Non Critical Introductory and Refresher Packet

1) Do's and Don'ts
2) OSHA excerpts
3) NASA STD.8719.9 excerpts
4) GPR 8834.1b
5) GPR 8719.1a
6) Arc Blast Information
7) Daily Inspection Procedure
8) Radio Remote Packet
9) Standard Hand Signal Chart
10) Emergency Operating Procedures
11) Lift Team Diagram
12) Riggers Worksheet
13) Selection and Care Q & A
14) Safe Rigging Q & A
15) Wire Rope Information Packet
16) Determining Weight Packet
17) Determining Center of Gravity Packet
18) Load Weight Estimation Exercise
19) Common Rigging Problems
20) The Rigging Plan
21) The Crosby Users Guide Q & A
22) Mishaps and Close Calls Packet (Contents to change as needed)

All overhead cranes consist of three basic units.

Bridge

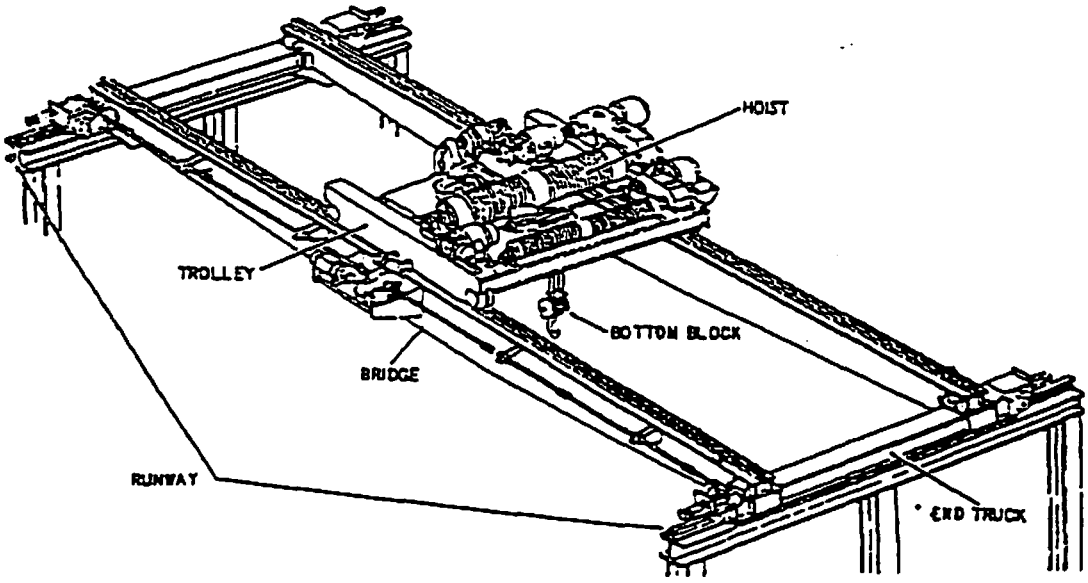
The bridge is the main structural member used to span the width of the runway area. It travels the length of the runway on rails fastened to the runway.

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

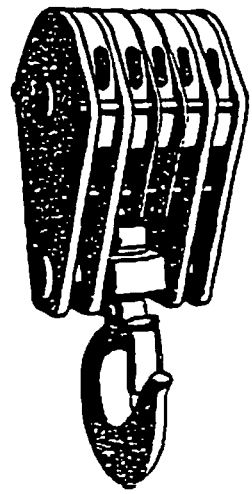
The hoist unit is an apparatus which exerts a force for lifting or lowering. It is power driven through a gear reducer and hoist drum. The bottom block is suspended from the hoist rope reeved between the upper block sheaves on the trolley structure, the bottom block sheaves, and dead ended at the hoist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



TYPICAL OVERHEAD CRANE

Blocks and Hooks

Blocks



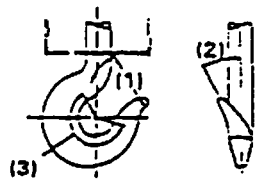
Crane blocks should be inspected regularly for sheave conditions and bent housing. Check the hook for excessive wear, gouging, or visible cracks.

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

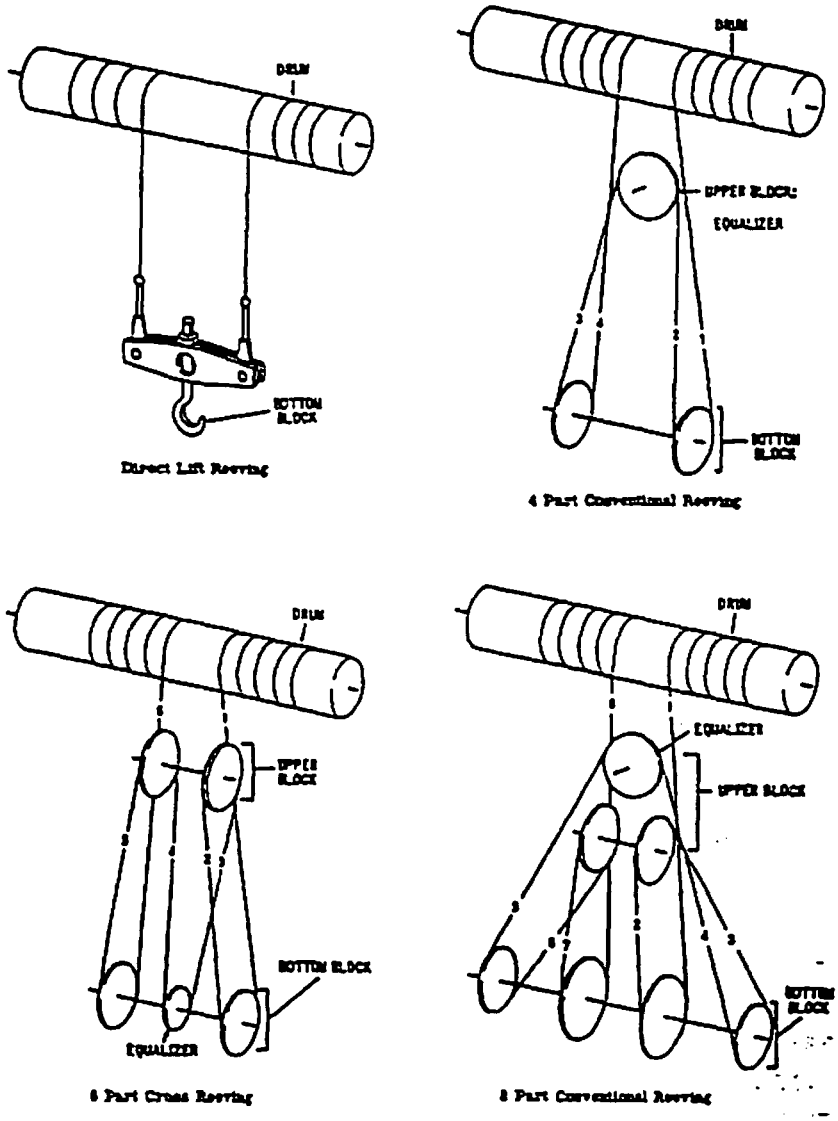
Do not weld on hooks or attempt to repair a damaged hook. Where one of the items above is found, the hook should be returned to the manufacturer for examination and possible reconditioning or replacement.

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

(2) DO READ and follow all instruction and warning information on or attached to a crane.

(3) 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.

(4) ESTABLISH a regular schedule of inspection and maintain records for all cranes with special attention given to hooks, ropes, brakes and limit switches.

(5) CHECK operation of brakes for excessive drift.

(6) CHECK operation of limit switches.

(7) CHECK for damaged hooks or ropes.

(8) KEEP wire rope clean and well lubricated.

(9) CHECK the wire rope or chain for improper seating, twisting, kinking, wear or other defects before operating the crane.

(10) 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.

(11) MAKE SURE a load clears neighboring stock piles, machinery, or other obstructions when raising, lowering, or traveling the load.

(12) CENTER the hook over the load before operating.

(13) AVOID swinging of load or load hook when traveling the crane.

(14) BE SURE the load attachment is properly seated in the bowl of the hook. Balance load properly before handling. *Never tip load.*

(15) PULL in a straight line, so that neither hoist body nor load ropes are angled around an object.

(16) MAKE SURE you take up slack slowly.

SAFE OPERATION OF CRANES AND HOISTS

The following are Do's and Don'ts for safe operation of overhead cranes. Taking precedence over any specific rule listed here, however, is the most important rule of all, USE COMMON SENSE. A few minutes spent reading these rules can make an operator aware of dangerous practices to avoid and precautions to take for his own safety and the safety to others. Frequent examinations and periodic inspections of the equipment as well as a conscientious observance of safety rules may save lives as well as time and money.

Don'ts

(1) NEVER lift or transport a load until all personnel are clear.

(2) DO NOT allow any unqualified personnel to operate crane.

(3) NEVER pick up a load beyond the capacity appearing on the crane. Overloading can be caused by jerking as well as by static overload.

(4) NEVER carry personnel on the hook or the load.

(5) DO NOT operate crane if you are not physically fit.

(6) DO NOT operate crane to extreme limits of wire rope.

(7) AVOID sharp contact between two cranes, between crane and end stop.

(8) DO NOT tamper with any parts of the crane.

(9) NEVER use the crane rope as a sling.

(10) DO NOT divert attention from load while operating crane.

(11) NEVER leave a suspended load unattended.

(12) DO NOT attempt to repair damaged wire rope.

(13) DO NOT use rope as ground for welding. NEVER touch a live welding electrode to the crane or rope.

..1910.179(m)(1)(ii)

(m)(1)(ii)

A number of broken outside wires and the degree of distribution or concentration of such broken wires.

(m)(1)(iii)

Worn outside wires.

(m)(1)(iv)

Corroded or broken wires at end connections.

(m)(1)(v)

Corroded, cracked, bent, worn, or improperly applied end connections.

(m)(1)(vi)

Severe kinking, crushing, cutting, or unstranding.

(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)

(n)

Handling the load -

(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.

(n)(2)

Attaching the load.

(n)(2)(i)

The hoist chain or hoist rope shall be free from kinks or twists and shall not be wrapped around the load.

(n)(2)(ii)

The load shall be attached to the load block hook by means of slings or other approved devices.

(n)(2)(iii)

Care shall be taken to make certain that the sling clears all obstacles.

(n)(3)

Moving the load.

(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.

(n)(3)(ii)

Before starting to hoist the following conditions shall be noted:

(n)(3)(ii)(a)

Hoist rope shall not be kinked.

(n)(3)(ii)(b)

Multiple part lines shall not be twisted around each other.

(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)

(n)(3)(iii)

During hoisting care shall be taken that:

(n)(3)(iii)(a)

There is no sudden acceleration or deceleration of the moving load.

(n)(3)(iii)(b)

The load does not contact any obstructions.

(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.

(n)(3)(v)

While any employee is on the load or hook, there shall be no hoisting, lowering, or traveling.

(n)(3)(vi)

The employer shall require that the operator avoid carrying loads over people.

(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.

(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)

(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.

(n)(3)(x)

The employer shall insure that the operator does not leave his position at the controls while the load is suspended.

(n)(3)(xi)

When starting the bridge and when the load or hook approaches near or over personnel, the warning signal shall be sounded.

(n)(4)

Hoist limit switch.

(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.

(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.

(o)

Other requirements, general -

(o)(1)

Ladders.

(o)(1)(i)

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

..1910.179(o)(1)(ii)

(o)(1)(ii)

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

(o)(2)

Cabs.

(o)(2)(i)

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

(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.

(o)(3)

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

[39 FR 23502, June 27, 1974, as amended at 40 FR 27400, June 27, 1975; 49 FR 5322, Feb. 10, 1984; 51 FR 34560, Sept. 29, 1986; 55 FR 32015, Aug. 6, 1990; 61 FR 9227, March 7, 1996]

OSHA Regulations (Standards - 29 CFR) - Table of Contents

rejection of the rope (see Wire Rope Users Manual for additional information on wire rope inspections):

(1) In running ropes, twelve randomly distributed broken wires in one rope lay or four broken wires in one strand in one lay or one valley break.

(2) Individual outside wires with wear of 1/3 the original diameter.

(3) Kinking, crushing, bird caging, or any other damage resulting in distortion.

(4) Evidence of heat damage.

(5) End connectors that are cracked, deformed, or with evidence of rope pullout.

(6) Corrosion (internal or external) that results in reduction of rope diameter, or at end connectors.

(7) Reductions of nominal diameter (measured with a caliper or go/no-go gage) of more than:

(a) 1/64 inch (0.4 mm) for diameters of rope up to 5/16 inch (8.0 mm).

(b) 1/32 inch (0.8 mm) for diameters 3/8 inch (9.5 mm) to 1/2 inch (13.0 mm).

(c) 3/64 inch (1.2 mm) for diameters 9/16 inch (14.5 mm) through 3/4 inch (19.0 mm).

(d) 1/16 inch (1.6 mm) for diameters 7/8 inch (22.0 mm) through 1-1/8 inches (29.0 mm).

(e) 3/32 inch (2.4 mm) for diameters greater than 1-1/8 inches (29.0 mm).

d. If replaced, the new rope shall be proof load tested using the associated crane proof load value.

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, pre-operational 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).

b. 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 pre-operational 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 handline.

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.

5. MOBILE CRANES AND DERRICKS

5.1 General. This section establishes minimum standards for the design, testing, inspection,maintenance, personnel certification, and operation of mobile cranes and derricks.

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.

Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	GPR 8719.1A	**APPROVED BY Signature:**	***Original signed by Arthur F. Obenschain for***
EFFECTIVE DATE:	May 8, 2009	**NAME:**	Robert Strain
EXPIRATION DATE:	May 8, 2014	**TITLE:**	Director

COMPLIANCE IS MANDATORY

Responsible Office: 540/Mechanical Systems Division

Title: Certification and Recertification of Lifting Devices and Equipment and Its Operators

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PREFACE

P.1 PURPOSE

This directive establishes the requirements for the GSFC Recertification Program (RECERT) to provide Center organizations with inspection, certification, and recertification of lifting devices and equipment (LDE). LDE Operator for cranes, mobile aerial platforms (MAP), and powered industrial trucks (PIT), and Critical Lift Coordinator (CLC) training and certification requirements are also established. 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 LD and LDE Operators.

