>

Our approach will be to break the beam down into three long thin box shapes. After finding the volume of each box, add them together.

Begin by dividing the cross section of the beam into simple rectangles. The flanges of an I-beam are tapered, so make the rectangles by using the thickest part of the flange to be on the safe side.

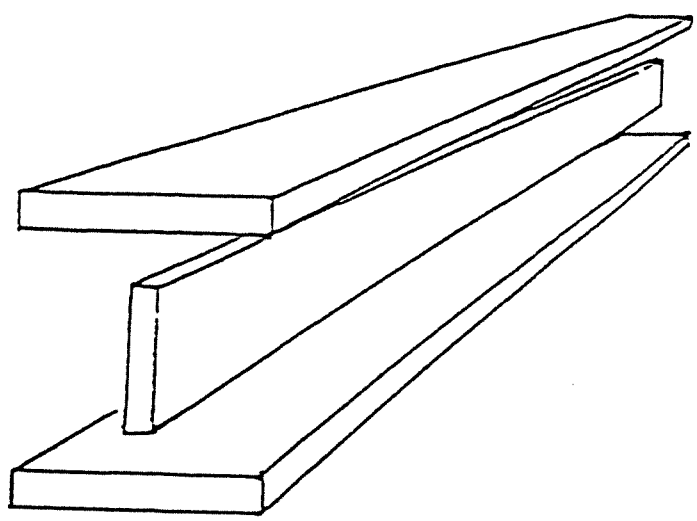


Measure the rectangles and convert the measurements into feet with decimals:



Flanges:	3 5/8 in. X 1/2 in.	converts to	.30 ft. X .042 ft.
Web:	6 in. X 1/2 in.	converts to	.50 ft. X .042 ft.

Now calculate the volume of each thin box-shape and add them together:



Upper flange:	.30 ft. X .042 ft. X 12 ft.	= .15 cu.ft.
Web:	.50 ft. X .042 ft. X 12 ft.	= .25 cu.ft.
Lower flange:	(Same as upper flange)	= .15 cu.ft.
Total volume:		.55 cu.ft. <<< ANSWER

If the object to be measured is shaped like a cylinder, find its volume by multiplying the area of the circular cross section times the length of the cylinder.

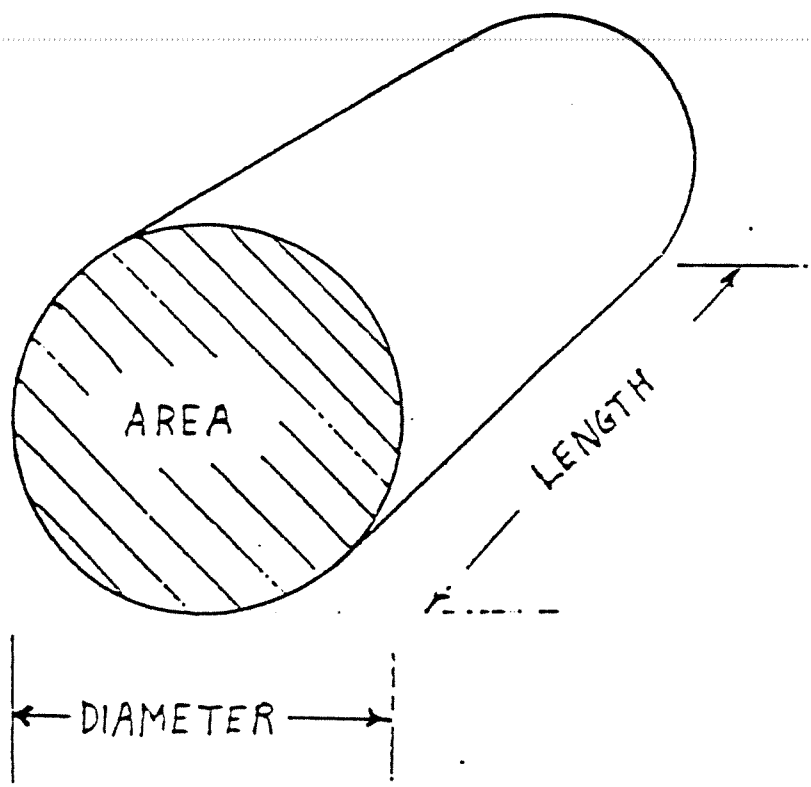
Use this formula to find the area of the cross section:

Cross sectional area = .79 X Diameter X Diameter

(This is the old "πr^2" formula rearranged for convenience.)

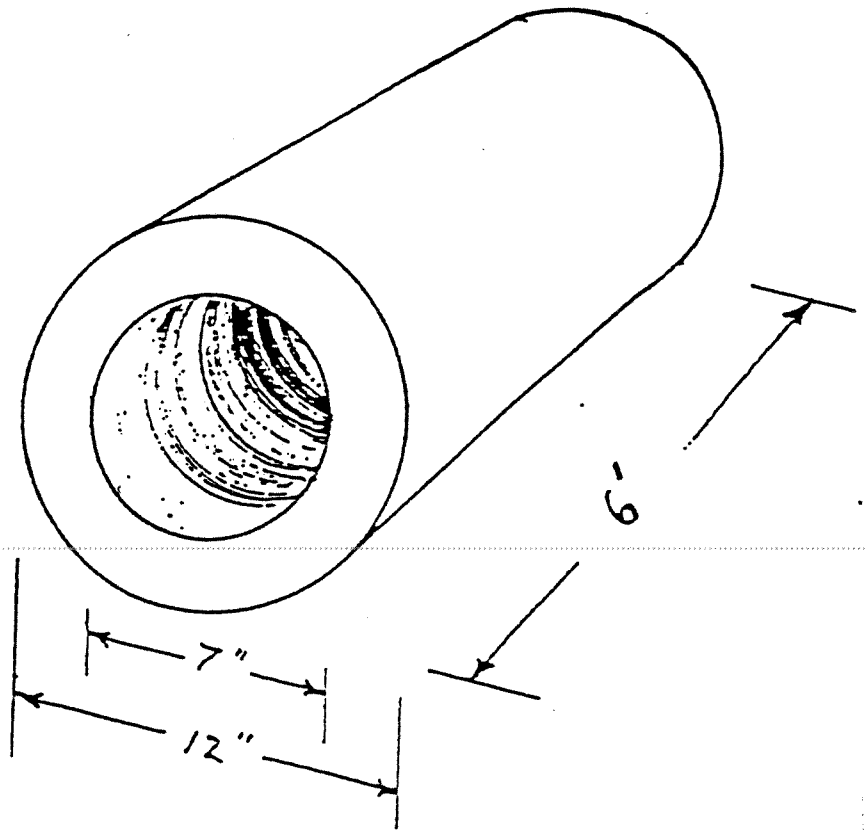
Then take that result and stick it into this formula:

Volume of a cylinder = Cross sectional area X Length



Example:

What is the volume of metal in a cylindrical shaped object, 6 ft. long, with a hole bored along the axis? The outside diameter (O.D.) is 12 in., and the inner diameter (I.D.) is 7 in.



Solution >>>

Our approach will be to find the volume of a solid cylinder 12" in diameter, then subtract the volume of the hole.

First, let's get rid of the inches and work only in feet with decimals.

O.D.	12 in.	converts to 1.00 ft.
I.D.	7 in.	converts to .58 ft.

Now calculate the volume of the cylinder as though it were solid metal:

Area of circular cross section = .79 X Diameter X Diameter
= .79 x 1 ft. X 1 ft.
= .79 sq.ft.

Volume of cylinder = Cross sectional area X Length
= .79 sq.ft. X 6 ft.
= 4.7 cu.ft.

Next find the volume of the cylindrical hole:

Area of cross section = .79 X Diameter X Diameter
= .79 X .58 ft. X .58 ft.
= .27 sq.ft.

Volume = Cross sectional area X Length
= .27 sq.ft. X 6 ft.
= 1.6 cu.ft.

Finally, subtract the volume of the hole from the volume of the solid shape:

4.7 cu.ft. - 1.6 cu.ft. = 3.1 cu.ft. <<< ANSWER

If the object is shaped like a sphere, use this formula:

Volume of a sphere = .52 X Diameter X Diameter X Diameter

For more complicated shapes, ask for help. Don't take chances trying to calculate something if you don't understand it.

Once you know the volume of each material in an object, you're half way there. Volume has to be multiplied by density to get the weight.

Now let's look at density.

Density can be loosely defined as how much one standard volume unit of material weighs.

We have already been using cubic feet (cu.ft.) and gallons (gal.) as standard volume units. We will use pounds (lb.) as the standard weight unit. So our densities will be in pounds per cubic foot (lb./cu.ft.) or pounds per gallon (lb./gal.).

For example, one cubic foot (a standard volume unit) of water weighs 62.4 lbs. You can express the density of water as 62.4 lb/cu.ft. If you choose to use the gallon as your standard volume unit, the density of water is expressed as 8.3 lb./gal. It's another way of saying the same thing.

Every material has its own unique density. Materials less dense than water, like wood and oil, float in water. Materials more dense than water, like metals, sink in water.

A convenient way to do these calculations is to learn the density of only one material, water, and compare everything else to it.

The method has three steps:

1. Find the volume.

2. Ask yourself, "How much would this weigh if it were all water?"

3. Multiply the weight in water by the right specific gravity from the density chart below.

The following chart shows how the density of water compares to the density of some other common materials.

DENSITIES OF MATERIALS

Reference material:

Water - 62.4 lb./cu.ft. or 8.3 lb./gal.

Specific Gravities (comparisons to water):

Wood	Cork	-	.25
	Pine	-	.50
	Oak	-	.75
Metal	Iron & Steel	-	7.8
	Aluminum	-	2.7
	Copper	-	9.0
	Brass	-	8.5
Liquids	Paints	-	.90 to 1.6
	Oil	-	.90
	Gasoline	-	.73
	Most solvents	-	.80 to .90
	Beer	-	?
Other	Concrete	-	2.0 to 3.0
	Plastics	-	.90 to 2.2

Many load weights can be determined well enough by rounding off numbers from the chart above:

Water weighs just over 60 lb./cu.ft.
Pine weighs half as much as water.
Steel weighs nearly 8 times as much as water.

Oil weighs 90% as much as water.
Etc.

Rough approximations like this are OK for loads that are much lighter than the capacity of the lifting device.

Example:

You need to pick up an aluminum structure of unknown weight. Measurements show that there are 11 cu.ft. of aluminum in the whole structure. What does it weigh?

Solution >>>

What would this structure weigh if it were all water? Remember, each cubic foot of water weighs just over 60 lb./cu.ft.

11 cu.ft. X 60 lb./cu.ft. = 660 lbs.

It would weigh 660 lbs. if the material were water. From the density chart, aluminum weighs nearly 3 times as much as water.

3 X 660 lb. = 1980 lb./cu.ft.

Since the structure is made out of aluminum instead of water, it weighs about 1980 lbs. To be safe, call it 2000 lbs. (1 ton). <<< ANSWER

This answer is not very accurate. It wasn't supposed to be. This is an example of a rough calculation that is acceptable if the crane's capacity is at least twice the load weight. It tells you that you're in no danger of exceeding the rated capacity.

Example:

1 dozen 5 gal. cans of acetone on a pallet are going to be unloaded from a truck by using a 1/4 T hoist and a sling weighing 10 lb. Will this be a safe lift?

Solution >>>

Looking first at the liquid, how much would 5 dozen gallons weigh if it were all water? Remember, each gallon of water weighs 8.3 lb.

60 gal. X 8.3 lb./gal. = 498 lb.

The liquid would weigh 498 lb. if it were water. The density chart shows that solvents weigh no more than 90% as much as water. (90% is the worst case, so use it.)

.90 X 498 lb. = 448 lb.

Since the liquid is acetone instead of water, it weighs at most 448 lb.

You know from experience that the pallet weighs about 50 lb. and the empty steel cans about 5 lb. each.

12 X 5 lb. = 60 lb., total weight of empty cans

Add everything:

Acetone	448 lb.
Cans	60 lb.
Pallet	50 lb.
Sling	10 lb.
Total	568 lb.

568 lb. is greater than 1/4 T.

Do not lift! <<< ANSWER

A 1/4 T hoist is no good.
You need at least a 1/2 T lifting device.

In the last example, note that the sling was counted as part of the load weight. Never forget to consider the rigging when making weight calculations. The rigging could be the straw that breaks the crane's back.

If a load weighs more than half of a lifting device's capacity, more accuracy is needed in the weight calculation. Instead of guessing, take exact measurements, use the exact densities, and use a calculator. Do not risk overloading the lifting device.

A tip on determining the weight of liquids: The exact specific gravity (comparison to the density of water) is likely to be written on the label or the MSDS (Material Safety Data Sheet). This will allow you to make a very accurate calculation and save some guesswork.

If you feel uncomfortable about determining the weight of a load, by all means get help or at least ask for a second opinion. Sources of help might be:

- More experienced operators
- Your supervisor
- Engineers

To help keep you honest in your weight determinations, remember this bit of sarcasm:

• Guess now, pay later! •

DETERMINING CENTER OF GRAVITY

Objective: To learn how to determine and control the center of gravity of a load.

Definition: The center of gravity (CG) is the point where an object balances.