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.

e. This directive does not apply to contractor lifting operations using contractor provided LDE which are exclusively associated with facility construction activities where these 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

The references as listed within the NASA-STD 8719.9 are applicable.

a. NPR 8715.3, NASA General Safety Program Requirements

b. GPR 1400.1, Waiver Processing
c. GPR 8621.1, Reporting of Mishaps and Close Calls
d. GPR 8834.1, Lifting Operations Requirements
e. ASME PALD, Safety Standard for Portable Automotive Lifting Devices
f. NASA-STD 8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S)
g. 540-WI-8719.1.3, Lifting Devices Daily Inspection Forms

P.5 CANCELLATION

GPR 8719.1, Certification and Recertification of Lifting Devices and Equipment.

P.6 SAFETY

Detailed safety requirements are contained in applicable test and inspection procedures.

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.
Completed Daily Checklists	Property Custodian	Permanent. NRRS 8/56.5D
RECERT documentation	RECERT Manager	*NRRS 3/33G
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.

**NRRS – NASA Records Retention Schedules (NPR 1441.1)*

P.9 METRICS

The RECERT Manager shall document the percentage of scheduled test and inspections completed.

P10. DEFINITIONS

Most of the terms used in this directive are defined in NASA-STD-8719.9. Those that are critical and or unique to this directive are listed below.

a. 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.

b. 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.

c. 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.

d. Critical Lift Coordinator (CLC) – An individual who is assigned or demonstrates a need to direct critical lift activities due to specific project requirements and who has obtained the necessary training and is certified by the RECERT Manager. The CLC is an optional position, used only when a project desires to have its own lifting expert. The role of the CLC shall be specified in the Critical Lift Procedure.

e. Daily Checklist – An inspection and/or test that is performed on a daily basis only for those days while in use.

f. Division Office – For the purposes of this GPR, use of the term “Division Office” includes Project Offices and Program Offices.

g. Flight Hardware – Hardware designed and fabricated for ultimate use in a vehicle intended to fly.

h. Lifting Devices (LD) and Equipment (LE) collectively (LDE) – LDE comprises LD such as overhead and gantry cranes (including top running monorail, underhung, 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..

i. 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.

j. MPJ – For the purposes of this directive, the collective term "MPJ" refers to MAPs, PITs and Jacks as defined in NASA-STD-8719.9.

k. 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.

l. RECERT Procedure – RECERT generated or OEM-provided documentation that describes the specific steps needed to inspect, test or operate LDE.

m. RECERT Manager and Deputy RECERT Manager/WFF – Positions appointed by the Center Director to implement and enforce the Center's LDE and ground-based pressure vessels and pressurized systems (PVS) Program meeting NASA-STD-8719.9 and NASA-STD-8719.17 requirements, respectively. The RECERT Manager and Deputy RECERT Manager/WFF positions are a combination of the LDEM and PSM positions described in both NASA Technical Standards.

n. Rigger – An individual who selects and attaches LE to an item to be lifted. For the purposes of this directive, a Rigger is a certified Crane Operator.

o. Support Services Contractors – Contract personnel who are based on-site and participate in on-going daily operations at GSFC.

P11. ACRONYMS

ASNT	American Society for Nondestructive Testing
CG	Center of Gravity
CLC	Critical Lift Coordinator
FMD	Facilities Management Division
GSC	Goddard Safety Council
GSFC	Goddard Space Flight Center
IMHE	Institutional Material Handling Equipment
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 P10.i)
NDT	Nondestructive Testing
NRRS	NASA Records Retention Schedules
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Health Administration
PIT	Powered Industrial Truck
PSM	Pressure Systems Manager
PVS	Pressure Vessels and Pressurized Systems
RECERT	Goddard Recertification Program
WFF	Wallops Flight Facility

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 and PVS.

1.2 RECERT Manager shall

a. Maintain overall responsibility for the management, implementation, and enforcement of the Center's LDE Recertification Program;
b. Provide technical direction to the Deputy RECERT Manager and the RECERT Support Contractor;
c. Serve as the GSFC interface with NASA Headquarters and other NASA Centers on matters pertaining to LDE.
d. Serve as the GSFC representative on the NASA LDE committee;
e. Chair the Center LDE Committee;
f. Serve as the Certifying Authority for the certification and recertification of LDE to which this directive is applicable;
g. Serve as the final authority on interpretation of, and compliance with, this directive and its references;
h. 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;
i. Furnish daily inspection forms for LDE operator's use. Note that daily inspection forms are limited to cranes, MAPs, and PITs. The daily inspection forms are listed in 540-WI-8719.1.3;
j. Ensure that certification and/or recertification tests and inspections are performed by personnel properly qualified and certified in accordance with applicable codes and standards;
k. Provide expert advice on LD design, specification, and modification;

l. Approve the re-rating of LDs;
m. Review and concur/nonconcur with waiver requests per GPR 1400.1;
n. Review and approve 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 as required; and
t. Coordinate with affected Center safety offices on issues of mutual interest.

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 Division Offices shall

a. Ensure documented compliance to this directive;
b. Submit LDE specifications to the RECERT Manager for review and approval prior to purchase;
c. Ensure that LDE are certified 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 provide the information to RECERT as required;
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 Division LDE including slings, shackles, turnbuckles, D-rings, load measuring devices, and other LE;
h. Manage and control uncertified or expired LDE to preclude inadvertent use;
i. Request that RECERT perform certification of new or transferred LDE 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 8621.1;
k. Initiate repair for LDE deficiencies found during test and inspections;
l. Ensure that OEM-recommended maintenance is performed on LDE;
m. Submit requirements to the appropriate budget to bring Division LDE into compliance with this directive;
n. Review Division LDE inventory as requested by the RECERT Manager;
o. Maintain responsibility for day-to-day operations of LDE under their cognizance;
p. Coordinate outages for load testing and inspections of inventoried LDE with RECERT to minimize conflicts with ongoing operations; and
q. Notify RECERT of any deficient LDE that is removed from service.

1.5 Safety and Environmental Division/Code 250 and Wallops Safety Office/Code 803 shall

a. Review RECERT operations for compliance with OSHA and NASA-STD-8719.9;
b. Monitor the institutional safety requirements of this directive; and
c. Provide medical expertise via the Medical Director to establish LDE operator physical examination criteria using applicable NASA and American National Standards Institute requirements.

1.6 Facilities Management Division (FMD)

FMD shall notify the RECERT Manager of any planned LDE acquisition, installation, upgrade, and/or removal as part of any 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.

1.7 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 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 if any deficiencies are observed and immediately enter the deficiencies into the log book and notify RECERT..

1.8 Certified Critical Lift Coordinators

Certified CLCs 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.

1.9 Certified MAP and PIT Operators and Authorized Jack 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 RECERT checklist before operation;
c. Provide entries in the equipment log book for all inspections, tests, and operations; and
d. Lock out the equipment and place an out-of-service tag on the equipment if any deficiencies are observed and immediately enter the deficiencies into the log book and notify RECERT.

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 Underhung 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.

Institutional Material Handling Equipment (IMHE) not covered by the RECERT Program may be tested and inspected by RECERT if specifically requested in writing and funded by the owning organization.

2.1.2 Traceability to Original Equipment Manufacturer (OEM).

2.1.2.1 All LE hardware components shall be traceable to a credible source of information, such as OSHA or OEM for certifiability.

2.1.2.2 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; or designed, documented, and approved by a registered professional engineer. In all cases, a tag or notice must be affixed to the equipment clearly showing the new CG and capacity restrictions.

2.1.2.3 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.

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 and by compliance with NASA-STD-8719.9 and this directive. It shall then be recertified periodically.

b. Altered LDE shall be recertified as a system unless specifically exempted by a safety variance reviewed and approved in accordance with Section 4 of this directive. Alteration is defined as extension, modification, addition, replacement, or deletion of components to the original. 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. 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 LDEs and jacks used for critical lifts. 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 lifts 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.

2.3.2 LD (except MPJ) Inspection Requirements. Inspection requirements are based on the usage categories of LDs. Inspections are "Daily," "Frequent" or "Periodic," and are defined in RECERT 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 log book in accordance with RECERT procedures.

- RECERT Frequent Inspections shall be performed at monthly intervals.
- RECERT Periodic Inspections for recertification shall be performed once a year. For critical cranes, a Rated Load Test shall be included as part of the annual Periodic Inspection. For noncritical cranes, the Rated Load Test shall be included as part of the Periodic Inspection every fourth year.

2.3.2.2 Standby LDs – These devices are to be secured from use by RECERT tags and locks 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. For critical cranes, a Rated Load Test shall be included as part of the annual Periodic Inspection. For noncritical cranes, the Rated Load Test shall be included as part of the Periodic Inspection every fourth year.
- At remote facilities, the LD owner shall secure the equipment using OSHA standard LOTO procedures

2.3.2.3 Idle LDs: – These devices are to be secured from use by RECERT tags and locks and there is no planned use of the LD for the next 12 months. If idle more than 6 months, the LD must 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.
- At remote facilities, the LD owner shall secure the equipment using OSHA standard LOTO procedures

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 requirements and those of the Crane Manufacturers Association of America 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 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 RECERT.

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 status of all LDE. The tagging shall be done in accordance with a Work Instruction(s) describing the tags for each application. Unless indicated otherwise, all LDE tags shall be for a duration of one year and 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 a lift 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 lift assembly is load tested as a unit with each item being individually NDT inspected and tagged as such.

b. Load test (re)certification tags are applied to each component for a lift assembly that will be disassembled and where the individual items are not color-coded, tethered, or otherwise controlled as an assembly. The lift assembly may be load tested as a unit or each component load tested individually with each item being individually NDT inspected and tagged as such.

c. One load test (re)certification tag per configuration is applied to a lift assembly where the configuration will be rearranged. The lift assembly is load tested in all applicable configurations with each item being individually NDT 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 inspected and tagged.

2.4 LDE Testing

2.4.1 Load Testing

New or extensively modified LDs and MPJ shall be proof load tested in accordance with Table 1. For periodic recertification, LDs shall be tested to 100% of their rated load. New or extensively modified LE shall be tested in accordance with Table 2 and inspected in accordance with Section 2.4.2.

Certified test weights or calibrated load cells and test equipment shall be used for all LDE load-testing activities.

2.4.2 Nondestructive Testing

a. All LDE designated for Noncritical Lifts shall be subjected to visual NDT inspection after the initial proof load test, and after each periodic load test.

b. All LDE designated for Critical Lifts shall be subjected to NDT inspection in accordance with Table 2.

3. Personnel Qualification and Certification Requirements

3.1 Personnel Performing NDT

Personnel performing LDE NDT, including visual inspections, shall be qualified and certified by their employer 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. (Note: This does not apply to daily tests and inspections of LDE performed by Certified LDE Operators.)

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 the applicable physical examination. 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, 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 appropriate supervisory personnel.

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 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. One 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 must complete the required hours of operation within 12 months from 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 rig for noncritical lifts only, excluding Hydra-sets.

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 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.

The operation of remote radio-controlled LD requires specific training and authorization. Specific radio-controlled LD operator training is provided only to licensed Crane Operators. Rosters listing trained and authorized radio-controlled Crane Operators are posted at the applicable LD. Annual radio control refresher training is required.

3.2.3 Crane Operator Recertification

All Certified Crane Operators shall be recertified and a new license issued on an annual basis by providing evidence of completion of refresher training, including written examination and hands-on training, and evidence of satisfactory physical examination to be given every three years. A new license will be issued to the Operator, or, in the case of the Operator roster update, to appropriate supervisory personnel.

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. 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 MAP and PIT Operator candidates shall pass a written exam, hands on proficiency demonstration, and the applicable physical examinations. If deemed necessary by the RECERT Manager, a written RECERT exam may be given to verify the adequacy of the commercial training that the operator candidate claims credit.

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 appropriate supervisory personnel.

3.3.2 Jack Operator Authorization.

Operators of jacks shall be instructed in their proper use per paragraph 13.6 of 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 3 years by providing evidence of completion of refresher training, including written examination and hands-on training, and evidence of continuing satisfactory physical examination. 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 physical examination requirement. Upon successful completion of CLC training and written examination requirements, the RECERT Manager shall certify CLCs 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 on an annual basis.

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 to meet RECERT-required refresher training or physical 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.

4. Waivers

a. Waivers to the requirements of this directive shall be prepared and approved as outlined in NPR 8715.3 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 NPR 8715.3 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/nonconcurrence.

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/QS within 14 days.

5. LDE Committee

5.1 A Center LDE Committee (LDEC) shall be established by the RECERT Manager via the 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. Represent his/her Directorate in the Committee's scheduled meetings. Invite other interested personnel to the meeting, including supporting contractors, as appropriate.
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.

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.

TABLE 2
NDT and Load Testing Requirements for
Critical LE Certification and Recertification

EQUIPMENT	PROOF LOAD TEST FACTOR	PERIODIC LOAD TEST FACTOR	POST-PROOF NDT[4]	POST-PERIODIC NDT[4]
Alloy Steel Chain Slings	2.0	1.0	Visual	Visual
Wire Rope Slings	2.0	1.0	Visual	Visual
Metal Mesh Slings	2.0	1.0	Visual	Visual
Synthetic Rope Slings	2.0	1.0[2]	Visual	Visual
Synthetic Web Slings	2.0	1.0	Visual	Visual
Linear Fiber Slings	2.0	1.0	Visual	Visual
Structural Slings	2.0[1]	1.0	Critical Welds: **Surface** Noncritical Welds: **Visual**	Critical Welds: **Surface** Noncritical Welds: **Visual**
Shackles, D-rings, Turnbuckles, Lifting Lugs, Safety Hoist Rings, etc.[3, 5, 6, 7]	2.0[3]	1.0	Single and Non-Single Failure Load Path: **Surface**	Single and Non-Single Failure Load Path: **Surface**

1. Unless otherwise specified by design, due to material characteristics, geometry, safety factors, etc., but in any case, at least 125 percent of the sling's rated capacity.
2. Critical lift rope slings of synthetic material shall not be used beyond 50% of the manufacturer's rating to maintain an equivalent safety factor in the load system.
3. Lifting lugs, including eyebolts, which are permanently affixed to the load are considered to be part of the load and are exempt from load testing and NDT, but must be qualified by calculation by the owning organization.
4. "POST-PROOF" = After the initial, first-time proof load test of new or extensively modified items. "POST-PERIODIC" = After the annual rated load test of the item.
5. Certain restrictions on the use of turnbuckles may apply. Contact the RECERT Manager for guidance.
6. With the exception of thimbles and tapered end fittings, metallic fittings that are integral to slings are included. Thimbles and tapered end fitting are subject to visual NDT only.
7. This category of lifting hardware/components includes custom designed and fabricated items that are within the load path. No protective coatings should be applied to these items prior to NDT.

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.

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.

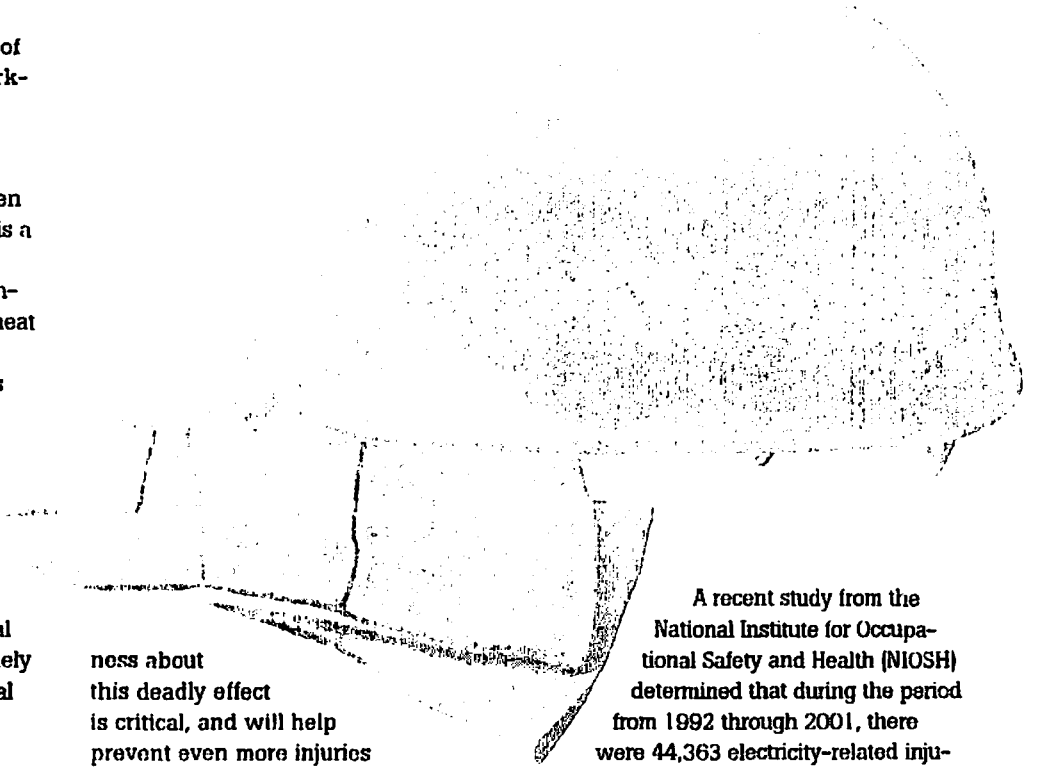
- The intense heat may melt metal electrical components and blast molten droplets considerable distances. These droplets harden rapidly and can lodge in a person's skin, ignite clothing and may cause lung damage.

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.

Don't get burned by arc flash!

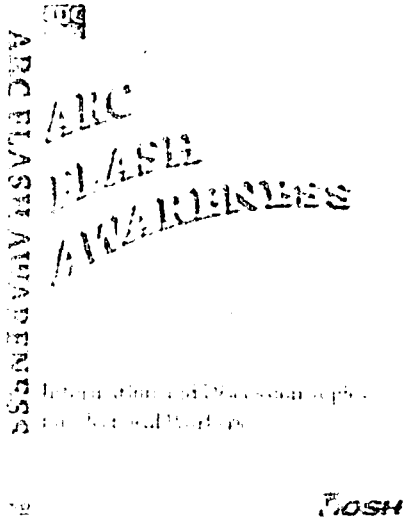
What is hotter than the surface of the sun, explodes with the energy of dynamite, and kills one to two workers a day, each year? *An arc flash.*



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.

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: Darren 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
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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.

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.

_____

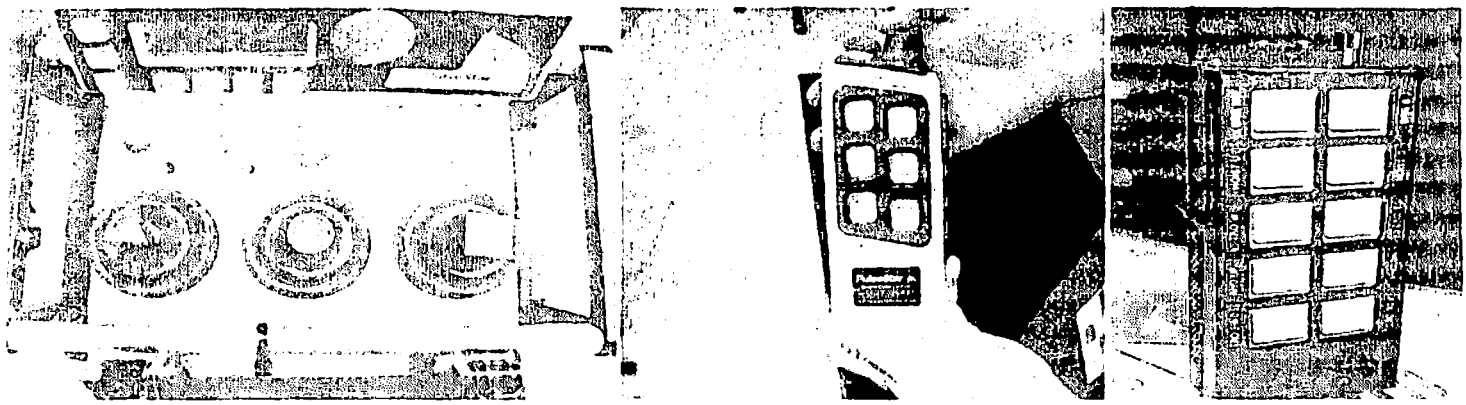
_____

_____

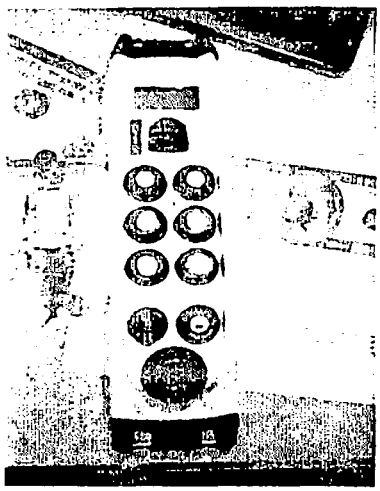
_____

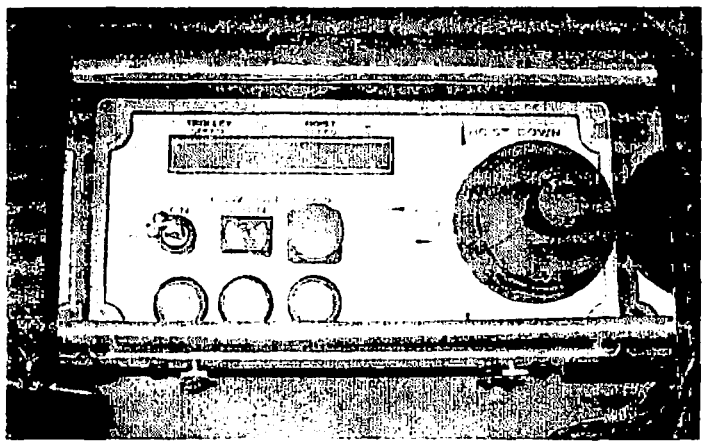
_____

_____



Radio Controlled Cranes
Basic Operating Procedures





SAFE OPERATING PROCEDURES

RADIO CONTROLLED CRANE OPERATION

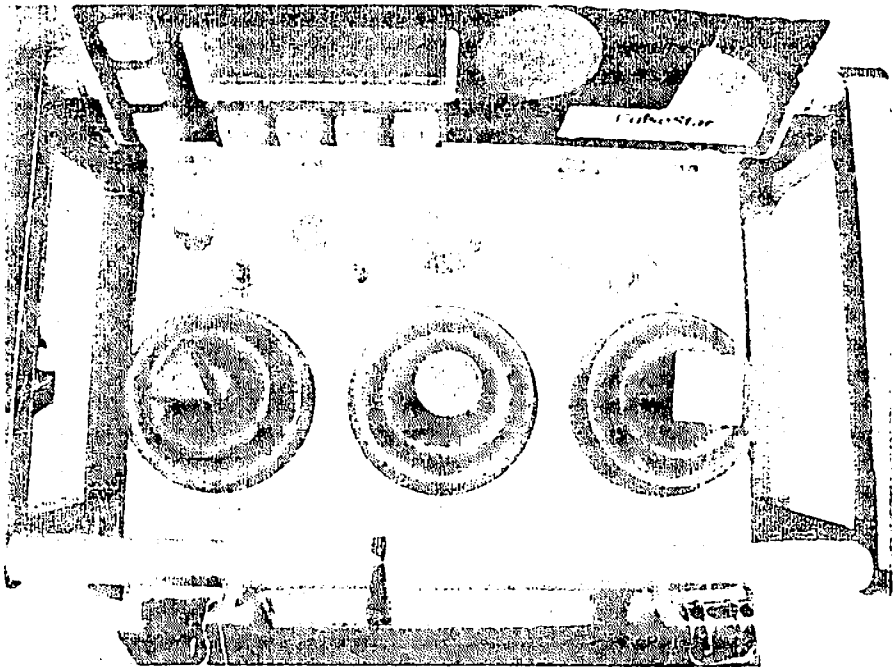
Crane radio operators responsibilities and qualifications are the same as pendant operators. They must be capable of meeting all physical requirements, have a thorough knowledge of crane operations and rigging procedures, and always exercise safe operating practices and load control.

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.

PulseStar 610 Radio Control System



Radio Training

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

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: ***PulseStar•610 receiver(s) and transmitter(s) 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.

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.

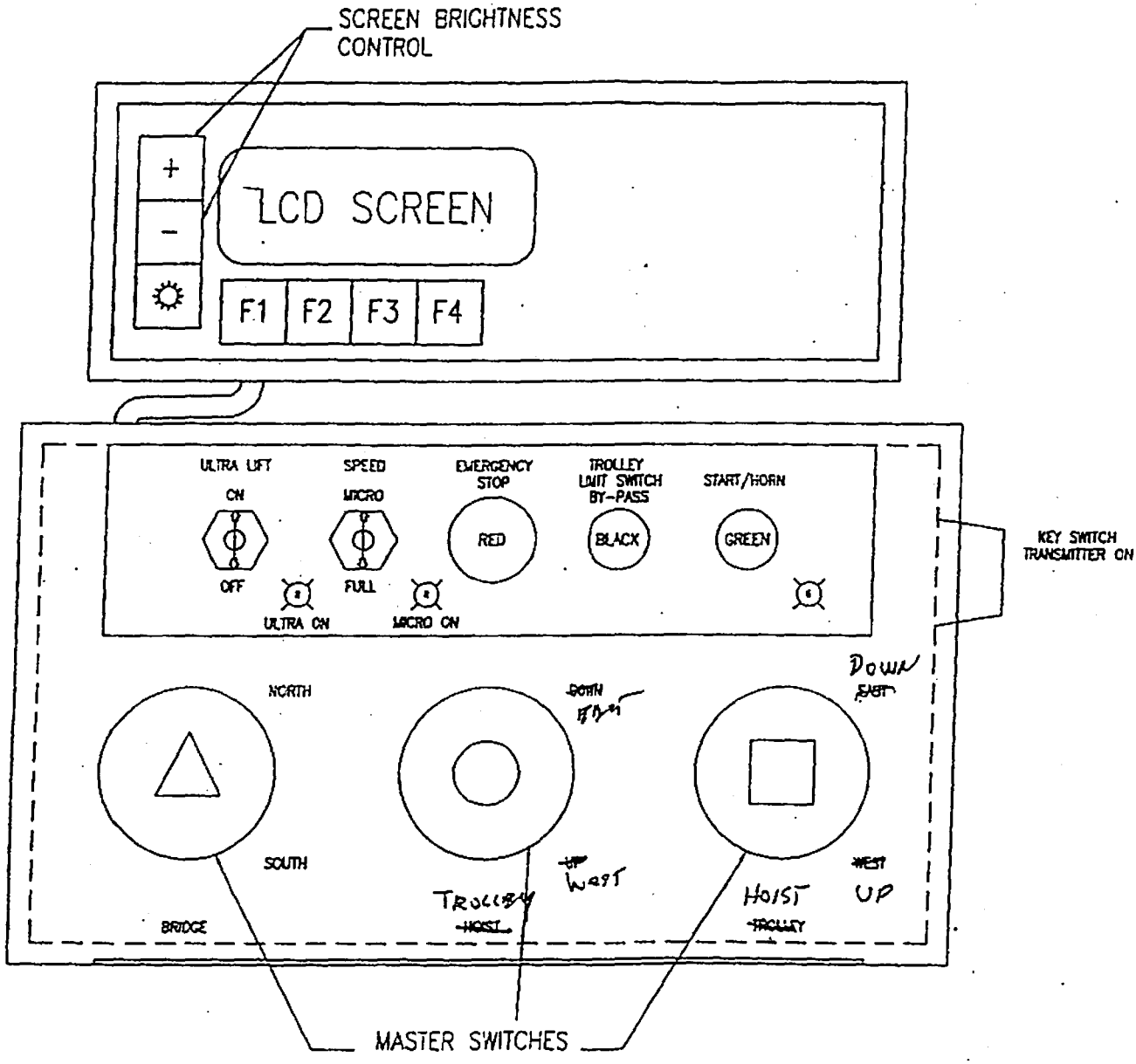
- Ultra Lift - provides a slightly faster than normal speed.