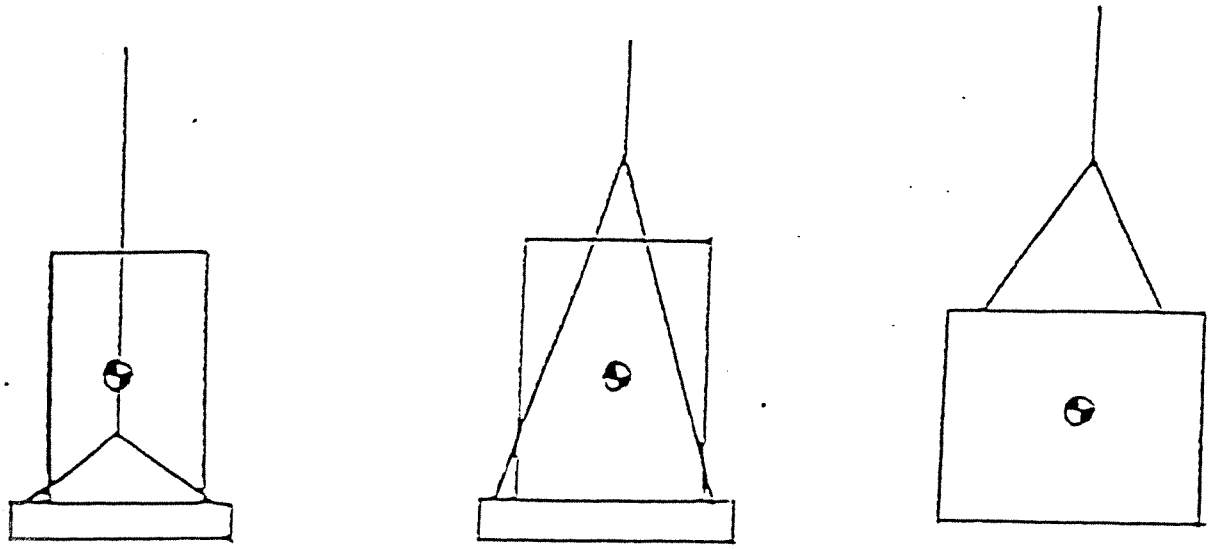
Symbol: CG = ⊕

In a lifting operation, the operators must know, with reasonable accuracy, where the CG of the load is.

Ideally, the CG should be half way between the blades of a fork truck or directly beneath the hook of a crane before the lift begins.

The CG, like water, tends to seek the lowest possible level. With a fork truck, the CG will try to fall to a lower level with bumps, turns, and vibrations. In a crane lift, the load will swing until the CG is directly beneath the hook. The CG of a suspended load will automatically center itself whether the operator wants it to or not.

Stability is the tendency of a load to stay where it belongs. Stability comes in degrees. Of the three examples shown below, the first load will tip without a doubt because there is no stability; the second is risky and should be avoided or handled with extreme caution.



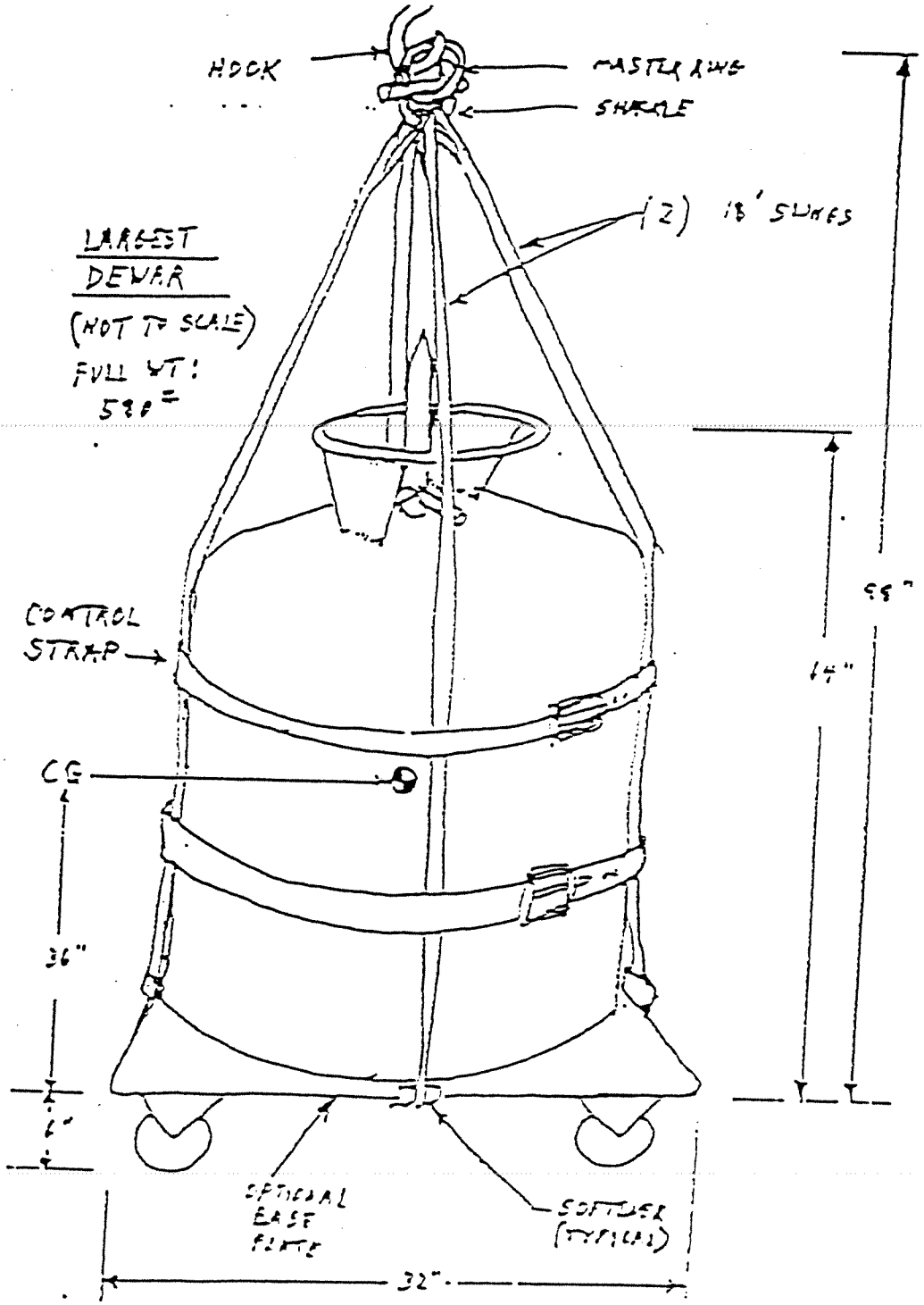
Unstable | Partially Stable | Completely Stable

To be completely stable, there must be some attachment points of the rigging above the CG.

With slings, use control straps where necessary to raise the slings attachment points above the CG.

Example:

Slings support the weight of a dewar from underneath, well below the CG. This load would fall without control straps. The upper control strap attaches the slings to the dewar above the CG and stabilizes the load.



The CG of a symmetric object is in its center. It is an easy matter to determine the CG of a round or box-shaped object. The determination becomes difficult with odd shaped loads.

To find the CG of an odd shaped load, break the shape into a couple of simple segments and determine their individual CG's. Then combine them to find the CG of the total load using the following method:

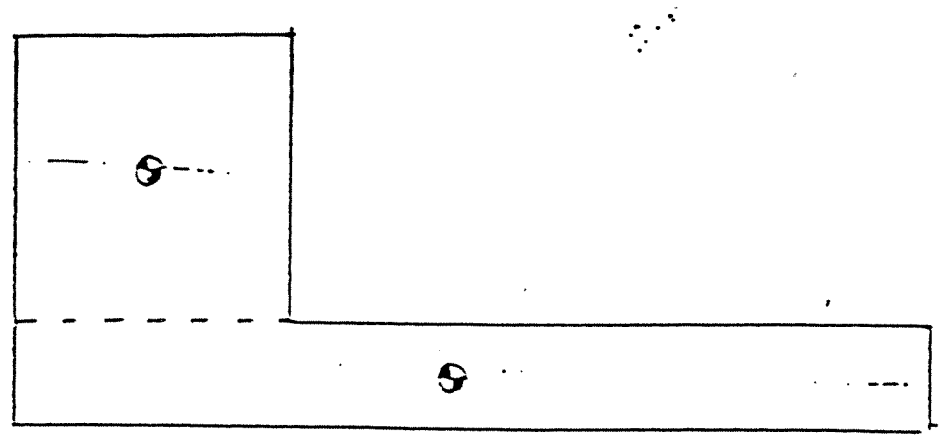
- Find the CG's of two adjacent simple segments.
- Determine the weight of both segments.
- Draw a line connecting the CG's of both segments.
- The total CG will be on this line, closer to the heavier segment by a distance proportional to its percentage of the total weight.
- Repeat the process until all segments have been included.

Example:

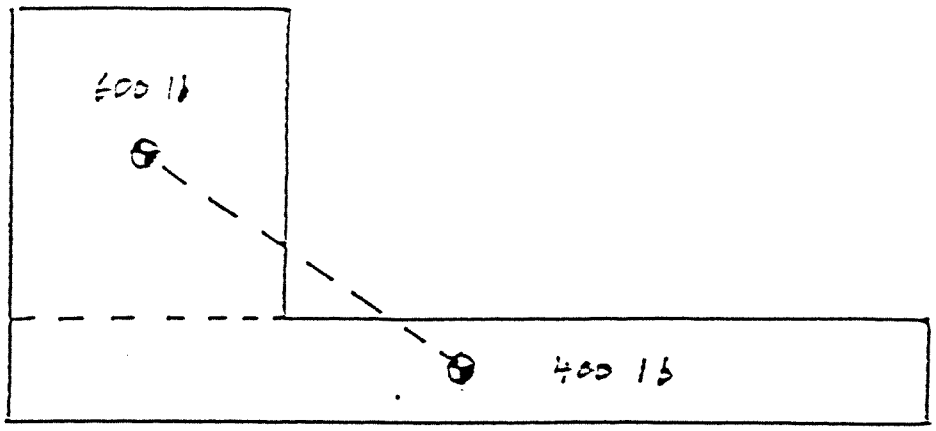
Find the CG of an L-shaped load.

Solution >>>

Break the L into two symmetric segments and find their individual CG's.



Using appropriate methods, determine the weight of each segment. Then draw a line connecting the two CG's.

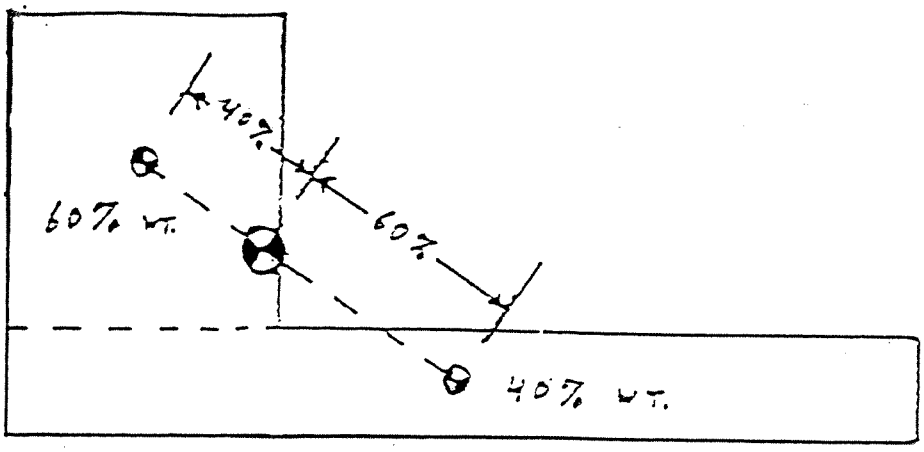


Determine what percentage of the total weight the heavier segment is.

$$\frac{\text{Heavier Segment}}{\text{Total Weight}} \qquad \frac{600 \text{ lbs.}}{1000 \text{ lbs.}} \qquad .60$$

The heavier segment is 60% of the total weight.

The total CG must be closer to the heavier segment on the connecting line. Divide the line into two parts using the same percentages as the weights. The CG is located at this dividing point.



<<< ANSWER

To find the CG of a shape with more than two segments, combine the third segment with the common CG from the first two using the same method. Then combine the fourth with the first three and so on.

More than two segments get difficult. Know your limits and don't be afraid to ask for help. A mechanical engineer is usually qualified to determine CG's.

The calculations described above will give the first approximation of the CG. The precise location will have to be found by trial and

error. After calculating the first approximation, pick up the load just a slight distance and see if it wants to tip. "Fine tune" the rigging by moving the attachment points until the load is stable.

Some loads, constructed of many odd shapes or different materials, are so complex that only the project manager or builder should take the responsibility for determining the weight and CG.

If the payload comes with its own lifting fixture, the CG is already accounted for in the design. The rigger only has to check for current inspection tags and attach the load to the hook.

After going to all the trouble to determine the CG correctly, the last thing anybody wants is to have the CG shift. That could spell disaster. Secure all the various parts of the load, if the are not already. Securing the load is just as important to good rigging as determining the correct weight and center of gravity.

To help you avoid making mistakes, memorize these wise words of wisdom:

- The GSFC corollaries to Murphy's Law:

  If it can swing, it will swing. (Cranes)
  If it can topple, it will topple. (Forklifts)

- Don't place your pride ahead of your knowledge.