- 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



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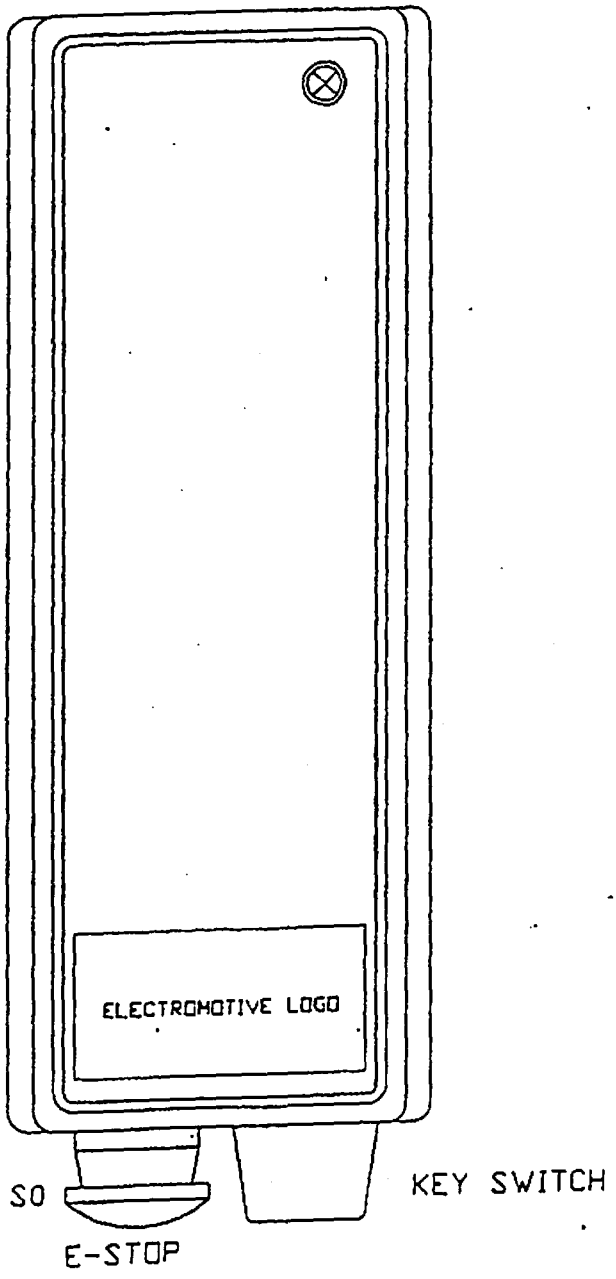
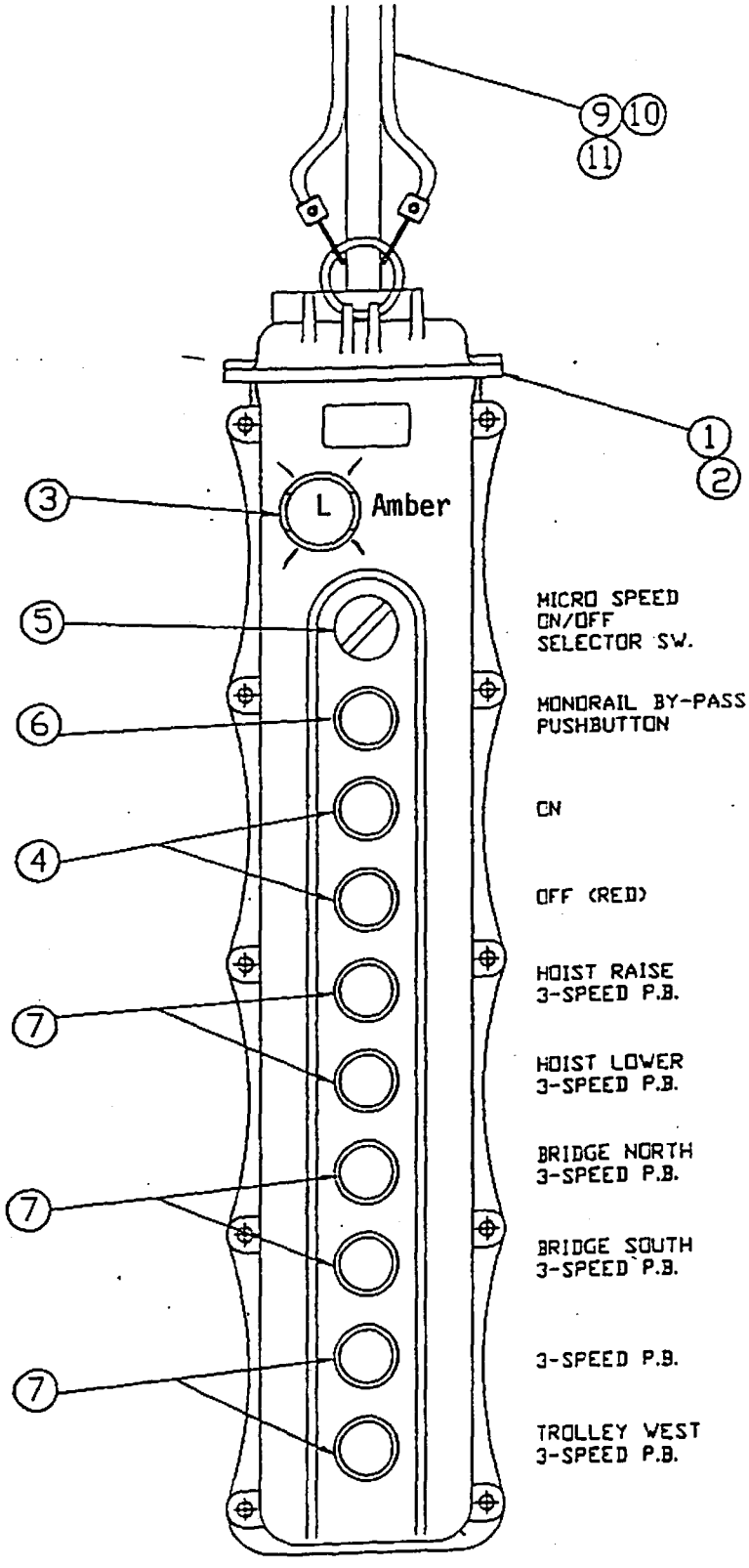
PULSESTAR 609 E-STOP
TRANSMITTER CONFIGURATION



PENDANT LAYOUT



CRANE 10-1
BRIDGE BY-PASS PROCEDURE

A BY-PASS FUNCTION HAS BEEN ADDED TO THE BRIDGE CONTROLS.

- When bridging north, the bridge will stop short of Clean Room 120.
- To continue, press and hold the by-pass button.
- **STOP THE CRANE WITH THE BRIDGE CONTROL LEVER *BEFORE RELEASING THE BY-PASS BUTTON* TO AVOID A SUDDEN STOP.**

  This will allow the bridge to decelerate slowly.
- When the bridge comes to a stop, release the by-pass button.

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."

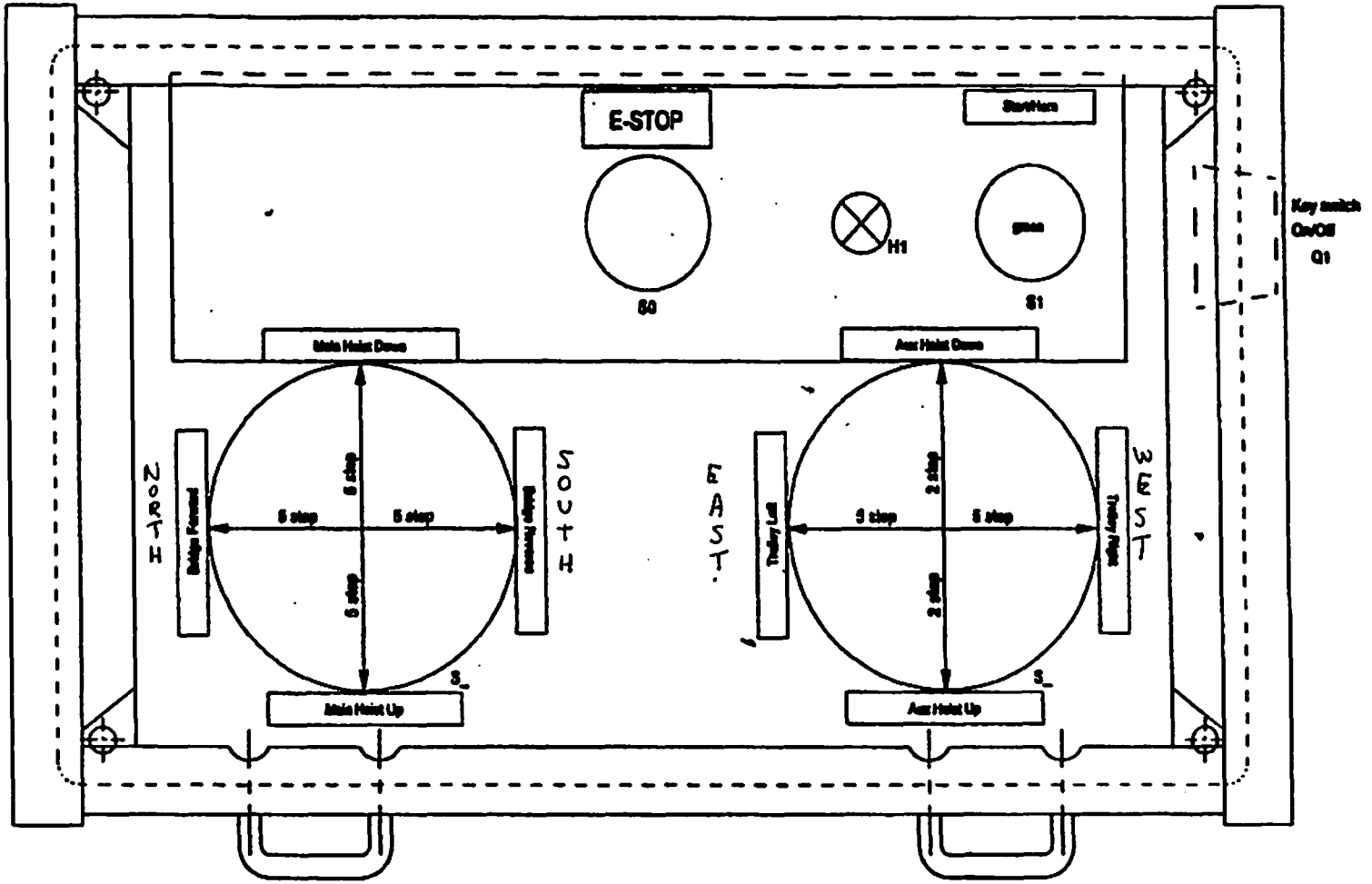
4. Start/By Pass Push Button - Push the button to activate the main line contactor on the crane. Hold the button down for "Bridge By Pass." The crane is interlocked that when the trolley is over the chillers, you must hold the By Pass button down to operate the bridge.

   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


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

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.

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.

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.

Zone Control—collision prevention of two-tiered cranes

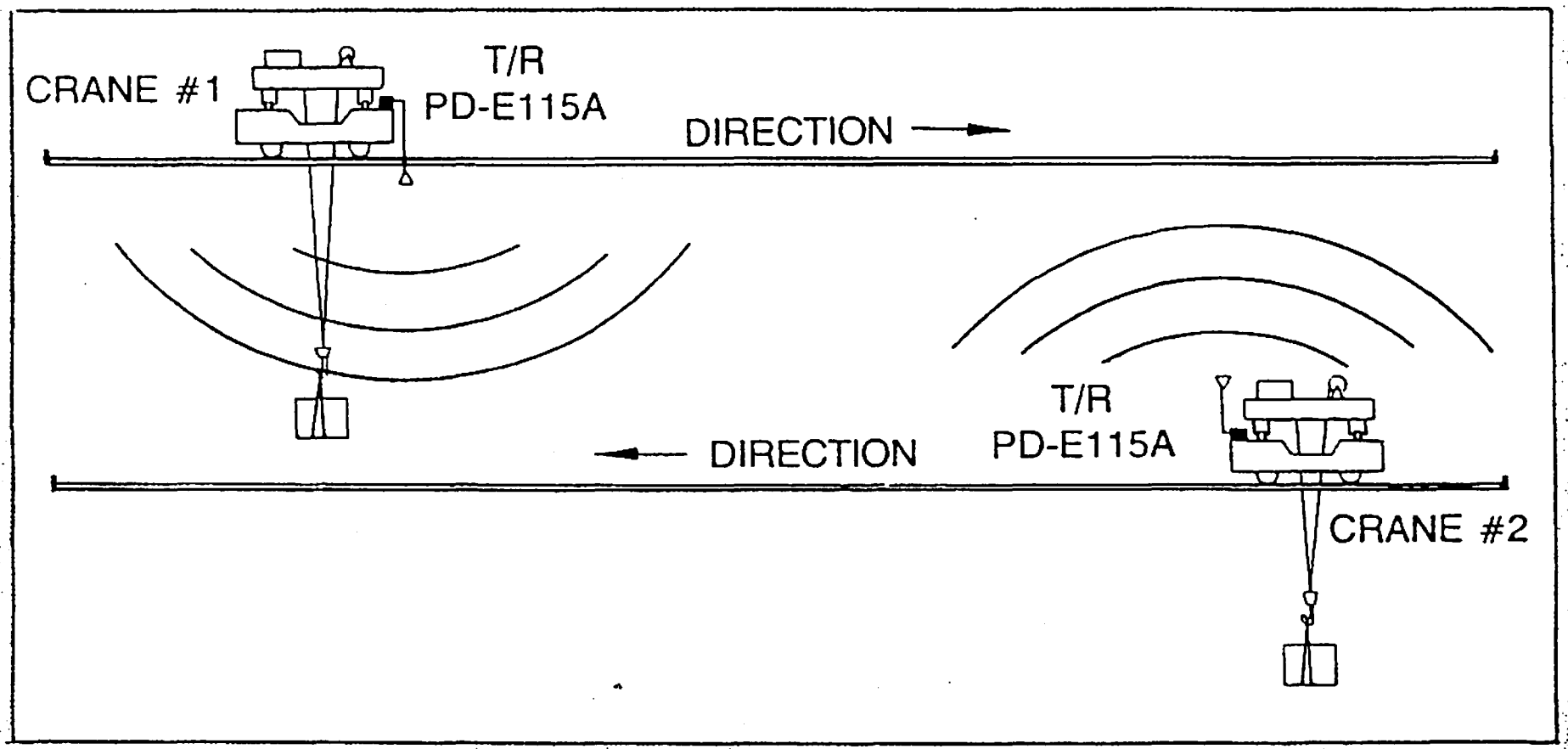
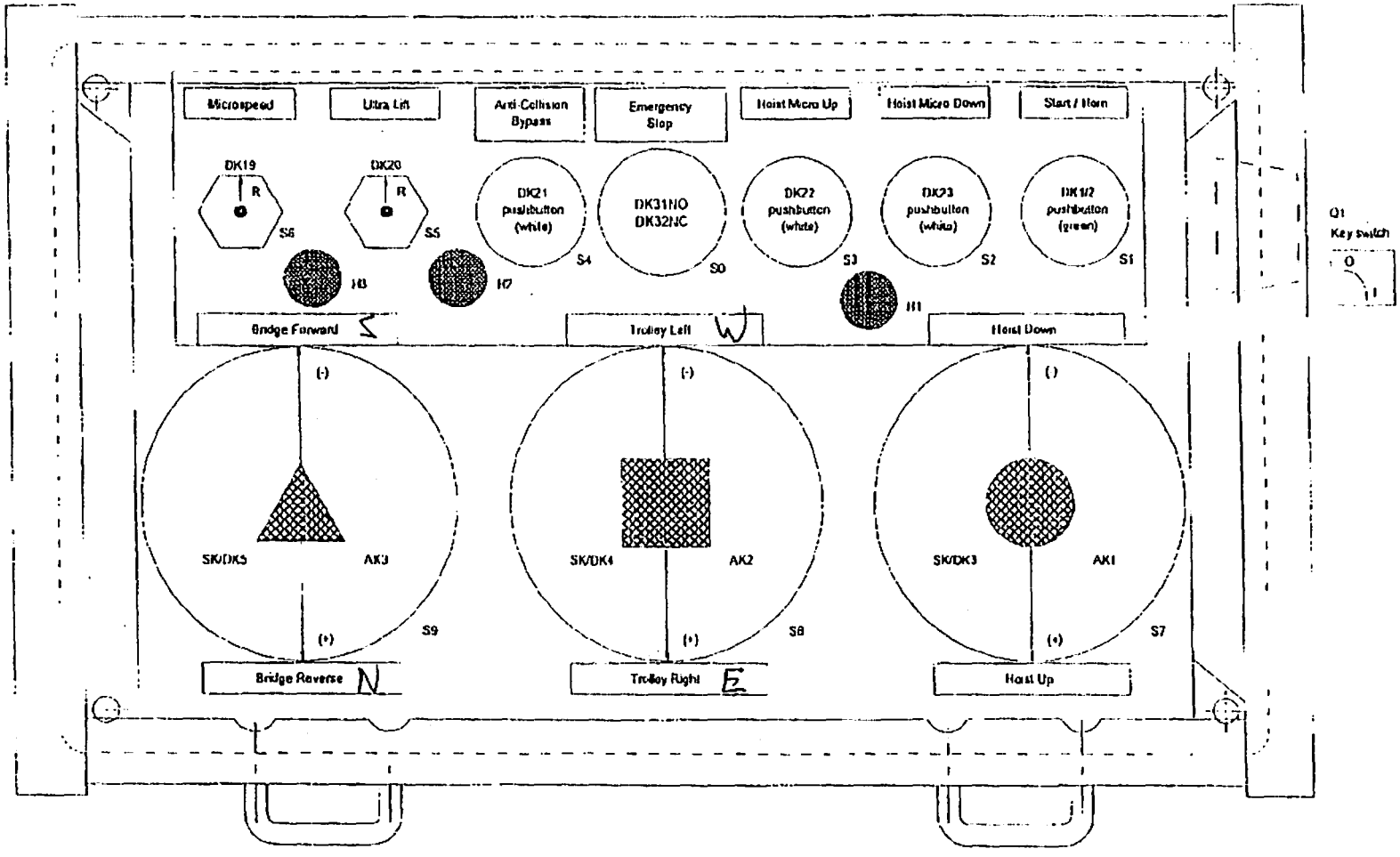


Fig. 3. TelTec being used to prevent collision of the upper crane's load with the bridge of the lower crane

Transmitter, GL-W



T: momentary
R: maintained
S#: switch, joystick ID
H#: LED ID

HETRONIC USA

Name:	Date:		
Aaron	08-08-00	design	
Aaron	10-03-00	model	
checked			

Transmitter GL-W

Customer: Electromotive

Type: GA610

ESI PO No. 54492

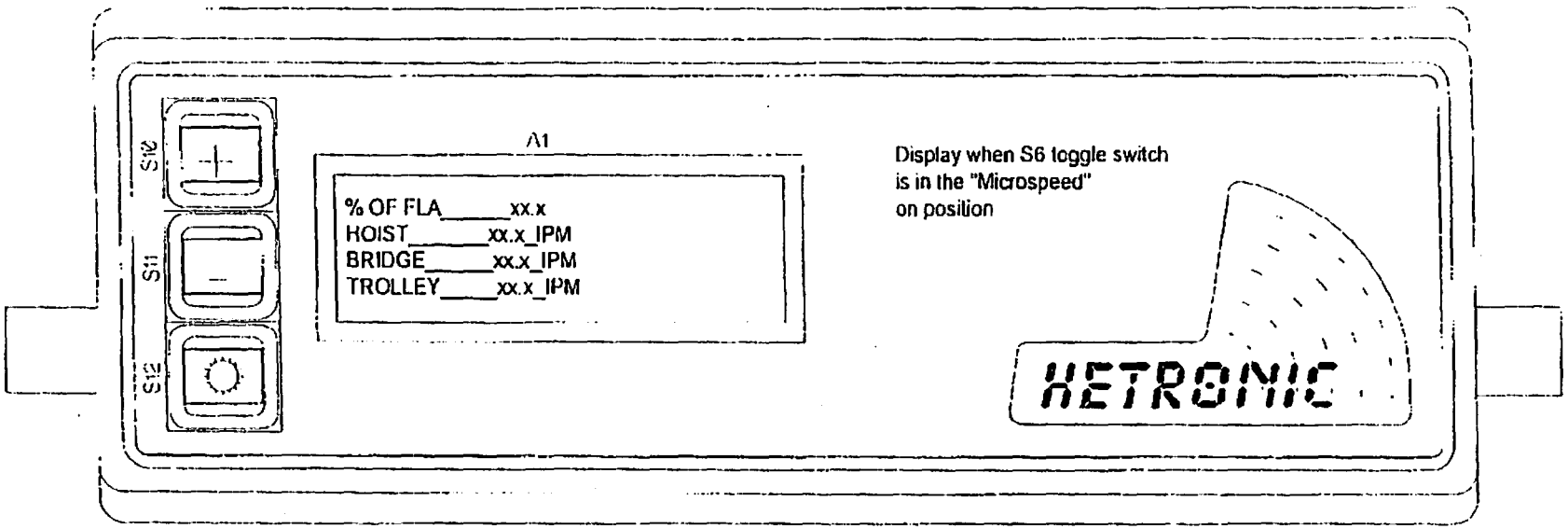
Page: 5 of 7

Item-No.: H1-00324

Identify-No.: 60079

CRANE 29-1

S10 & S11: Contrast control
S12: Illumination control



HETRONIC USA

Name:	Date:		
Aaron	09-14-00		
Aaron	10-24-00		
Transmitter			
Electromotive			
ESI PO No. 54492			
GA 610			
H1-00324			

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.

- 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 29-4

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.

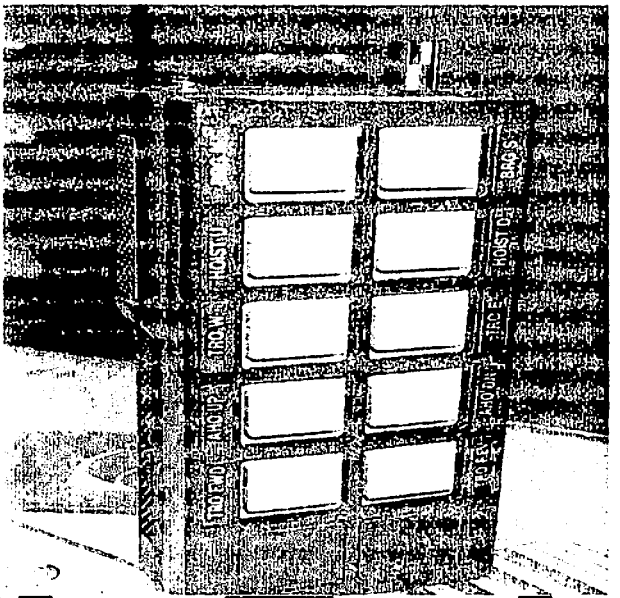
  - Reset/Horn Button - pushing this button resets the crane control and/or sounds a horn. A strobe light on the bridge indicates that the crane control is reset. (Note: allow at least one minute between crane resets.)

  - 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.

CATTRON Radio Remote System



Radio Training

Cranes 5-20/15-5/15-6/15-7

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

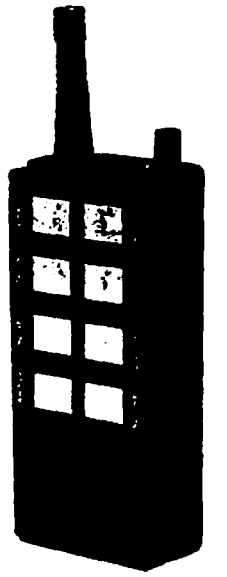
The receiving and decoding hardware, along with the relay interface, is housed within a compact NEMA 12 steel enclosure. The RF receiver, decoder, and power supply circuit boards are housed in a sub-chassis which provides EMI shielding and isolation from the output relay interface. The sub-chassis also 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

TAB 5 TRANSMITTER DESCRIPTIONS AND OPERATING INSTRUCTIONS

CAT 804
CAT 808
CAT 812

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

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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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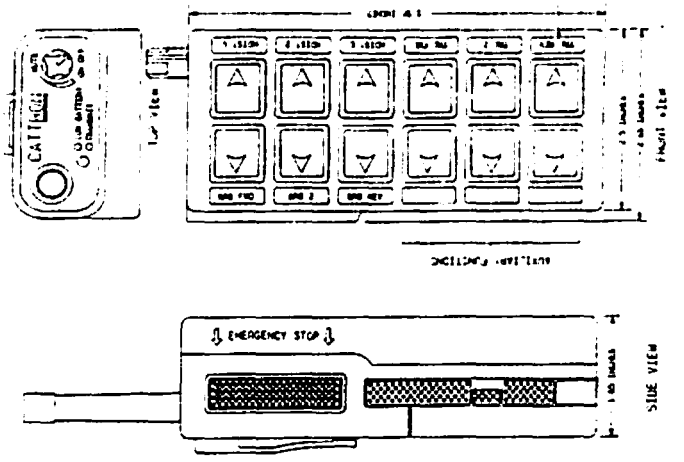
pressed, the output relay for forward is closed and the crane typically will move in first speed. If you press the speed two button for that motor, either while holding forward, or within two seconds of releasing forward, both the speed relay output and the forward output will be energized (by pressing 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 in "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.

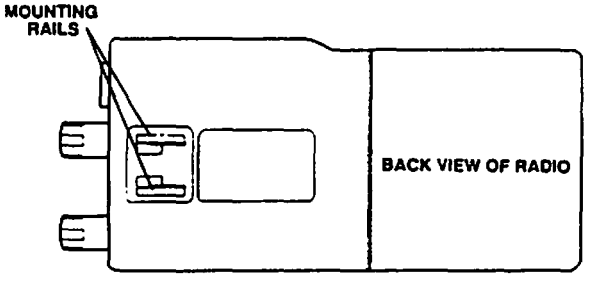


KEYPAD CONTROL TRANSMITTER DISASSEMBLY/REASSEMBLY

Refer to the accompanying diagrams while disassembling and reassembling the radio.

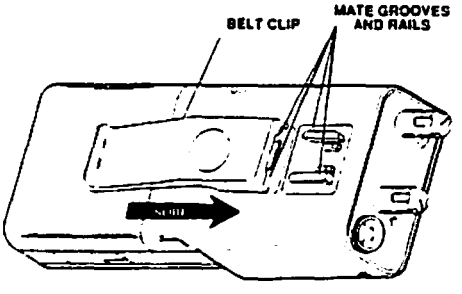
To attach the belt clip to the radio:

1. Locate the mounting rails on the back side of the radio.



(LOCATING MOUNTING RAILS)

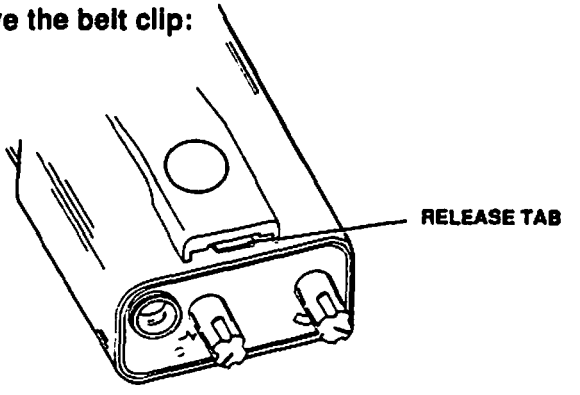
2. Position the belt clip, so the fastener end of the clip is nearest the mounting rails, and the other end of the clip is over the battery compartment.



(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.

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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.

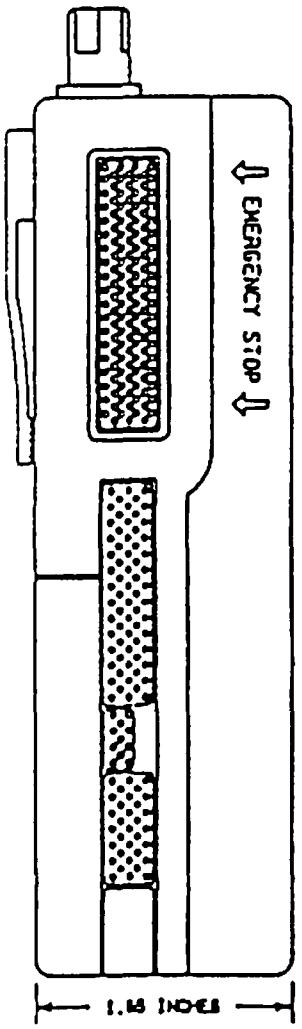
Follow the above procedure for the reverse direction.

Hoisting Motions

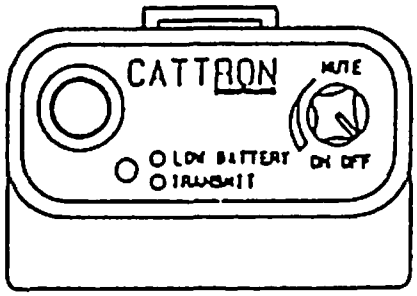
Select the up direction and press the up direction/hold push button. This push button provides the up direction and the hold speed function when the motor is at the speed the operator desires. To accelerate, press and hold the accelerate push button associated

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.