Crosby USER'S GUIDE LIFTING

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

THE BASIC RIGGING PLAN

PLAN EVERY LIFT, INCLUDE THE FOLLOWING QUESTIONS WITH THE QUESTIONS YOUR EXPERIENCE PROVIDES:

1. WHO IS RESPONSIBLE (COMPETENT) FOR THE RIGGING?
2. HAS COMMUNICATIONS BEEN ESTABLISHED?
3. IS THE RIGGING IN ACCEPTABLE CONDITION?
4. IS THE RIGGING APPROPRIATE FOR LIFTING?
5. DOES THE RIGGING HAVE PROPER IDENTIFICATION?
6. DOES ALL GEAR HAVE KNOWN WORKING LOAD LIMITS?
7. WHAT IS THE WEIGHT OF THE LOAD?
8. WHERE IS THE LOAD'S CENTER OF GRAVITY?
9. WHAT IS THE SLING ANGLE?
10. WILL THERE BE ANY SIDE OR ANGULAR LOADING?
11. ARE THE SLINGS PADDED AGAINST SHARP CORNERS?
12. ARE THE WORKING LOAD LIMITS ADEQUATE?
13. IS THE LOAD RIGGED TO THE CENTER OF GRAVITY?
14. IS THE HITCH APPROPRIATE FOR THE LOAD?
15. IS A TAG LINE REQUIRED TO CONTROL LOAD?
16. WILL PERSONNEL BE CLEAR OF SUSPENDED LOADS?
17. IS THERE ANY POSSIBILITY OF FOULING?
18. WILL THE LOAD LIFT LEVEL AND BE STABLE?
19. ANY UNUSUAL ENVIRONMENTAL CONCERNS?
20. ANY SPECIAL REQUIREMENTS?

THE RIGGING MUST BE USED WITHIN MANUFACTURER'S RECOMMENDATIONS AND INDUSTRY STANDARDS THAT INCLUDE OSHA, ASME, ANSI, API AND OTHERS.

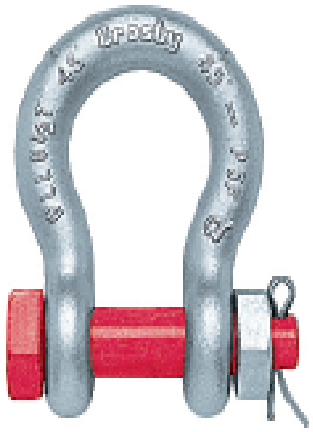
RESPONSIBILITY

USER RESPONSIBILITY

1. UTILIZE APPROPRIATE RIGGING GEAR SUITABLE FOR OVERHEAD LIFTING.
2. UTILIZE THE RIGGING GEAR WITHIN INDUSTRY STANDARDS AND THE MANUFACTURER'S RECOMMENDATIONS.
3. CONDUCT REGULAR INSPECTION AND MAINTENANCE OF THE RIGGING GEAR.
4. PROVIDE EMPLOYEES WITH TRAINING TO MEET OSHA AND ASME (B30.9, B30.26, ETC.) REQUIREMENTS.

MANUFACTURERS RESPONSIBILITY

1. PRODUCT AND APPLICATION INFORMATION
2. PRODUCT THAT IS CLEARLY IDENTIFIED
   - NAME OR LOGO
   - LOAD RATING AND SIZE
   - TRACEABILITY
3. PRODUCT PERFORMANCE
   - WORKING LOAD LIMIT
   - DUCTILITY
   - FATIGUE PROPERTIES
   - IMPACT PROPERTIES
4. PRODUCT TRAINING AND TRAINING RESOURCES



INSPECTION OF RIGGING HARDWARE

INSPECTION FREQUENCY PER ASME B30.26

A VISUAL INSPECTION SHALL BE PERFORMED BY THE USER OR DESIGNATED PERSON EACH DAY BEFORE THE RIGGING HARDWARE IS USED.

A PERIODIC INSPECTION SHALL BE PERFORMED BY A DESIGNATED PERSON, AT LEAST ANNUALLY. THE RIGGING HARDWARE SHALL BE EXAMINED AND A DETERMINATION MADE AS TO WHETHER THEY CONSTITUTE A HAZARD. WRITTEN RECORDS ARE NOT REQUIRED.

SEMI-PERMANENT AND INACCESSIBLE LOCATIONS WHERE FREQUENT INSPECTIONS ARE NOT FEASIBLE SHALL HAVE PERIODIC INSPECTIONS PERFORMED.

REJECTION CRITERIA PER ASME B30.26

MISSING OR ILLEGIBLE MANUFACTURER'S NAME OR TRADEMARK AND/OR RATED LOAD IDENTIFICATION (OR SIZE AS REQUIRED)

A 10% OR MORE REDUCTION OF THE ORIGINAL DIMENSION

BENT, TWISTED, DISTORTED, STRETCHED, ELONGATED, CRACKED OR BROKEN LOAD BEARING COMPONENTS

EXCESSIVE NICKS, GOUGES, PITTING AND CORROSION

INDICATIONS OF HEAT DAMAGE INCLUDING WELD SPATTER OR ARC STRIKES, EVIDENCE OF UNAUTHORIZED WELDING

LOOSE OR MISSING NUTS, BOLTS, COTTER PINS, SNAP RINGS, OR OTHER FASTENERS AND RETAINING DEVICES

UNAUTHORIZED REPLACEMENT COMPONENTS OR OTHER VISIBLE CONDITIONS THAT CAUSE DOUBT AS TO THE CONTINUED USE OF THE SLING

ADDITIONALLY INSPECT WIRE ROPE CLIPS FOR:

1. INSUFFICIENT NUMBER OF CLIPS
2. INCORRECT SPACING BETWEEN CLIPS
3. IMPROPERLY TIGHTENED CLIPS
4. INDICATIONS OF DAMAGED WIRE ROPE OR WIRE ROPE SLIPPAGE
5. IMPROPER ASSEMBLY

ADDITIONALLY, INSPECT WEDGE SOCKETS FOR:

1. INDICATIONS OF DAMAGED WIRE ROPE OR WIRE ROPE SLIPPAGE
2. IMPROPER ASSEMBLY

ADDITIONAL REJECTION CRITERIA PER ASME B30.10 - HOOKS

ANY VISIBLY APPARENT BEND OR TWIST FROM THE PLANE OF THE UNBENT HOOK
ANY DISTORTION CAUSING AN INCREASE IN THROAT OPENING OF 5%, NOT TO EXCEED 1/4"

INSPECTION OF SLINGS

INSPECTION FREQUENCY PER ASME B30.9

A VISUAL INSPECTION FOR DAMAGE SHALL BE PERFORMED BY THE USER OR DESIGNATED PERSON EACH DAY OR SHIFT THE SLING IS USED.

A COMPLETE INSPECTION FOR DAMAGE SHALL BE PERFORMED PERIODICALLY BY A DESIGNATED PERSON, AT LEAST ANNUALLY.

WRITTEN RECORDS OF MOST RECENT PERIODIC INSPECTION SHALL BE MAINTAINED.

REJECTION CRITERIA PER ASME B30.9

MISSING OR ILLEGIBLE SLING IDENTIFICATION; EVIDENCE OF HEAT DAMAGE; SLINGS THAT ARE KNOTTED; FITTINGS THAT ARE PITTED, CORRODED, CRACKED, BENT, TWISTED, GOUGED, OR BROKEN; OTHER CONDITIONS, INCLUDING VISIBLE DAMAGE, THAT CAUSE DOUBT AS TO THE CONTINUED USE OF THE SLING.

WIRE ROPE SLINGS

EXCESSIVE BROKEN WIRES, FOR STRAND-LAID AND SINGLE PART SLINGS, TEN RANDOMLY DISTRIBUTED BROKEN WIRES IN ONE ROPE LAY OR FIVE BROKEN WIRES IN ONE STRAND IN ONE ROPE LAY

SEVERE LOCALIZED ABRASION OR SCRAPING, KINKING, CRUSHING, BIRDCAGING

ANY OTHER DAMAGE RESULTING IN DAMAGE TO THE ROPE STRUCTURE

SEVERE CORROSION OF THE ROPE OR END ATTACHMENTS

CHAIN SLINGS

CRACKS OR BREAKS

EXCESSIVE WEAR, NICKS OR GOUGES

STRETCHED CHAIN LINKS OR COMPONENTS

BENT, TWISTED OR DEFORMED CHAIN LINKS OR COMPONENTS

EXCESSIVE PITTING OR CORROSION

LACK OF ABILITY OF CHAIN OR COMPONENTS TO HINGE FREELY

WELD SPLATTER

WEB SLINGS

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

DISCOLORATION AND BRITTLE OR STIFF AREAS ON ANY PART OF THE SLING, WHICH MAY MEAN CHEMICAL OR ULTRAVIOLET / SUNLIGHT DAMAGE

ROUNDSLINGS

ACID OR CAUSTIC BURNS

EVIDENCE OF HEAT DAMAGE

HOLES, TEARS, CUTS, ABRASIVE WEAR OR SNAGS THAT EXPOSE THE CORE YARNS

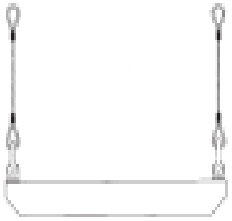
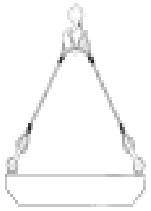
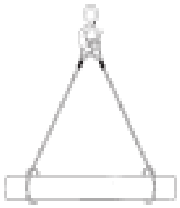
BROKEN OR DAMAGED CORE YARNS

WELD SPLATTER THAT EXPOSES CORE YARNS

DISCOLORATION AND BRITTLE OR STIFF AREAS ON ANY PART OF THE SLINGS, WHICH MAY MEAN CHEMICAL OR OTHER DAMAGE

WIRE ROPE SLING CAPACITIES - TONS (2000 LBS.) - FLEMISH EYE - ASME B30.9

BASED ON 6 X 19 AND 6 X 37 EIP STEEL, IWRC (FOR FIBER CORE DEDUCT APPROXIMATELY 15%) WITH DESIGN FACTOR OF 5

WIRE ROPE SIZE INCHES						
	SINGLE LEG (VERTICAL)	SINGLE CHOKER	TWO LEG SLING VERTICAL	TWO LEG SLING 60° HORIZONTAL SLING ANGLE	TWO LEG SLING 45° HORIZONTAL SLING ANGLE	TWO LEG CHOKER 60° HORIZONTAL SLING ANGLE
1/4	0.65	0.48	1.3	1.1	0.9	0.8
3/8	1.4	1.1	2.9	2.5	2.0	1.8
7/16	1.9	1.4	3.9	3.4	2.7	2.5
1/2	2.5	1.9	5.1	4.4	3.6	3.2
9/16	3.2	2.4	6.4	5.5	4.5	4.1
5/8	3.9	2.9	7.8	6.8	5.5	5.0
3/4	5.6	4.1	11.0	9.7	7.9	7.1
7/8	7.6	5.6	15.0	13.0	11.0	9.7
1	9.8	7.2	20.0	17.0	14.0	13.0
1-1/8	12.0	9.1	24.0	21.0	17.0	16.0
1-1/4	15.0	11.0	30.0	26.0	21.0	19.0

FOR SLING ANGLES OTHER THAN THOSE SHOWN, USE THE RATED LOAD FOR THE NEXT LOWER ANGLE OR A QUALIFIED PERSON SHALL CALCULATE THE RATED LOAD

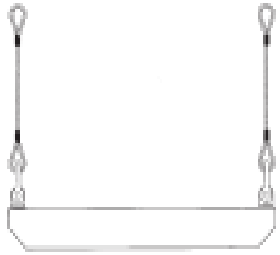
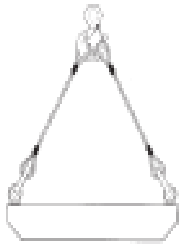
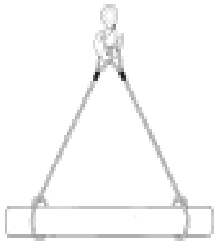
HORIZONTAL SLING ANGLES OF LESS THAN 30 DEGREES ARE NOT RECOMMENDED. THE CAPACITY OF A BRIDLE AT A 30 DEGREE HORIZONTAL IS SAME AS SINGLE VERTICAL LEG.

RATED LOAD BASED ON PIN DIAMETER NO LARGER THAN ONE HALF THE NATURUAL EYE LENGTH OR NOT LESS THAN THE NOMINAL SLING DIAMETER
BASKET HITCH CAPACITY BASED ON MINIMUM D/d RATIO OF 25/1
FOR CHOKER HITCH, THE ANGLE OF CHOKE SHALL BE 120 DEGREES OR GREATER

WIRE ROPE SLING CAPACITIES - TONS (2000 LBS.) - FLEMISH EYE - ASME B30.9

5A

BASED ON 6 X 19 AND 6 X 37 EEIP (EXTRA EXTRA IMPROVED PLOW STEEL), IWRC WITH DESIGN FACTOR OF 5

WIRE ROPE SIZE INCHES						
	SINGLE LEG (VERTICAL)	SINGLE CHOKER	TWO LEG SLING VERTICAL	TWO LEG SLING 60° HORIZONTAL SLING ANGLE	TWO LEG SLING 45° HORIZONTAL SLING ANGLE	TWO LEG CHOKER 60° HORIZONTAL SLING ANGLE
1/4	.71	.52	1.4	1.2	1.0	.90
3/8	1.6	1.2	3.2	2.7	2.2	2.0
7/16	2.1	1.6	4.3	3.7	3.0	2.7
1/2	2.8	2.0	5.5	4.8	3.9	3.5
9/16	3.5	2.6	7.0	6.1	5.0	4.5
5/8	4.3	3.2	8.6	7.5	6.1	5.5
3/4	6.2	4.5	12	11	8.7	7.9
7/8	8.3	6.1	17	14	12	11
1	11	8.0	22	19	15	14

FOR SLING ANGLES OTHER THAN THOSE SHOWN, USE THE RATED LOAD FOR THE NEXT LOWER ANGLE OR A QUALIFIED PERSON SHALL CALCULATE THE RATED LOAD

HORIZONTAL SLING ANGLES OF LESS THAN 30 DEGREES ARE NOT RECOMMENDED. THE CAPACITY OF A BRIDLE AT A 30 DEGREE HORIZONTAL IS SAME AS SINGLE VERTICAL LEG.