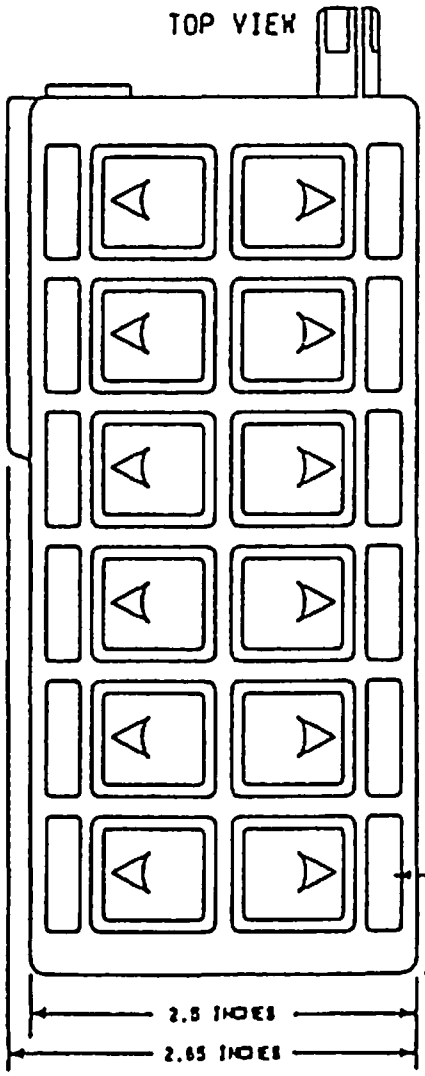
Follow the above procedure for the down direction.



SIDE VIEW



TOP VIEW



FRONT VIEW

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.

BLDG 15 HIGH BAY

TOP VIEW

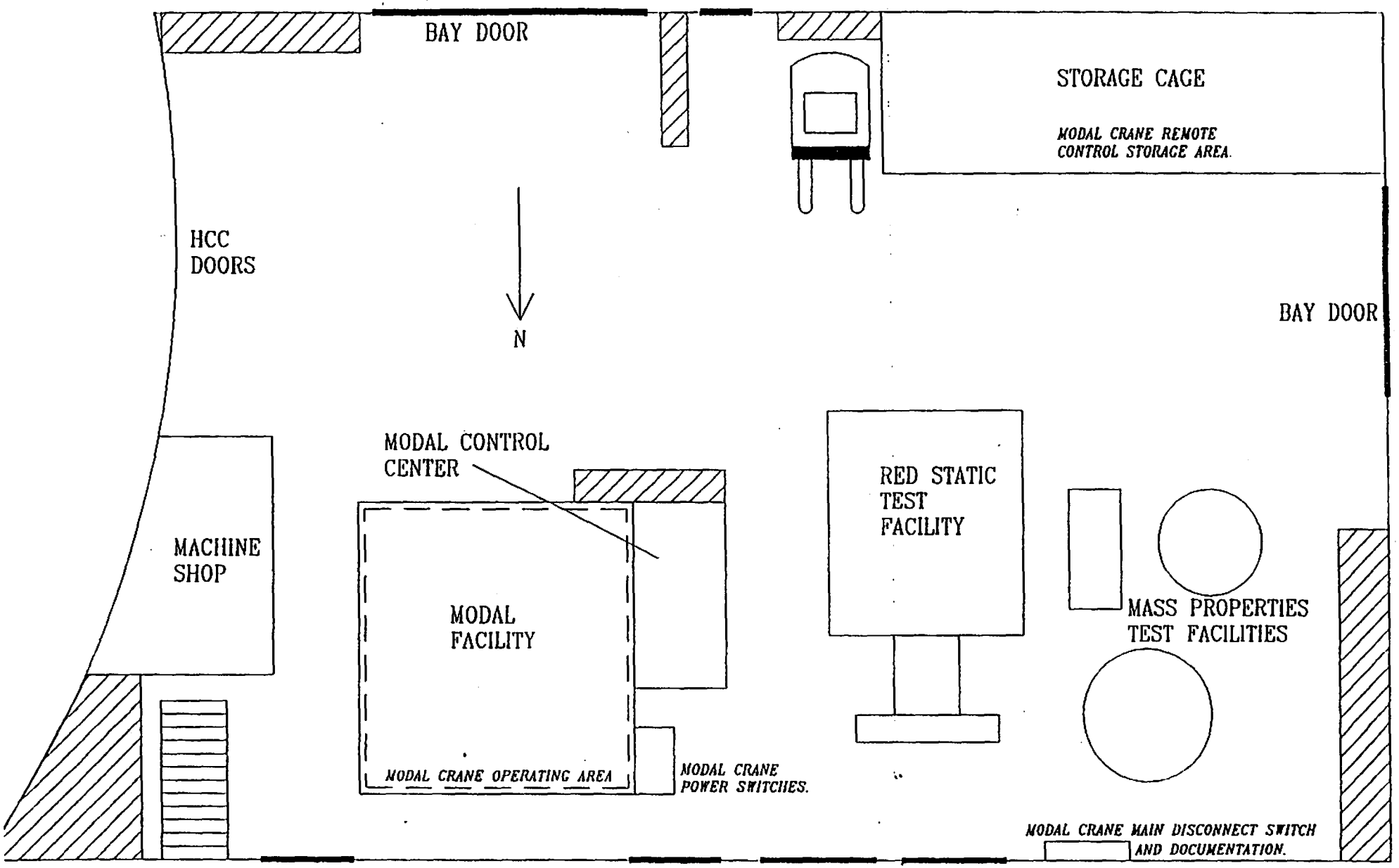


FIGURE 1

MODAL CRANE REMOTE CONTROL UNIT

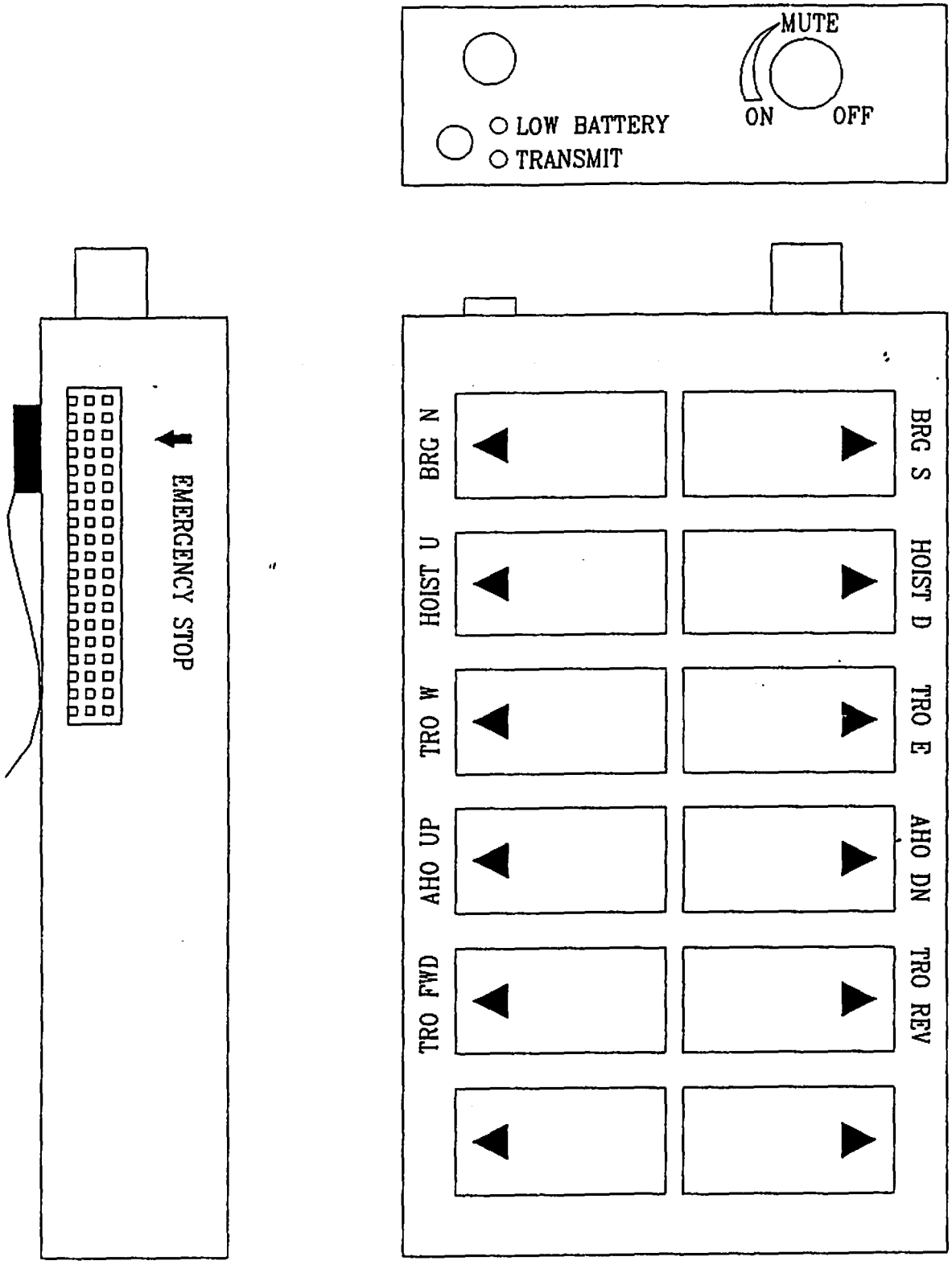
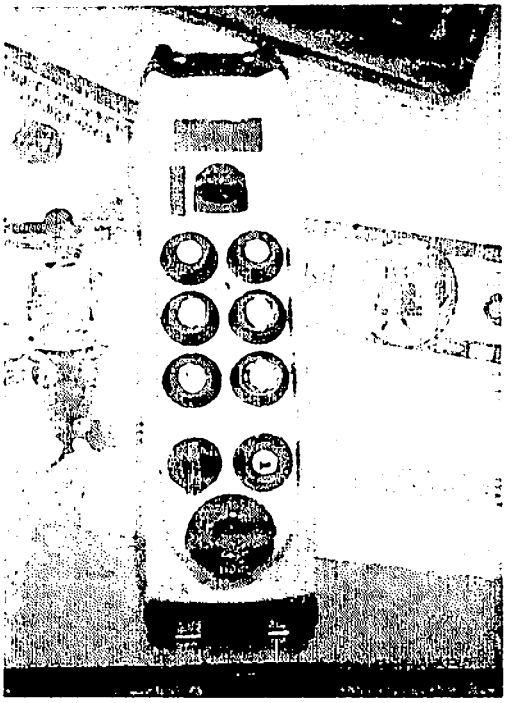


FIGURE 2

RaCon Series II Radio Remote System



Radio Training

Cranes 10-2

RaCon Series II

Radio remote control

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	-20°C to +65°C	-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 BT08K batteries			
	Voltage	4.8 V	
	Capacity	700 mAh, NiMH	
	Charging temperature	5°C to 35°C	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.

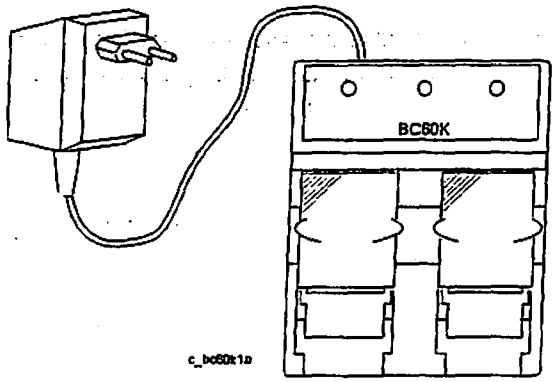
Do not use the equipment if failure is detected.

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 5°C (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 35°C (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 5°C (41F) and 35°C (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.

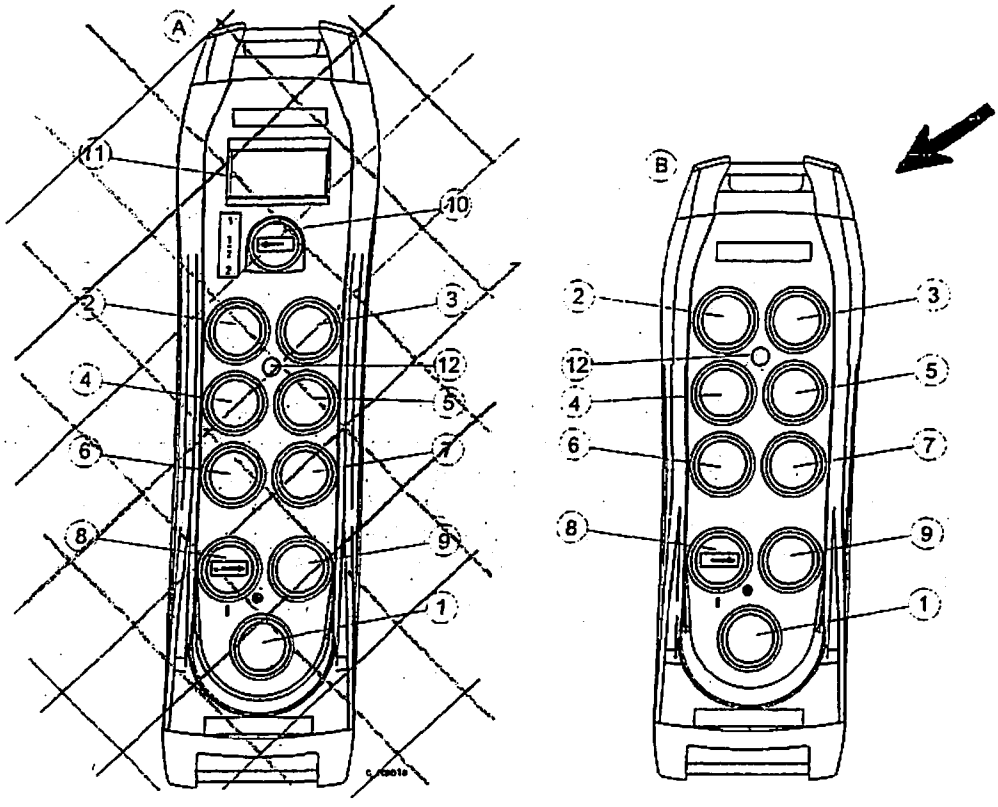
4.1 Receiver

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.



~~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~~.

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

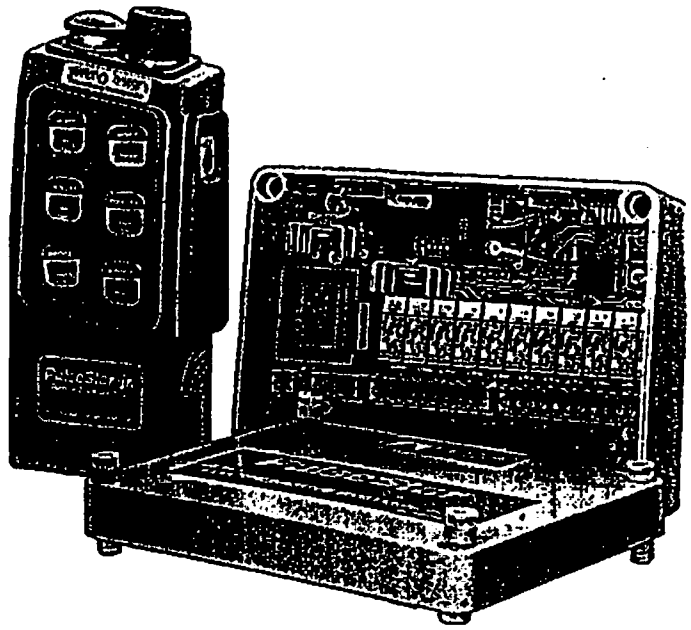
PulseStrar JR JRT Transmitter Radio Remote System

Radio Training

Cranes 5-4 and 31-1

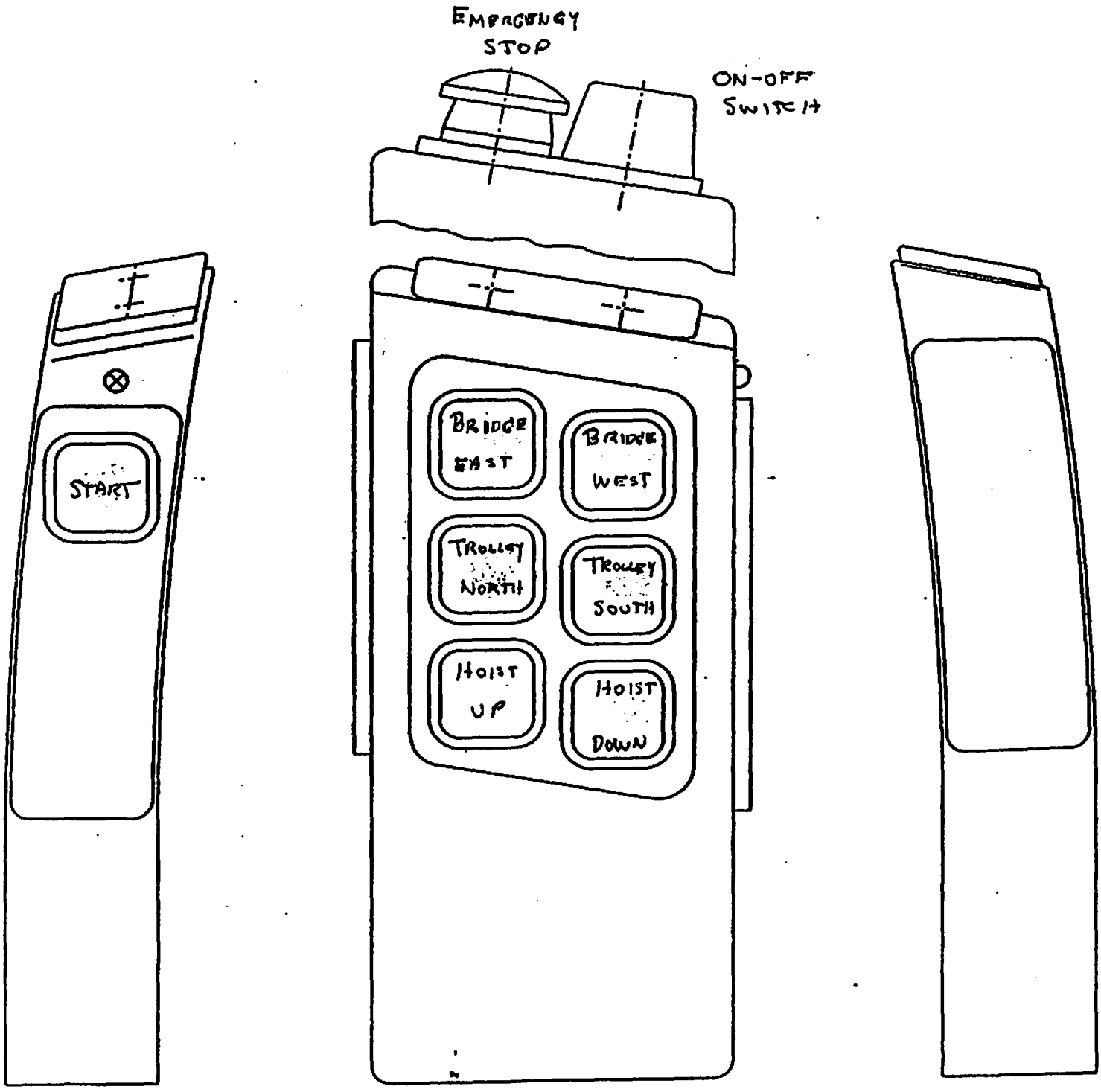
PulseStar™ •jr.

JRT Transmitter



Type	• JRT (Pushbutton)
Weight	• < 1.25 lbs. (includes battery)
Physical Size	• 8" x 3.5" x 1.5" (L x W x H) (21 cm x 8.7 cm x 4 cm)
HF Output Power	• Maximum 10mW
Deviation	• +/- 2kHz
Power Supply	• 9.6 V Ni Cd recargeable battery
Operation Time	• 7 – 9 hours with one charge
Enclosure	• IP65 Weatherproof (Exceeds NEMA 12/13)
Protection	• Key switch with cap
Antenna	• Built-in
Functions	• Active Emergency-Stop button (push/pull) • Three crane motions, two speeds, interlocked • Horn and mainline activation
Features	• Sleep Mode (ten minutes) • Switch on protection • Mechanical protection against accidental activation
Battery and Charger	• 115/220 VAC (+/- 20%) • Charging time = three hours • Batteries are recharegeable approximately 800 times • Gold self-cleaning contacts • Battery charger and two batteries included
Holster	• Holster with belt clip is included • Pocket holder and carrying belt (optonal)

ELECTROMOTIVE SYSTEMS INC
P.O. Box 13615
Milwaukee, WI 53213
USA
Tel 414•783•3500 Fax 414•783•3510
http://www.electromotive.com


EMERGENCY STOP
ON-OFF SWITCH
START
BRIDGE EAST
BRIDGE WEST
TROLLEY NORTH
TROLLEY SOUTH
HOIST UP
HOIST DOWN

Battery and Charger Information

Removing and Inserting the Battery From the Transmitter

JRT Transmitter

To remove or insert the battery from the JRT transmitter, refer to Figure 3.21: 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.

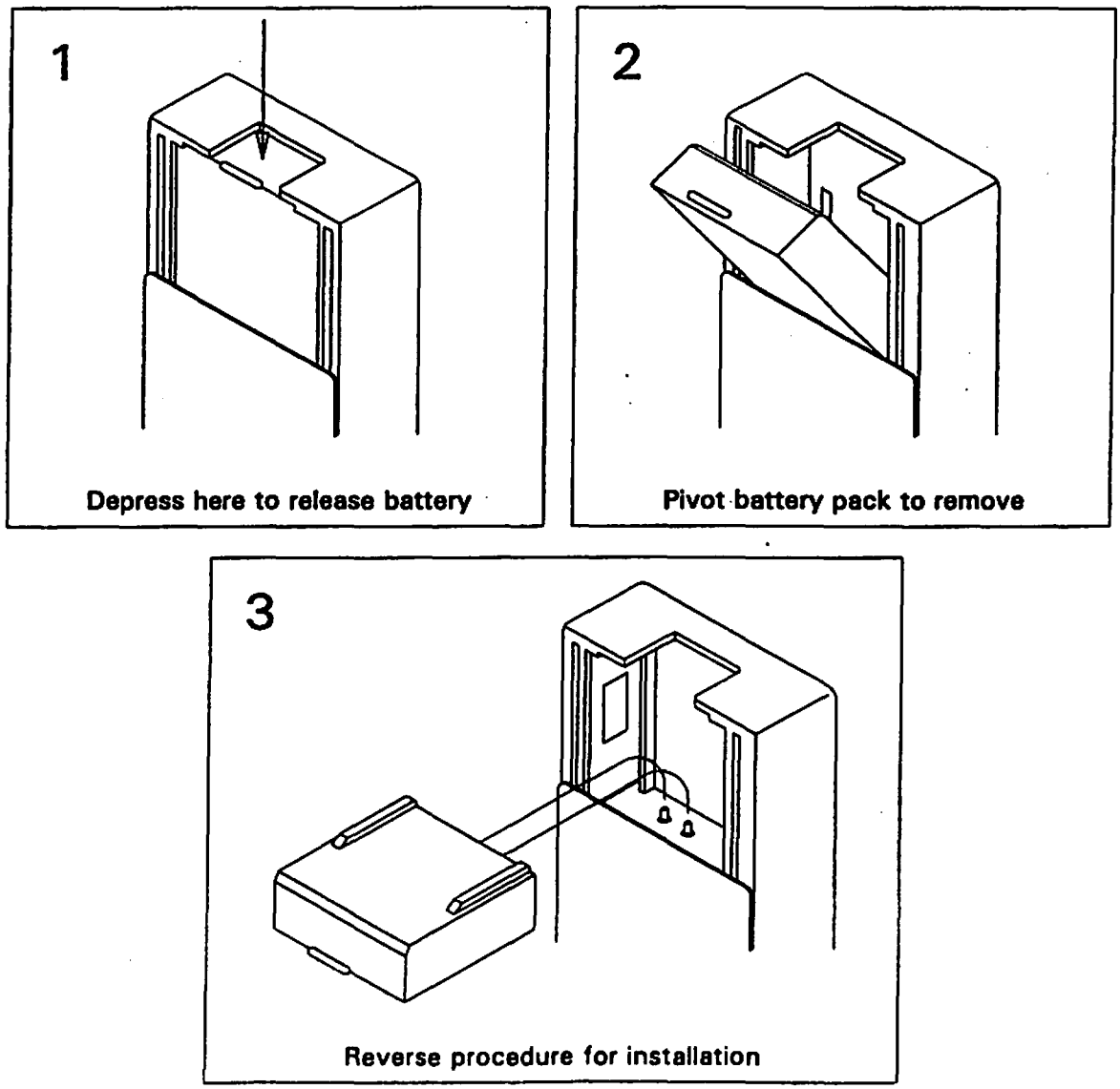


Figure 3.21: JRT Transmitter Battery Removal

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.

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:

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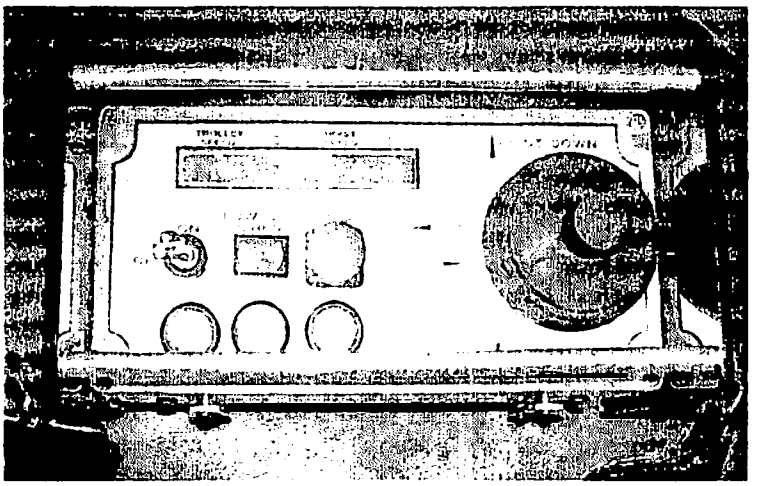
To start up the crane, unlock the crane disconnect, be sure the E-Stop button on the disconnect panel is pulled "out" and close the disconnect. Then follow the radio control instructions.

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.

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.

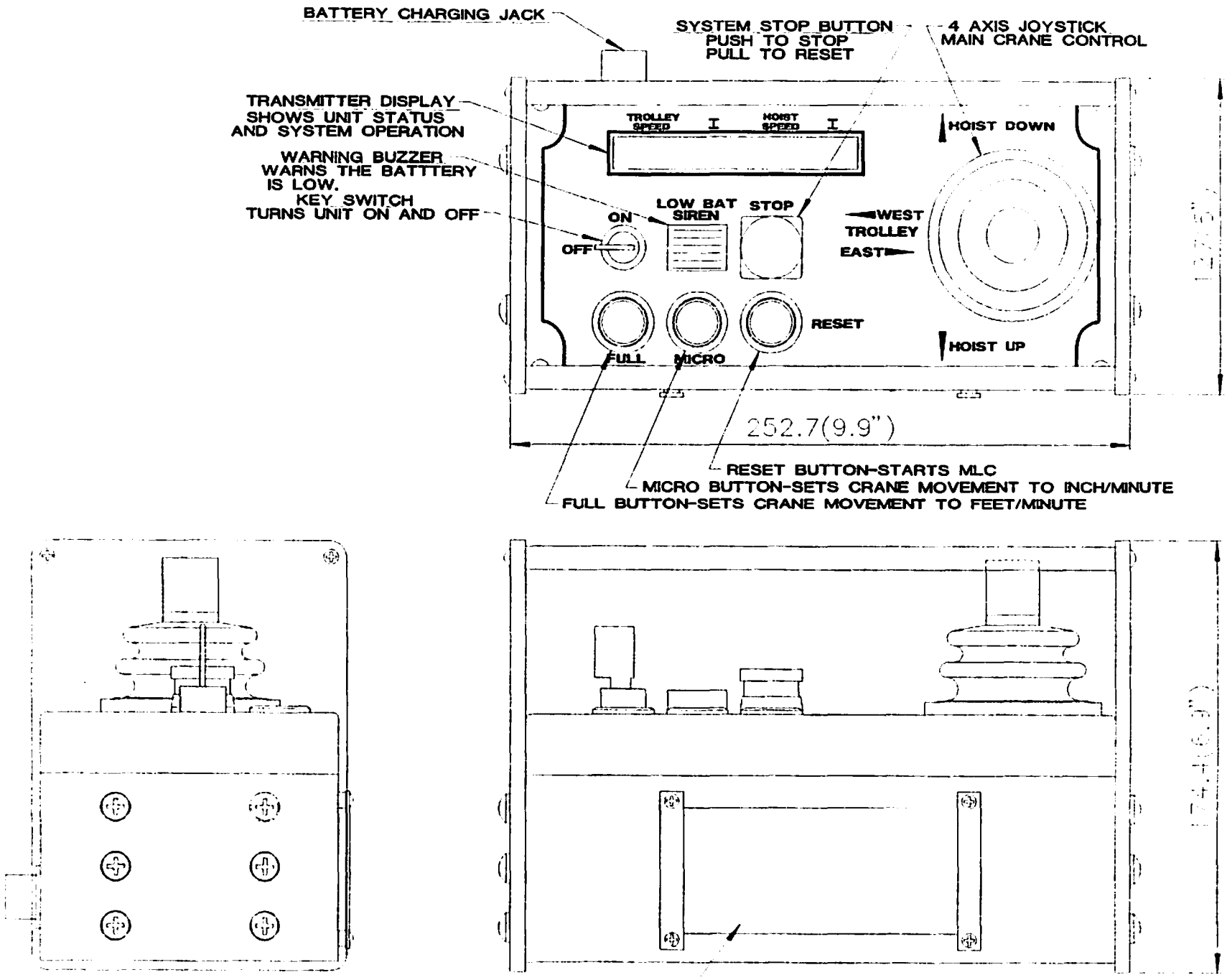
System Warnings!!!