NOTE: ONLY USE THE CAPACITIES SHOWN IN THIS CHART WHEN SLING IS IDENTIFIED AS EEIP (EXTRA EXTRA IMPROVED PLOW STEEL)

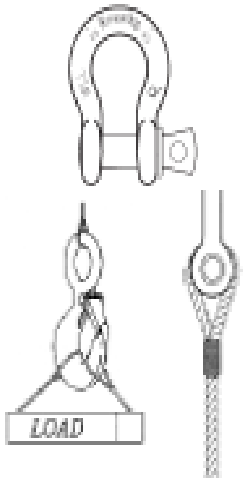
RATED LOAD BASED ON PIN DIAMETER NO LARGER THAN ONE HALF THE NATURUAL EYE LENGTH OR NOT LESS THAN THE NOMINAL SLING DIAMETER

BASKET HITCH CAPACITY BASED ON MINIMUM D/d RATIO OF 25/1

FOR CHOKER HITCH, THE ANGLE OF CHOKE SHALL BE 120 DEGREES OR GREATER

WIRE ROPE SLING CONNECTIONS AND HITCHES

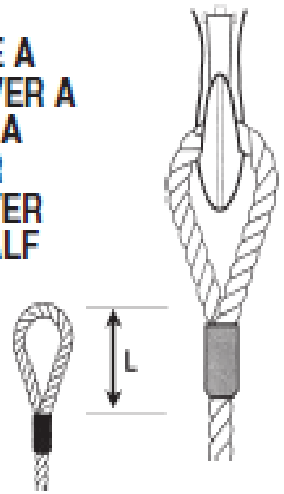
CONNECTION TO FITTINGS



USE A THIMBLE TO PROTECT SLING AND INCREASE D/d

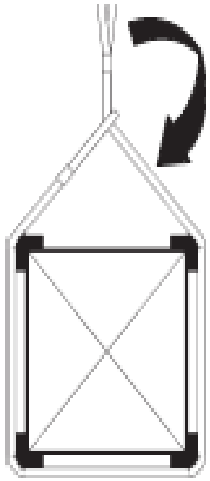
NEVER PLACE EYE OVER A FITTING SMALLER DIAMETER OR WIDTH THAN THE ROPE'S DIAMETER.

NEVER PLACE A SLING EYE OVER A FITTING WITH A DIAMETER OR WIDTH GREATER THAN ONE HALF THE LENGTH OF THE EYE.

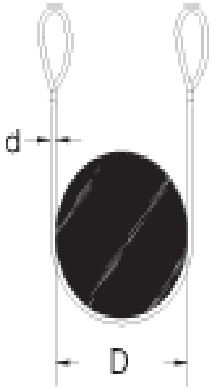


CHOKER CAPACITY

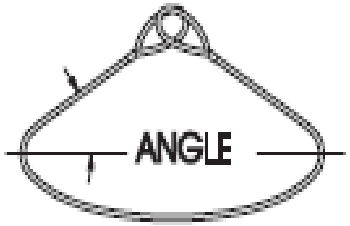
A CHOKER HITCH HAS 75% OF THE CAPACITY OF A SINGLE LEG SLING ONLY IF THE ANGLE OF CHOKE IS 120 DEGREES OR GREATER. A CHOKE ANGLE LESS THAN 120 DEGREES CAN RESULT IN A CAPACITY AS LOW AS 40% OF THE SINGLE LEG.



BASKET HITCH CAPACITY



A BASKET HITCH HAS TWICE THE CAPACITY OF A SINGLE LEG ONLY IF D/d RATIO IS 25/1 AND THE LEGS ARE VERTICAL.



CAPACITY % OF ANGLE SINGLE LEG	
90	200 %
60	170 %
45	140 %
30	100 %

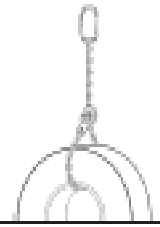
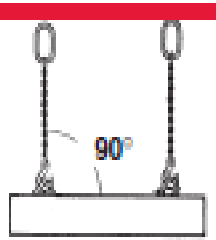
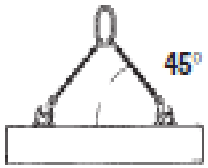
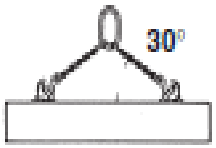
MULTIPLE LEG SLINGS

TRIPLE LEG SLINGS HAVE 50% MORE CAPACITY THAN DOUBLE LEG SLINGS (AT SAME SLING ANGLE) ONLY IF THE CENTER OF GRAVITY IS IN CENTER OF CONNECTION POINTS AND LEGS ARE ADJUSTED PROPERLY (THEY MUST HAVE AN EQUAL SHARE OF THE LOAD).

QUAD (4LEG) SLINGS OFFER IMPROVED STABILITY BUT PROVIDE INCREASED CAPACITY ONLY IF ALL LEGS SHARE AN EQUAL SHARE OF THE LOAD.

CHAIN SLING CAPACITIES (LBS.) — ASME B30.9 - DESIGN FACTOR OF 4

GRADE 8 (80)

CHAIN SIZE (IN.)						
CHAIN GR - 8 DESIGN FACTOR 4/1	VERTICAL (SINGLE LEG)	SINGLE-LEG VERTICAL CHOKER HITCH	TWO LEG OR BASKET HITCH	60 DEGREE SLING ANGLE	45 DEGREE SLING ANGLE	30 DEGREE SLING ANGLE
1/4 - (9/32)	3500	2800	7000	6100	4900	3500
3/8	7100	5700	14200	12300	10000	7100
1/2	12000	9600	24000	20800	17000	12000
5/8	18100	14500	36200	31300	25600	18100
3/4	28300	22600	56600	49000	40000	28300
7/8	34200	27400	68400	59200	48400	34200
1	47700	38200	95400	82600	67400	47700
1-1/4	72300	57800	144600	125200	102200	72300

GRADE 10 (100)

CHAIN GR - 10 DESIGN FACTOR 4/1	VERTICAL (SINGLE LEG)	SINGLE-LEG VERTICAL CHOKER HITCH	TWO LEG OR BASKET HITCH	60 DEGREE SLING ANGLE	45 DEGREE SLING ANGLE	30 DEGREE SLING ANGLE
1/4 - (9/32)	4300	3500	8600	7400	6100	4300
5/16	5700	4500	11400	9900	8100	5700
3/8	8800	7100	17600	15200	12400	8800
1/2	15000	12000	30000	26000	21200	15000
5/8	22600	18100	45200	39100	32000	22600

FOR SLING ANGLES OTHER THAN THOSE SHOWN, USE THE RATED LOAD FOR THE NEXT LOWER ANGLE OR A QUALIFIED PERSON SHALL CALCULATE THE RATED LOAD.

HORIZONTAL SLING ANGLES OF LESS THAN 30 DEGREES ARE NOT RECOMMENDED. THE CAPACITY OF A BRIDLE AT A 30 DEGREE HORIZONTAL IS SAME AS SINGLE VERTICAL LEG.

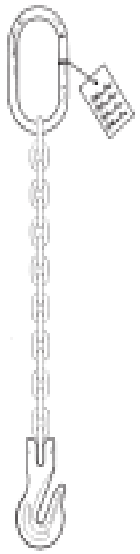
RATED LOADS BASED ON COMPONENTS OF PROPER SHAPE AND SIZE THAT IT SEATS PROPERLY IN THE LOAD HOOK.
FOR CHOKER HITCH, THE ANGLE OF CHOKE SHALL BE 120 DEGREES OR GREATER.

CHAIN SLING CONNECTIONS AND HITCHES

CONNECTION TO FITTINGS

USE MASTER LINKS TO COLLECT SLINGS AND TO CONNECT TO HOOK.

USE GRADE 8 (80) OR GRADE 10 (100) FITTINGS THAT MATCH THE W.L.L. OF CHAIN AND OFFER PROPER SECUREMENT.



CHOKER CAPACITY

A CHOKER HITCH HAS 80% OF THE CAPACITY OF A SINGLE LEG SLING ONLY IF THE ANGLE OF CHOKE IS 120 DEGREES OR GREATER. CHOKE ANGLES LESS THAN 120 DEGREES WILL RESULT IN A SIGNIFICANTLY REDUCED CAPACITY.

NO LOSS IN CAPACITY RESULTS IF A CRADLE GRAB HOOK IS USED.

BASKET HITCH CAPACITY

A TRUE BASKET HITCH HAS TWICE THE CAPACITY OF A SINGLE LEG ONLY IF THE LEGS ARE VERTICAL. NOTE THAT THE BASKET IS FORMED BY USING A CHAIN SLING WITH TWO MASTERLINKS AT EACH END CONNECTED TO THE HOOK.

HORIZONTAL CAPACITY % OF ANGLE SINGLE LEG	
90	200 %
60	170 %
45	140 %
30	100 %

MULTIPLE LEG SLINGS

TRIPLE LEG CHAIN SLINGS HAVE 50% MORE CAPACITY THAN DOUBLE LEG CHAIN SLINGS (AT SAME SLING ANGLE) ONLY IF THE CENTER OF GRAVITY IS IN CENTER OF CONNECTION POINTS AND LEGS ARE ADJUSTED PROPERLY (THEY MUST HAVE AN EQUAL SHARE OF THE LOAD). QUAD (4LEG) CHAIN SLINGS OFFER IMPROVED STABILITY, BUT DO NOT PROVIDE INCREASED CAPACITY. THE CAPACITY OF A FOUR LEG CHAIN SLING IS CONSIDERED THE SAME AS THREE LEG CHAIN SLING.

PRICE $5.00

the Crosby group, inc.®

CROSBY PRODUCTS DISTRIBUTED BY:

#9999875
03/07

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WEB SLING AND ROUNDSLING CAPACITIES

WEB SLING IDENTIFICATION INCLUDES:

SLING TYPE:
TC - TRIANGLE CHOKER,
TT - TRIANGLE TRIANGLE,
EE - EYE AND EYE,
EN - ENDLESS

NUMBER OF PLIES: 1 OR 2
WEBBING GRADE: 9 OR 6
SLING WIDTH (INCH)

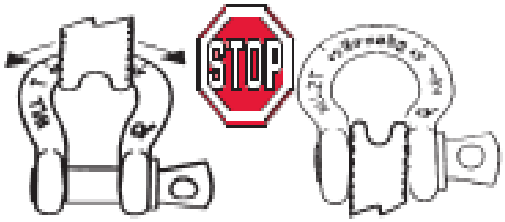
EE 2-9 04 X 12 ← SLING LENGTH (INCH)

ROUNDSLING IDENTIFICATION INCLUDES:

SLING NUMBER: 1-13
SLING NUMBERS ARE FOR REFERENCE ONLY, SOME ROUNDSLINGS HAVE DIFFERENT RATINGS.

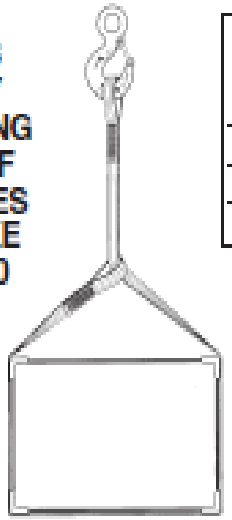
SLING COLOR: PURPLE, GREEN, YELLOW, TAN, RED, WHITE, BLUE, ORANGE
SLING COLOR IS NOT FOLLOWED BY ALL MANUFACTURERS AND SOME COLORS HAVE MORE THAN ONE RATED LOAD.

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



CHOKER CAPACITY

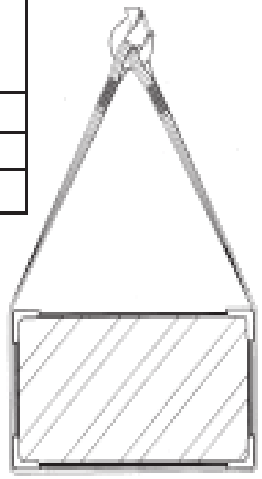
A CHOKER HITCH HAS 80% OF THE CAPACITY OF A SINGLE LEG SLING ONLY IF THE ANGLE OF CHOKE IS 120 DEGREES OR GREATER. A CHOKE ANGLE LESS THAN 120 DEGREES WILL RESULT IN A CAPACITY AS LOW AS 40% OF THE SINGLE LEG.



BASKET HITCH CAPACITY

HORIZONTAL ANGLE	CAPACITY % OF SINGLE LEG
90	200 %
60	170 %
45	140 %
30	100 %

A TRUE BASKET HITCH HAS TWICE THE CAPACITY OF A SINGLE LEG ONLY IF THE LEGS ARE VERTICAL.



MULTIPLE LEG SLINGS

TRIPLE LEG SLINGS HAVE 50% MORE CAPACITY THAN DOUBLE LEG SLINGS (AT SAME SLING ANGLE) ONLY IF THE CENTER OF GRAVITY IS IN CENTER OF CONNECTION POINTS AND LEGS ADJUSTED PROPERLY (THEY MUST HAVE AN EQUAL SHARE OF THE LOAD).

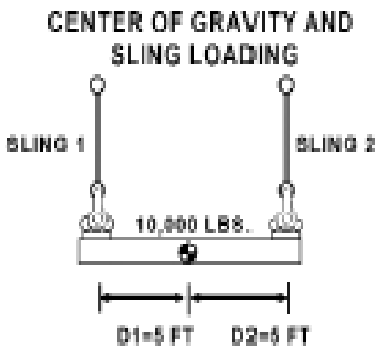
QUAD (4LEG) SLINGS OFFER IMPROVED STABILITY BUT PROVIDE INCREASED CAPACITY ONLY IF ALL LEGS SHARE AN EQUAL SHARE OF THE LOAD.

ALWAYS SELECT AND USE WEB SLINGS AND ROUND SLINGS BY THE RATED LOAD SHOWN ON THE SLING IDENTIFICATION, NEVER BY WIDTH, COLOR OR SLING NUMBER

CENTER OF GRAVITY AND SLING LOADING

WHEN LIFTING VERTICALLY, THE LOAD WILL BE SHARED EQUALLY IF THE CENTER OF GRAVITY IS PLACED EQUALLY BETWEEN THE PICK POINTS.

IF THE WEIGHT OF THE LOAD IS 10,000 LBS., THEN EACH SLING WILL HAVE A LOAD OF 5,000 LBS. AND EACH SHACKLE AND EYEBOLT WILL ALSO HAVE A LOAD OF 5,000 LBS.



WEIGHTS AND MEASURES

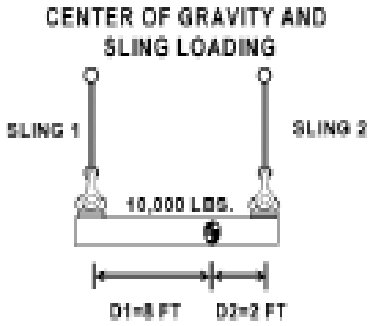
UNIT WEIGHT STEEL = 490 LBS/FT^3
UNIT WEIGHT ALUMINUM = 165 LBS/FT^3
UNIT WEIGHT CONCRETE = 150 LBS/FT^3
UNIT WEIGHT WOOD = 50 LBS/FT^3
UNIT WEIGHT WATER = 62 LBS/FT^3
UNIT WEIGHT SAND AND GRAVEL = 120 LBS/FT^3
UNIT WEIGHT COPPER = 560 LBS/FT^3
UNIT WEIGHT OIL = 58 LBS/FT^3

1 CUBIC FT. = 7.5 GALS
1 METRIC TON = 1.1 US TONS
1 KILOGRAM = 2.2 LBS

1/2 INCH = 12.7 mm
1 INCH = 25.4 mm

CENTER OF GRAVITY AND SLING LOADING

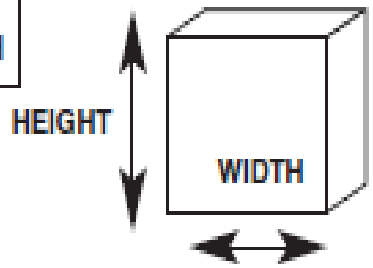
WHEN THE CENTER OF GRAVITY IS NOT EQUALLY SPACED BETWEEN THE PICK POINTS, THE SLING AND FITTINGS WILL NOT CARRY AN EQUAL SHARE OF THE LOAD. THE SLING CONNECTED TO THE PICK POINT CLOSEST TO THE CENTER OF GRAVITY WILL CARRY THE GREATEST SHARE OF THE LOAD.



SLING 2 IS CLOSEST TO COG. IT WILL HAVE THE GREATEST SHARE OF THE LOAD.

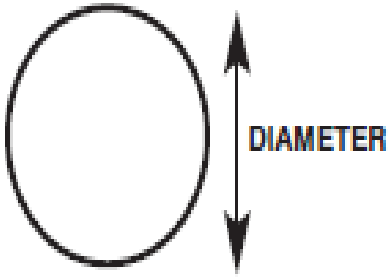
SLING 2 = 10,000 X 8 / (8+2) = 8,000 LBS.
SLING 1 = 10,000 X 2 / (8+2) = 2,000 LBS.

VOLUME OF CUBE =
HEIGHT x WIDTH x LENGTH

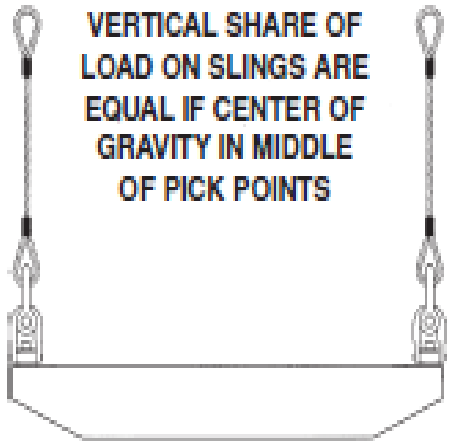


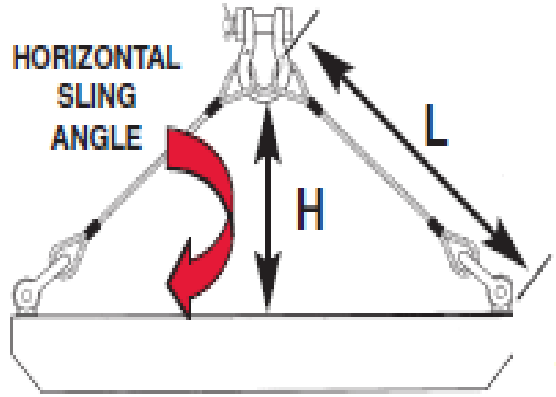
VOLUME OF SPHERE =
3.14 x (DIAM. x DIAM. x DIAM.) / 6

VOLUME OF CYLINDER =
3.14 x (DIAM. x DIAM. x LENGTH) / 4



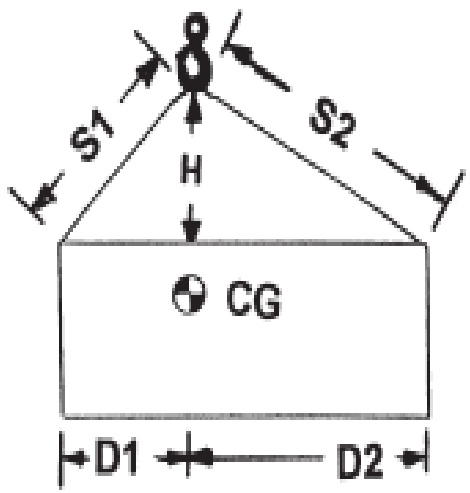
TWO LEGGED SLING - WIRE ROPE, CHAIN, SYNTHETICS





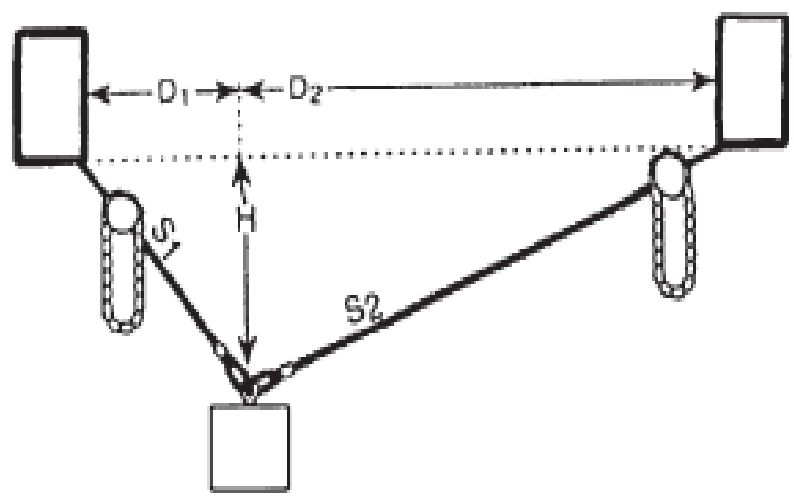
HORIZONTAL SLING ANGLE (A) DEGREE	LOAD ANGLE FACTOR = L/H
90	1.000
60	1.155
50	1.305
45	1.414
30	2.000

LOAD ON EACH LEG OF SLING = VERTICAL SHARE OF LOAD X LOAD ANGLE FACTOR



LOAD ON SLING CALCULATED
TENSION 1 = LOAD X D2 X S1/(H(D1+D2))
TENSION 2 = LOAD X D1 X S2/(H(D1+D2))

HORIZONTAL SLING ANGLES OF LESS THAN 30 DEGREES ARE NOT RECOMMENDED REFER TO ANSI B30.9 FOR FULL INFORMATION



LOAD ON SLING CALCULATED
TENSION 1 = LOAD X D2 X S1/(H(D1+D2))
TENSION 2 = LOAD X D1 X S2/(H(D1+D2))

CROSBY SHACKLES

NOMINAL SIZE (IN) DIAMETER OF BOW	CARBON MAXIMUM WORKING LOAD TONS	ALLOY MAXIMUM WORKING LOAD TONS	INSIDE WIDTH AT PIN (INCHES)	DIAMETER OF PIN (INCHES)
3/16	1/3	—	.38	.25
1/4	1/2	—	.47	.31
5/16	3/4	—	.53	.38
3/8	1	2	.66	.44
7/16	1-1/2	2.6	.75	.50
1/2	2	3.3	.81	.63
5/8	3-1/4	5	1.06	.75
3/4	4-3/4	7	1.25	.88
7/8	6-1/2	9.5	1.44	1.00
1	8-1/2	12.5	1.69	1.13
1-1/8	9-1/2	15	1.81	1.25
1-1/4	12	18	2.03	1.38
1-3/8	13 - 1/2	21	2.25	1.50
1-1/2	17	30	2.38	1.63

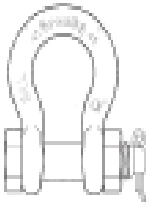
CROSBY HOIST HOOKS

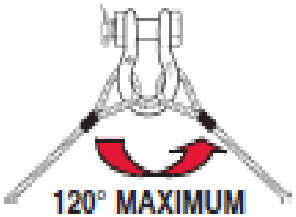
CARBON MAXIMUM WORKING LOAD TONS	CODE	ALLOY MAXIMUM WORKING LOAD TONS	CODE	THROAT OPENING WITH LATCH	DEFORMATION INDICATOR A - A
3/4	DC	1	DA	.88	1.50
1	FC	1-1/2	FA	.97	2.00
1-1/2	GC	2	GA	1.00	2.00
2	HC	3	HA	1.12	2.00
3	IC	*4-1/2 /5	IA	1.06	2.50
5	JC	7	JA	1.50	3.00
7-1/2	KC	11	KA	1.75	4.00
10	LC	15	LA	1.91	4.00
15	NC	22	NA	2.75	5.00
20	OC	30	OA	3.25	6.50
25	PC	37	PA	3.00	7.00
30	SC	45	SA	3.38	8.00
40	TC	60	TA	4.12	10.00

* 320 EYE HOOK IS NOW RATED AT 5 TONS

USE SCREW PIN SHACKLES WHEN PICKING AND PLACING, TIGHTEN PIN BEFORE EACH LIFT

USE BOLT SHACKLES IN PERMANENT OR LONG TERM INSTALLATIONS

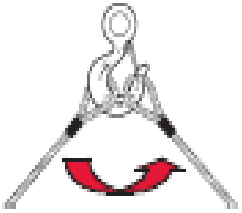




120° MAXIMUM INCLUDED ANGLE. SHACKLE PIN MUST BE PLACED IN HOOK WHEN USED AS A COLLECTOR. USE ONLY SCREW PIN OR BOLT TYPE SHACKLES

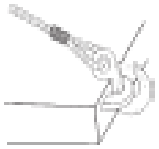
VISUAL VERIFICATION OF PROPER HOOK ENGAGEMENT IS REQUIRED IN ALL CASES

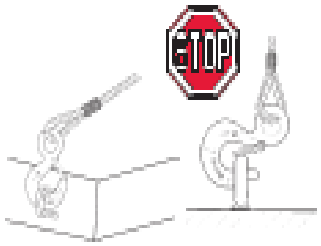
MAKE SURE SLINGS ARE IN BASE OF THE HOOK AND THAT THE LATCH IS NOT FOULED



90° MAXIMUM INCLUDED ANGLE

DO NOT TIP LOAD, SIDE LOAD OR BACK LOAD HOIST HOOKS





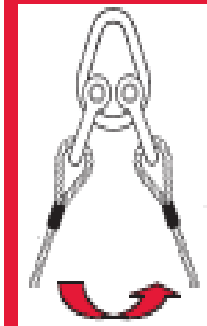
WHEN SLINGS PLACED INTO HOOK, THE MINIMUM HORIZONTAL SLING ANGLE IS 45°

CROSBY SHACKLES AND HOIST HOOKS ARE RATED IN METRIC TONS

CROSBY LINKS AND RINGS

WORKING LOAD LIMITS IN LBS. ARE FOR USE WITH WIRE ROPE AND SYNTHETIC SLINGS AT A DESIGN FACTOR OF 5.

SIZE OF LINK IN INCHES	G-341 CARBON	A-341 ALLOY	A-342 ALLOY
1/2	2900	7000	7000
5/8	4200	9000	9000
3/4	6000	12300	12300
7/8	8300	15000	15000
1	10800	24360	24360
1-1/8	N/A	30600	N/A
1-1/4	16750	36000	36000
1-3/8	20500	43000	N/A
1-1/2	N/A	54300	54300
1-5/8	N/A	62600	N/A
1-3/4	N/A	84900	84900
2	N/A	102600	102600



120° MAXIMUM INCLUDED ANGLE FOR PEAR SHAPE LINKS AND MASTER LINKS

THE USE OF A COLLECTOR RING INSURES THAT THE SLINGS WILL BE IN THE BASE OF THE HOOK

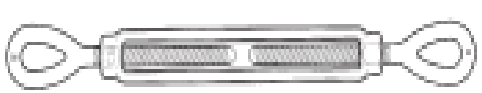
CROSBY TURNBUCKLES 13

CROSBY HEAT TREATED TURNBUCKLES ARE SUITABLE FOR CRITICAL APPLICATIONS. WORKING LOAD LIMITS ARE IN LBS.

USE JAW OR EYE END TURNBUCKLES FOR OVERHEAD LIFTING. HOOK STYLE TURNBUCKLES ARE FOR GUYING OR "PLUMBING UP

SIZE	WORKING LOAD LIMIT JAW AND EYE 5/1 DESIGN FACTOR	WORKING LOAD LIMIT HOOK END FITTING 5/1 DESIGN FACTOR
1/4	500	400
5/16	800	700
3/8	1200	1000
1/2	2200	1500
5/8	3500	2250
3/4	5200	3000
7/8	7200	4000
1	10000	5000
1-1/4	15200	6500
1-1/2	21400	7500

LOAD APPLIED SHOULD BE IN LINE AND IN TENSION, TURNBUCKLES SHOULD NOT BE SIDE LOADED



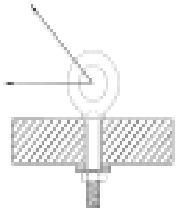
TURNBUCKLES MUST BE SECURED TO PREVENT UNSCREWING DURING THE LIFT OR FOR LONG-TERM INSTALLATIONS SHOULD BE ADJUSTED WITH A PROPERLY SIZED WRENCH, USED ON THE WRENCH FLATS OF THE TURNBUCKLE BODY.

CROSBY SHOULDERED G-277 AND S-279 EYE BOLTS

SHANK DIAMETER (IN.)	WORKING LOAD LIMIT IN-LINE PULL (LBS.)	WORKING LOAD LIMIT 60 DEGREES SLING ANGLE (LBS.)	WORKING LOAD LIMIT 45 DEGREES SLING ANGLE (LBS.)	WORKING LOAD LIMIT/ANGLE LESS THAN 45 DEGREES (LBS.)
1/4	650	420	195	160
5/16	1200	780	360	300
3/8	1550	1000	465	380
1/2	2600	1690	780	650
5/8	5200	3380	1560	1300
3/4	7200	4680	2160	1800
7/8	10600	6890	3180	2650
1	13300	8645	3990	3325
1-1/4	21000	13600	6300	5250
1-1/2	24000	15600	7200	6000

SHOULDER EYE BOLTS

- NEVER EXCEED WORKING LOAD LIMITS.
- NEVER USE REGULAR NUT EYE BOLTS FOR ANGULAR LIFTS.
- ALWAYS USE SHOULDER NUT EYE BOLTS FOR ANGULAR LIFTS.
- FOR ANGULAR LIFTS, ADJUST WORKING LOAD AS SHOWN ABOVE.
- ALWAYS TIGHTEN NUTS SECURELY AGAINST THE LOAD.
- ALWAYS APPLY LOAD TO EYE BOLT IN THE PLANE OF THE EYE.

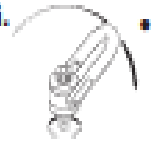


CROSBY HR-125 HOIST RINGS 14

THREAD SHANK SIZE U.N.C. (IN.)	WORKING LOAD LIMIT AT ALL ANGLES (LBS.)	TORQUE (FT - LBS)
5/16	800	7
3/8	1000	12
1/2	2500	28
5/8	4000	60
3/4	7000	100
7/8	8000	160
1	10000	230
1-1/4	15000	470
1-1/2	24000	800
2	30000	1100

SWIVEL HOIST RINGS

- WHEN USING LIFTING SLINGS OF TWO OR MORE LEGS MAKE SURE THE FORCES IN THE LEG ARE CALCULATED. SELECT THE PROPER SIZE SWIVEL HOIST RING TO ALLOW FOR LOAD IN SLING LEG.
- ALWAYS INSURE HOIST RING IS FREE TO ALIGN ITSELF WITH SLING.



- ALWAYS INSURE HOIST RING IS PROPERLY TORQUED TO REQUIRED VALUE.

CROSBY EYE BOLTS AND HOIST RINGS

OPERATING PRACTICES - ANSI B30.9

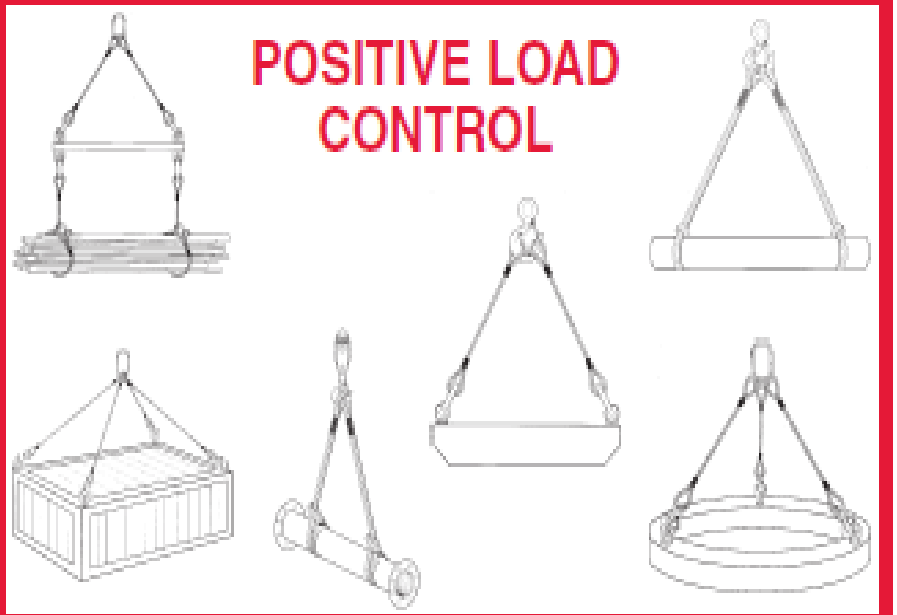
WHENEVER ANY SLING IS USED, THE FOLLOWING PRACTICES SHALL BE OBSERVED.

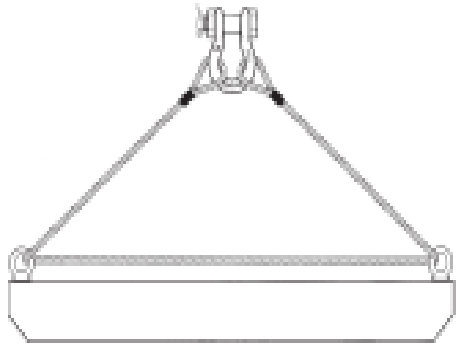
1. SLINGS THAT ARE DAMAGED OR DEFECTIVE SHALL NOT BE USED.
2. SLINGS SHALL NOT BE SHORTENED WITH KNOTS OR BOLTS OR OTHER MAKESHIFT DEVICES.
3. SLING LEGS SHALL NOT BE KINKED.
4. SLINGS SHALL NOT BE LOADED IN EXCESS OF THEIR RATED CAPACITIES.
5. SLINGS USED IN A BASKET HITCH SHALL HAVE THE LOADS BALANCED TO PREVENT SLIPPAGE.
6. SLINGS SHALL BE SECURELY ATTACHED TO THEIR LOAD.
7. SLINGS SHALL BE PADDED OR PROTECTED FROM THE SHARP EDGES OF THEIR LOADS.
8. SUSPENDED LOADS SHALL BE KEPT CLEAR OF ALL OBSTRUCTION.
9. ALL EMPLOYEES SHALL BE KEPT CLEAR OF LOADS ABOUT TO BE LIFTED AND OF SUSPENDED LOADS.
10. HANDS OR FINGERS SHALL NOT BE PLACED BETWEEN THE SLING AND ITS LOAD WHILE THE SLING IS BEING TIGHTENED AROUND THE LOAD.
11. SHOCK LOADING IS PROHIBITED!
12. A SLING SHALL NOT BE PULLED FROM UNDER A LOAD WHEN THE LOAD IS RESTING ON THE SLING.

INSPECTION: 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.

LOAD CONTROL

POSITIVE LOAD CONTROL



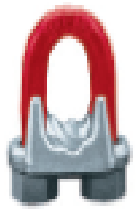


REEVING THROUGH CONNECTIONS TO LOAD INCREASES LOAD ON CONNECTION FITTINGS BY AS MUCH AS TWICE.

DO NOT REEVE!

Crosby

WIRE ROPE CLIPS



G-450 U-Bolt Clip

NEVER SADDLE A DEAD HORSE.

NEVER USE MALLEABLE CLIPS FOR ANY CRITICAL APPLICATION.

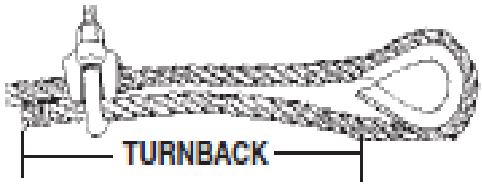
FOR ELEVATOR, PERSONNEL HOIST, AND SCAFFOLD APPLICATIONS, ANSI A17.1 AND A10.4. DO NOT RECOMMEND U-BOLT CLIPS. CROSBY RECOMMENDS FIST GRIP CLIPS FOR TIE OFF LINES FOR FALL PROTECTION.

G-429 Fist Grip Clip

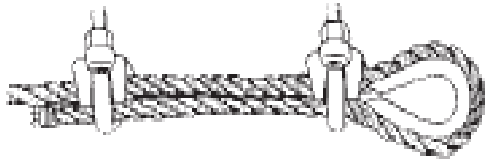
SIZE (IN.)	NUMBER OF CLIPS	TURNBACK LENGTH (IN.)	TORQUE FT-LBS.
1/8	2	3-1/4	4.5
3/16	2	3-3/4	7.5
1/4	2	4-3/4	15
5/16	2	5-1/4	30
3/8	2	6-1/2	45
7/16	2	7	65
1/2	3	11-1/2	65
9/16	3	12	95
5/8	3	12	95
3/4	4	18	130
1	5	26	225

SIZE (IN.)	NUMBER OF CLIPS	TURNBACK LENGTH (IN.)	TORQUE FT-LBS.
3/16	2	4	30
1/4	2	4	30
5/16	2	5	30
3/8	2	5-1/4	45
7/16	2	6-1/2	65
1/2	3	11	65
9/16	3	12-3/4	130
5/8	3	13-1/2	130
3/4	3	16	225
1	5	37	225

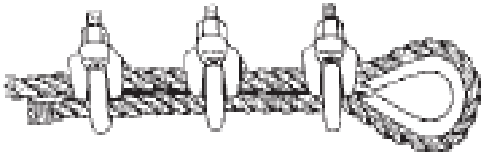
SOME STANDARDS MAY REQUIRE A MINIMUM OF 3 WIRE ROPE CLIPS. THE NUMBER OF CLIPS SHOWN IS BASED UPON USING RRL OR RLL WIRE ROPE, 6 X 19 OR 6 X 37 CLASS, FC OR IWRC; IPS OR XIP, XXIP, ALSO APPLIES TO ROTATION - RESISTANT RRL WIRE ROPE, 8 X 19 CLASS, IPS, XIP, XXIP, SIZES 1-1/2 INCH AND SMALLER; AND TO ROTATION-RESISTANT RRL WIRE ROPE, 19 X 7 CLASS, IPS, XIP, XXIP SIZES 1-3/4 INCH AND SMALLER. IF A PULLEY (SHEAVE) IS USED FOR TURNING BACK THE WIRE ROPE, ADD ONE ADDITIONAL CLIP. CLIPS ARE 80% EFFICIENT UNDER 1" AND 90% 1" AND ABOVE.



1 APPLY FIRST CLIP ONE BASE WIDTH FROM DEAD END



2 APPLY SECOND CLIP AS NEAR THIMBLE AS POSSIBLE



3 APPLY ALL ADDITIONAL CLIPS EVENLY BETWEEN THE FIRST TWO

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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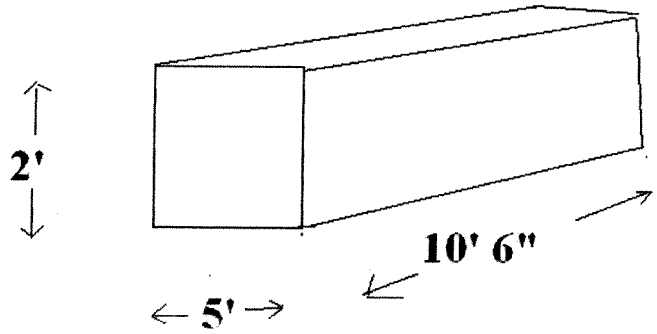
Load Weight Estimation

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

Exercise #1

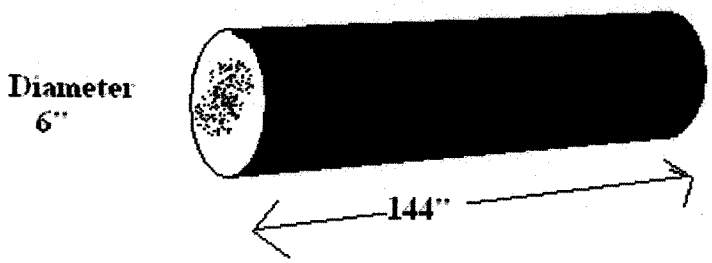
(Concrete Block) **Concrete = (150 Pounds per Cubic Foot)**



Volume_____ **Weight** _____

Exercise #2

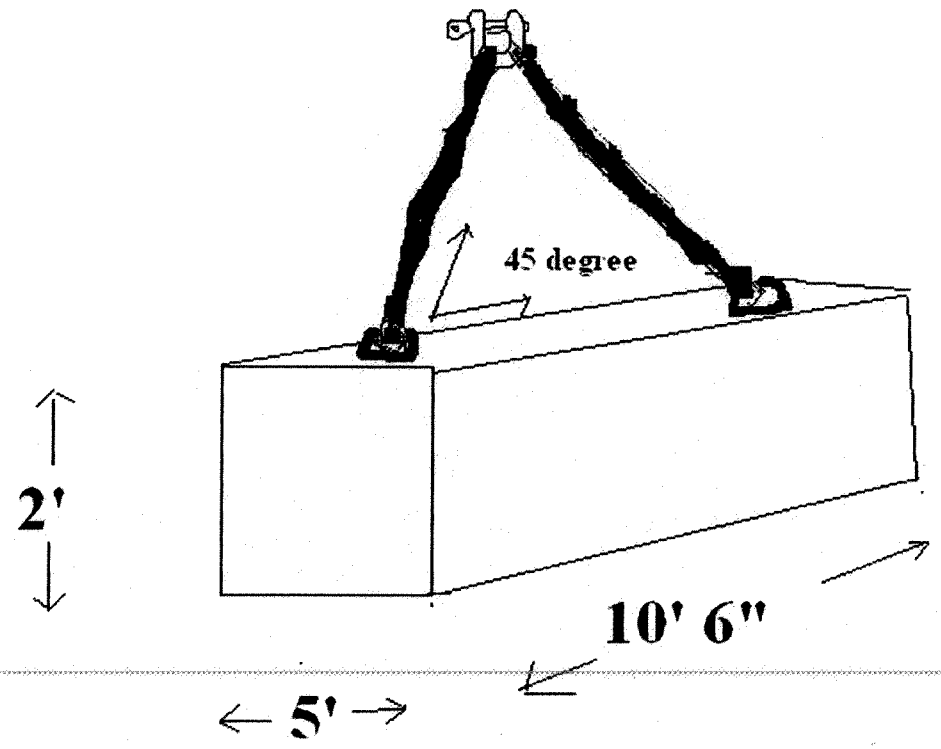
(Steel Shaft) **(Steel = 490 LBS per Cubic Foot)**



Volume _____ **Weight** _____

Load Weight Estimation

Exercise #3



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)

Common Rigging Problems

D/d Ratio

Wire Rope Slings - Introduction

Wire Rope Sling Features

- Lowest cost per ton of lift of all slings
- Ideal for heavy loads and rugged conditions
- Flexible and abrasion resistant
- Wide range of possible end terminations
- More Information

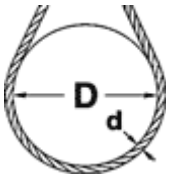
Wire Rope Sling Sizes

- Wire rope diameters from 1/4 to 3 inches
- Capacities from 0.65 to 153 tons

Sling Eye

A sling eye should never be used over a hook or pin with a body diameter larger than the natural width of the eye. Never force an eye over a hook.
Conversely, the eye should always be used on a hook or pin with a diameter at least equal to that of the wire rope.

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.

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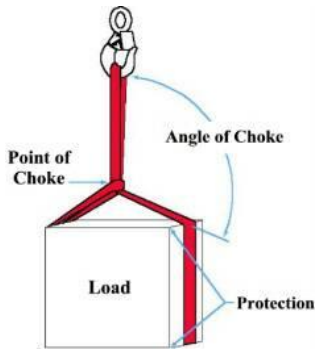
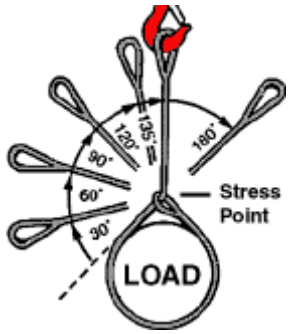
Common Rigging Problems

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°.

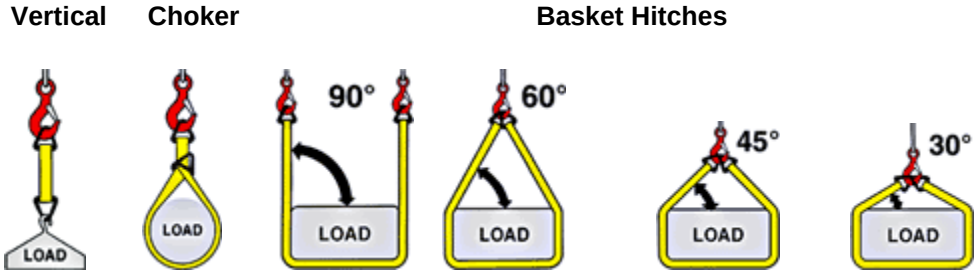
Not Calculating Sling Angle

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.



	Vertical	Choker	Basket Hitches			
Sample Sling WLL (lbs.):	**500**	**375**	**1,000**	**866**	**707**	**500**

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.

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.

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.**

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

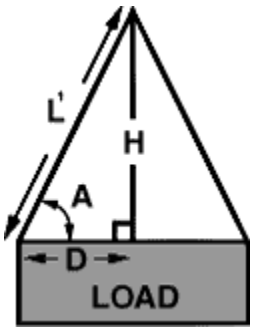
Load Angle Factor = L / H

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) =

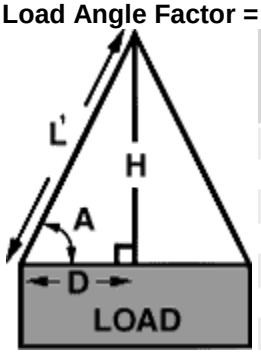
$$\frac{\textbf{Load (lbs.) x Load Angle Factor}}{\textbf{Number of Legs*}}$$



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
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		

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

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

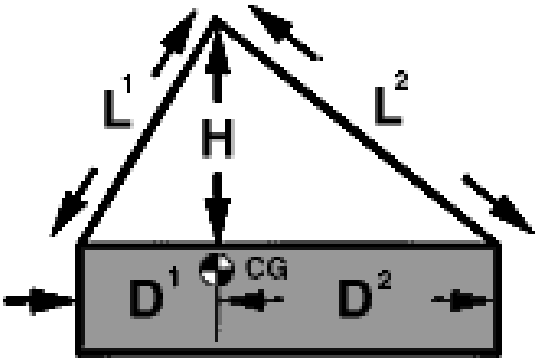
Unequal Legs

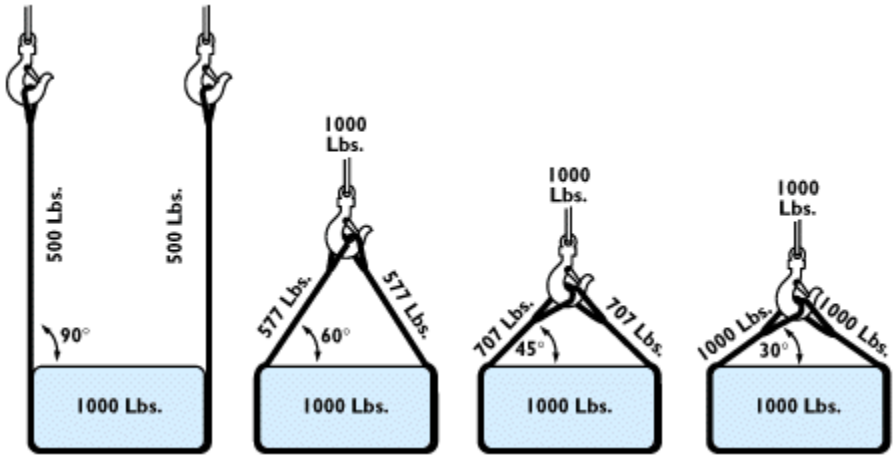
To calculate the load on each leg of a sling with unequal legs:

Load on Leg L^1 =

$$\frac{\textbf{Load (lbs) x } D^2 \textbf{ x } L^1}{H \times (D^1 + D^2)}$$

Load on Leg L^2 =





Common Rigging Problems

Not Inspecting Rigging Before every use.

Synthetic Slings

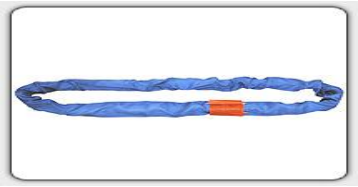
Make a thorough inspection of slings and attachments. Items to look for include:

- 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

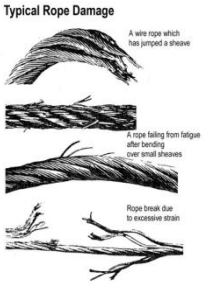


Use and Inspection:

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 on stand 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

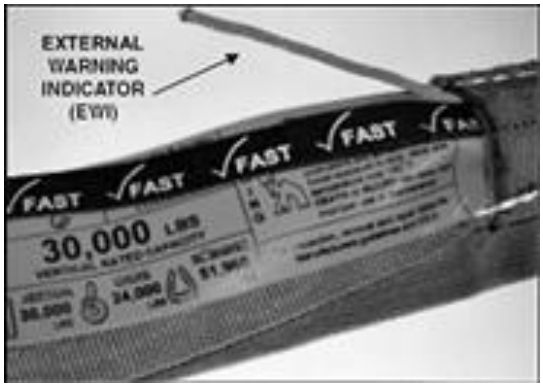
Make a thorough inspection of slings and attachments. Items to look for include:

- 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



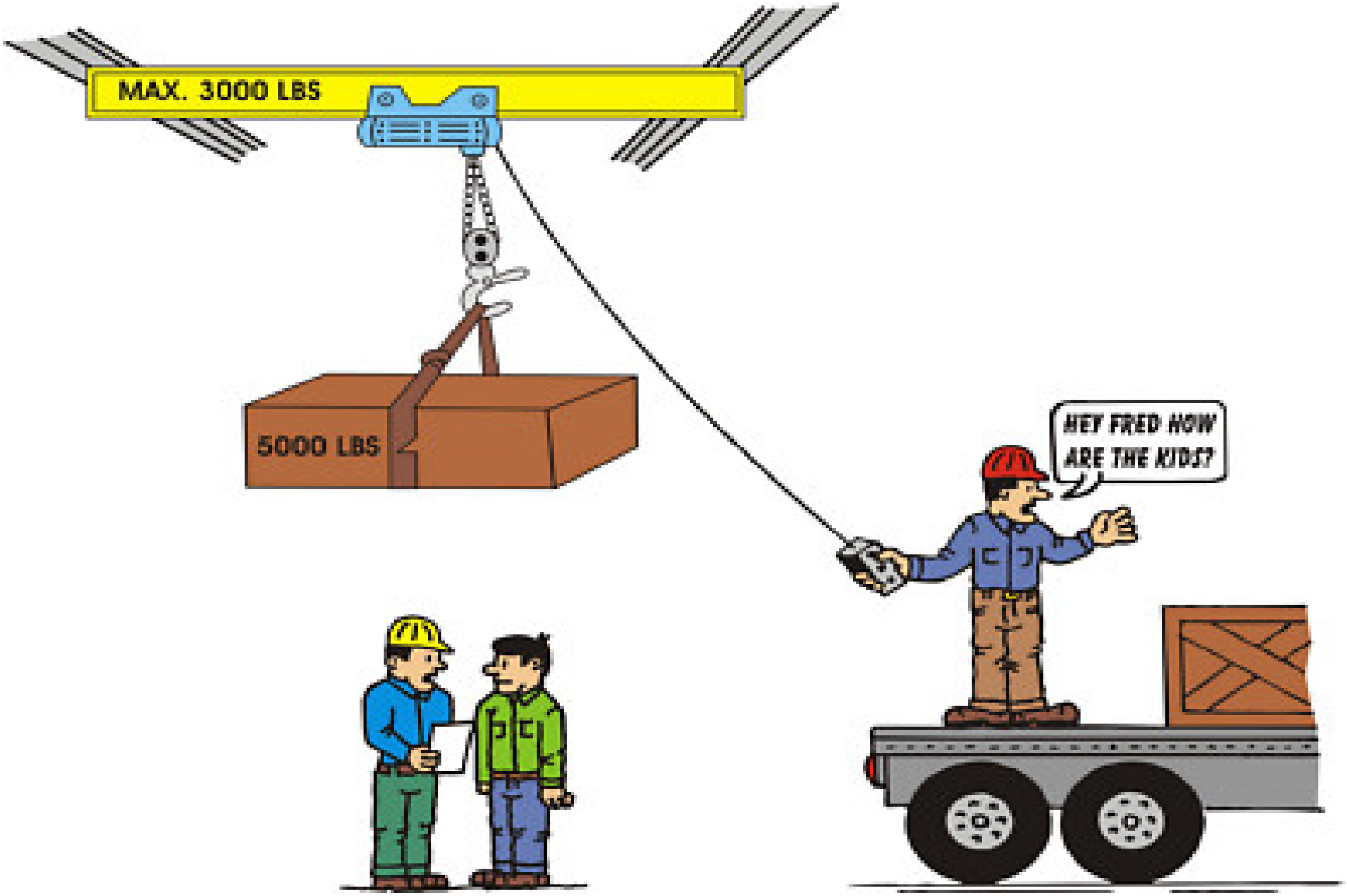
Capacity No Known

Not Able to read and understand Rigging Selection Charts

Common Rigging Problems

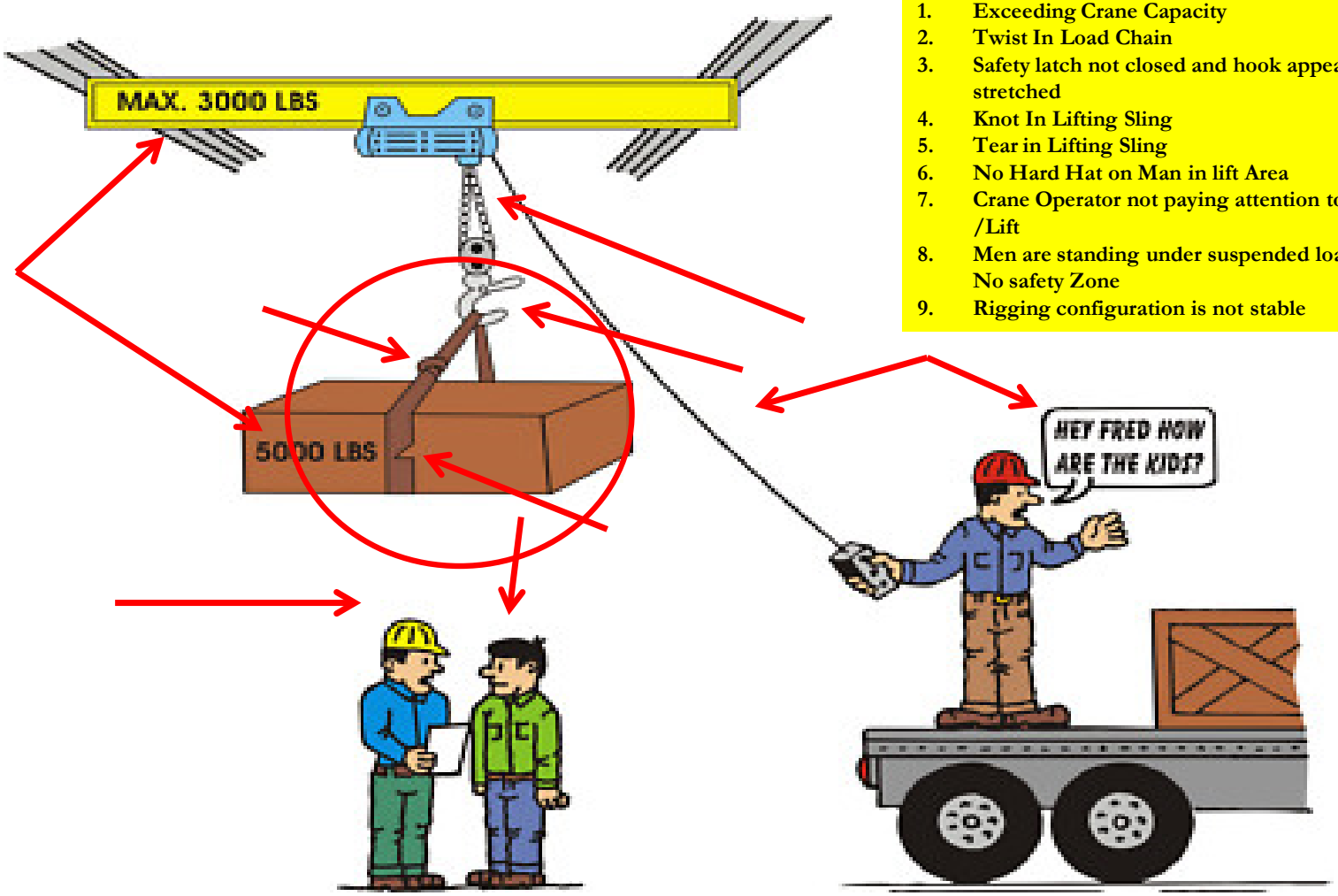
Use of Improperly made below the hook lifting devices

How Many Violations Can You Find?



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



THE RIGGING PLAN

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 **YOU** have a Plan?

THE RIGGING PLAN

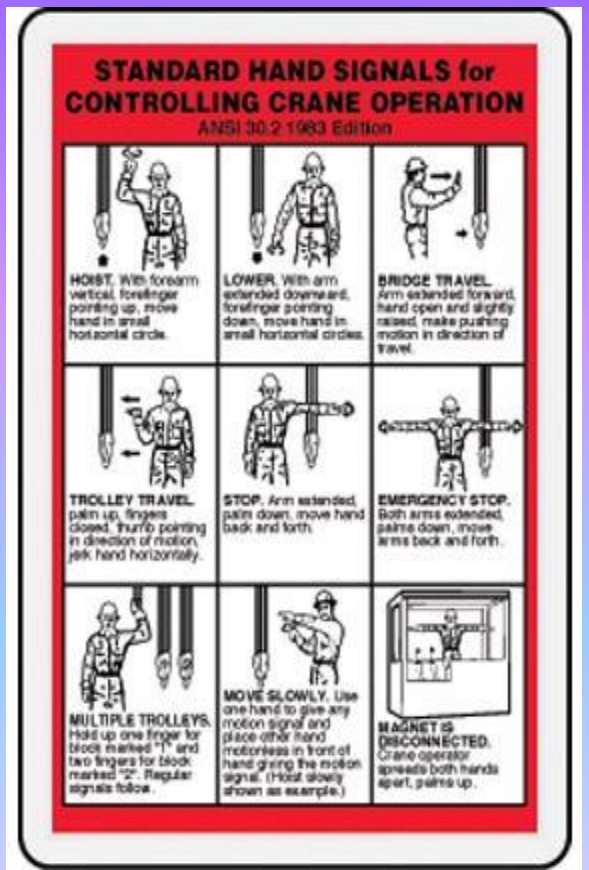
Is there any possibility of the gear or load fouling on an obstruction?

THE RIGGING PLAN

Are personnel clear of the load to be suspended?

THE RIGGING PLAN

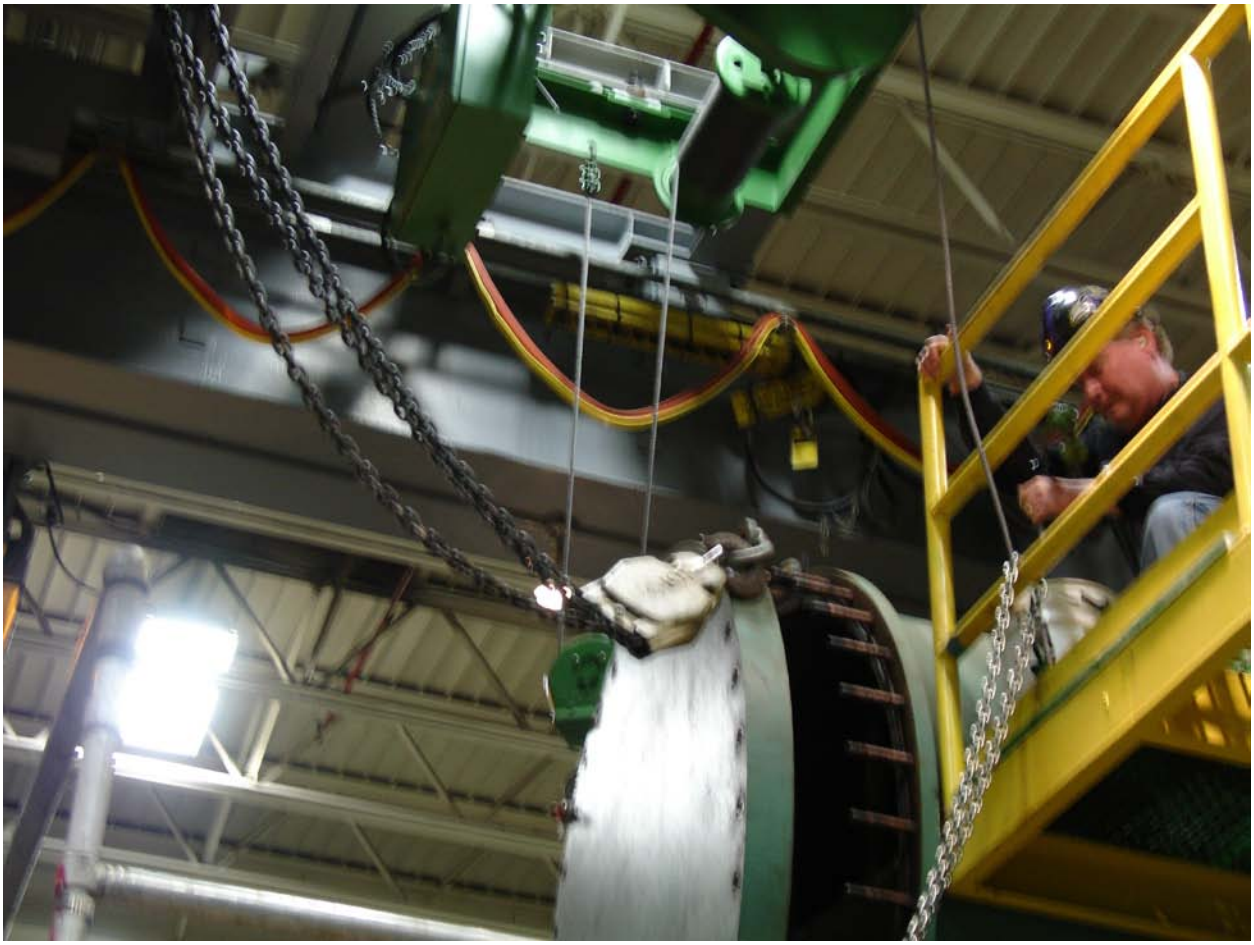
- Who is responsible for the rigging and have communications been properly established?



THE RIGGING PLAN

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

The Flip-Right Spreader Sling



Mishaps and Close Calls

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:	**(11) Affiliation**	**(12) Injury**
D. Holliday B. Gauss T. Keim G. Mooney C. Tolman A. Nwagu D. Dassoulas M. Pilecki	- Mooney – Sigma - Nwagu – ManTech - Pilecki – Honeywell - Tolman, Dassoulas - Genesis - All others - QNA	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:**

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)				
Verified Effective:		**Originator:** Phil Matthews RECERT Supervisor		

KSC NASA Advisory

GOVERNMENT INDUSTRY DATA EXCHANGE PROGRAM

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

This is a NASA Advisory issued in accordance with the requirements of NASA Procedures and Guidelines 8735.1, "Procedures for Exchanging Parts, Materials, and Safety Problem Data Utilizing NASA Advisories and the Government-Industry Data Exchange Program." For information concerning processing and actions required to be conducted in conjunction with this information, refer to your contract or NASA Procedures and Guidelines 8735.1.

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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	

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

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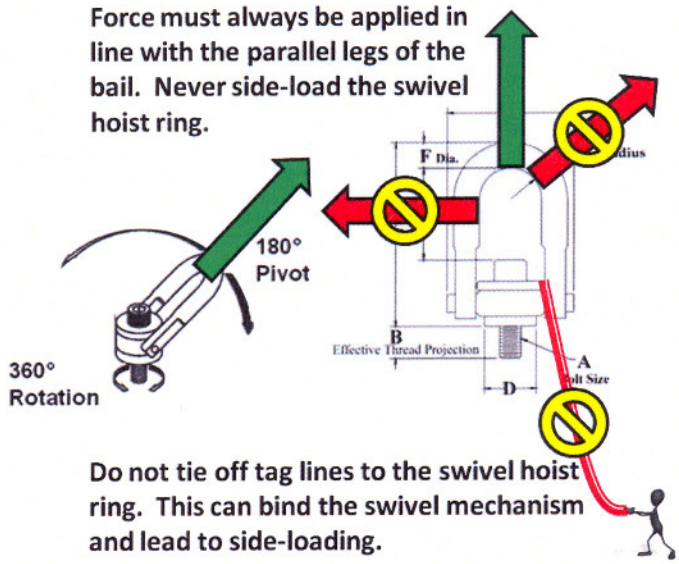
24. Problem Description (continued)



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.)