Operators should be familiar with the following rules and warnings:

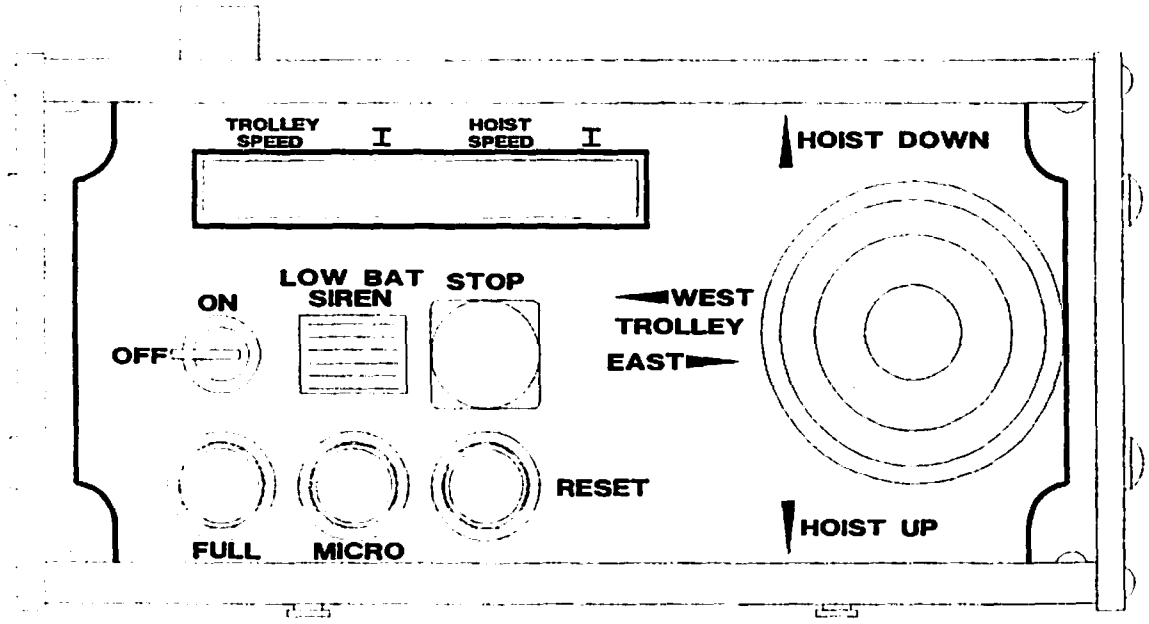
- Always be in visual contact with the crane before turning the radio ON.
- Range between the remote and the base can vary, but in ideal conditions maximum range could be 1 mile. The system could be operated outside the working area and out of sight.
- Never operate the base unit without an antenna. 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).



GENERAL TRANSMITTER LAYOUT



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)

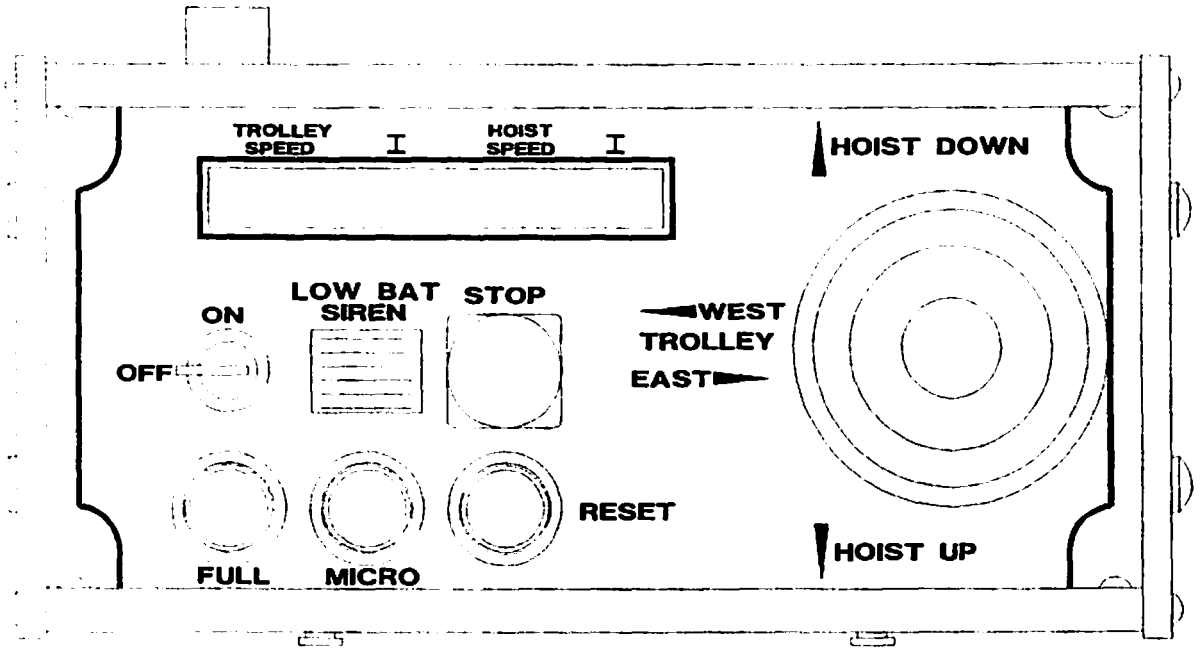
2.) To start the main line contactor
- Press the RESET button to bring in the M.L.C..
- This will put power to the motor control drives

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.



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

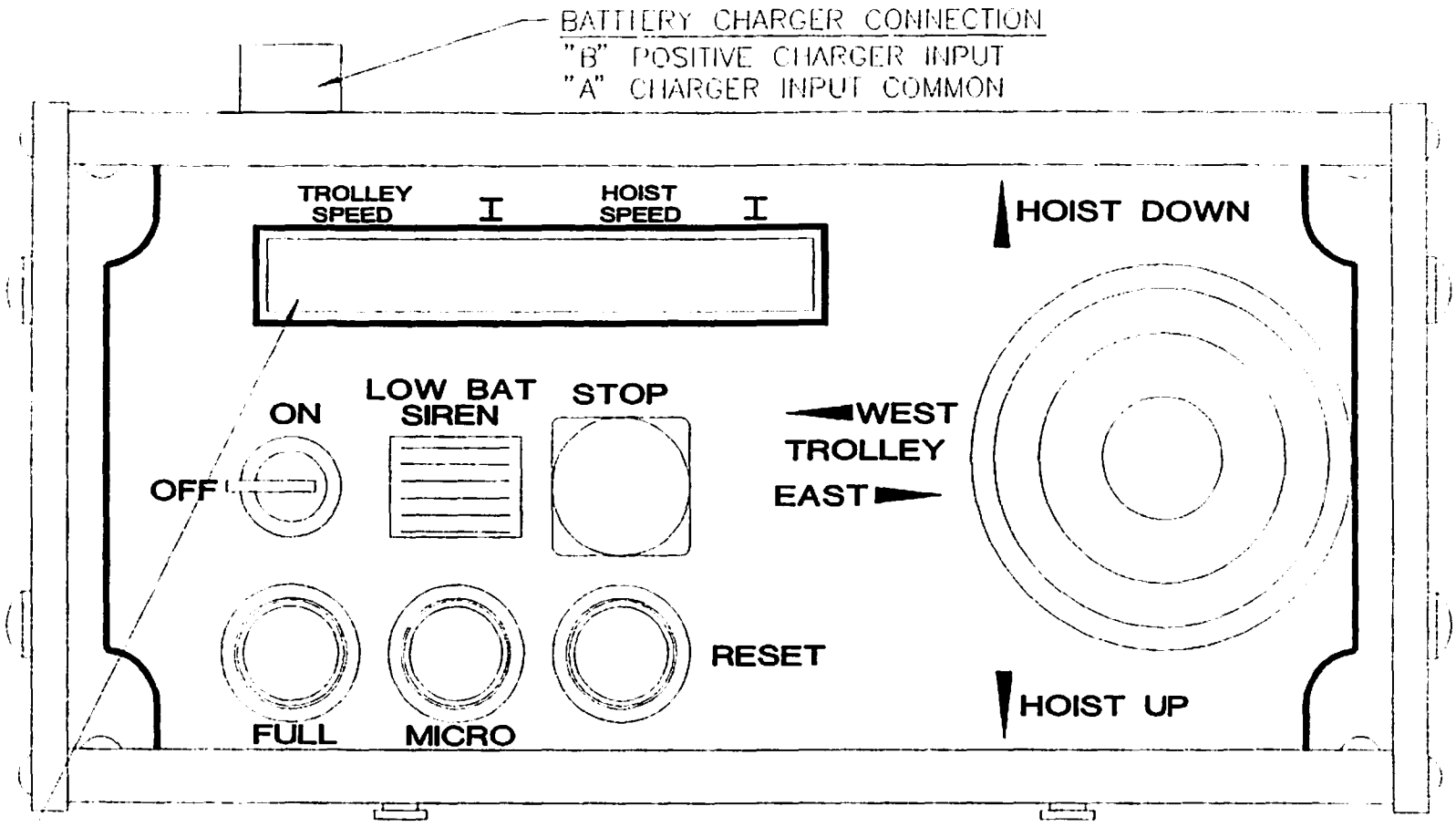
TROLLEY SPEED	I	HOIST SPEED	I
POW DOWN INACTIVE			

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



BATTERY DISPLAY SCREEN:

8 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:

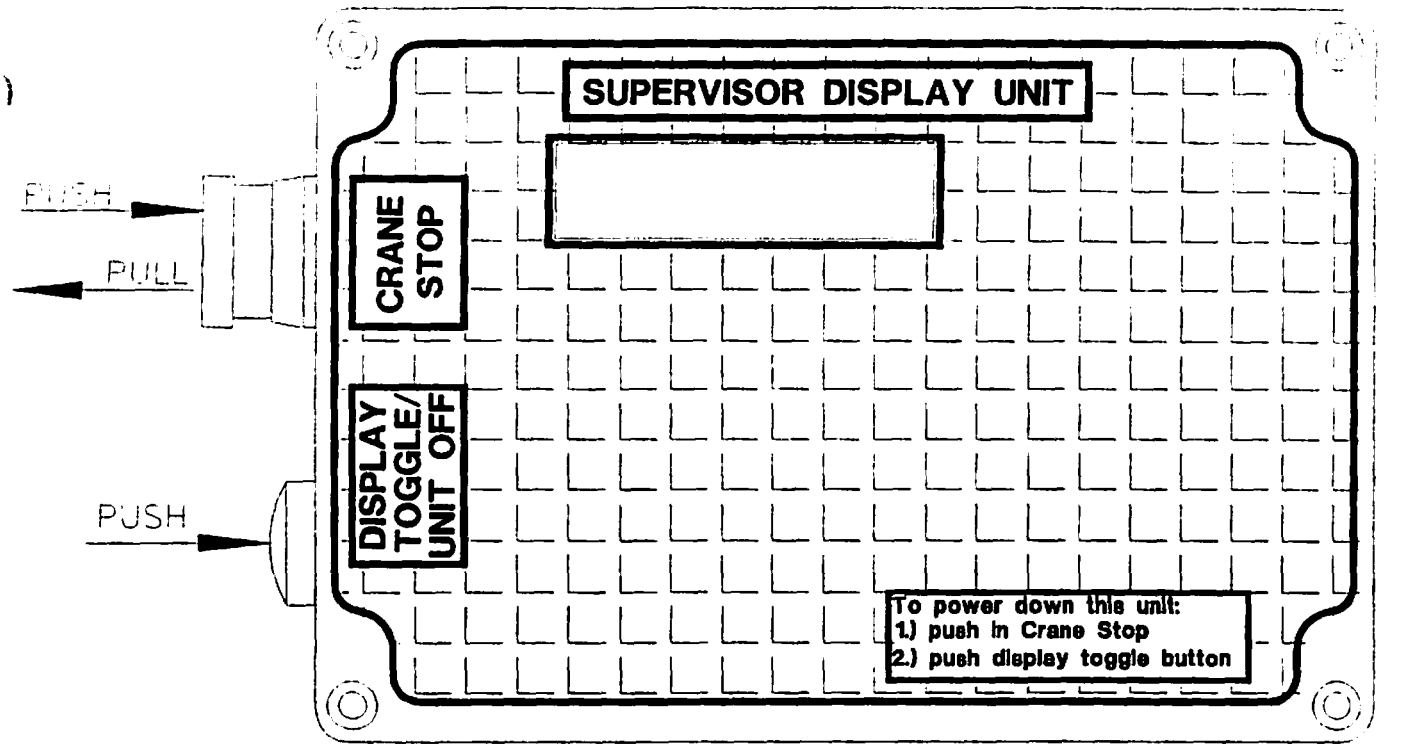
BEEPS AT 1/4 POWER

CONTINUOUS BUZZ AT 1/8 POWER

(1/2 HOUR WARNING!!!)

BATTERY POWER INFORMATION

E-STOP TRANSMITTER



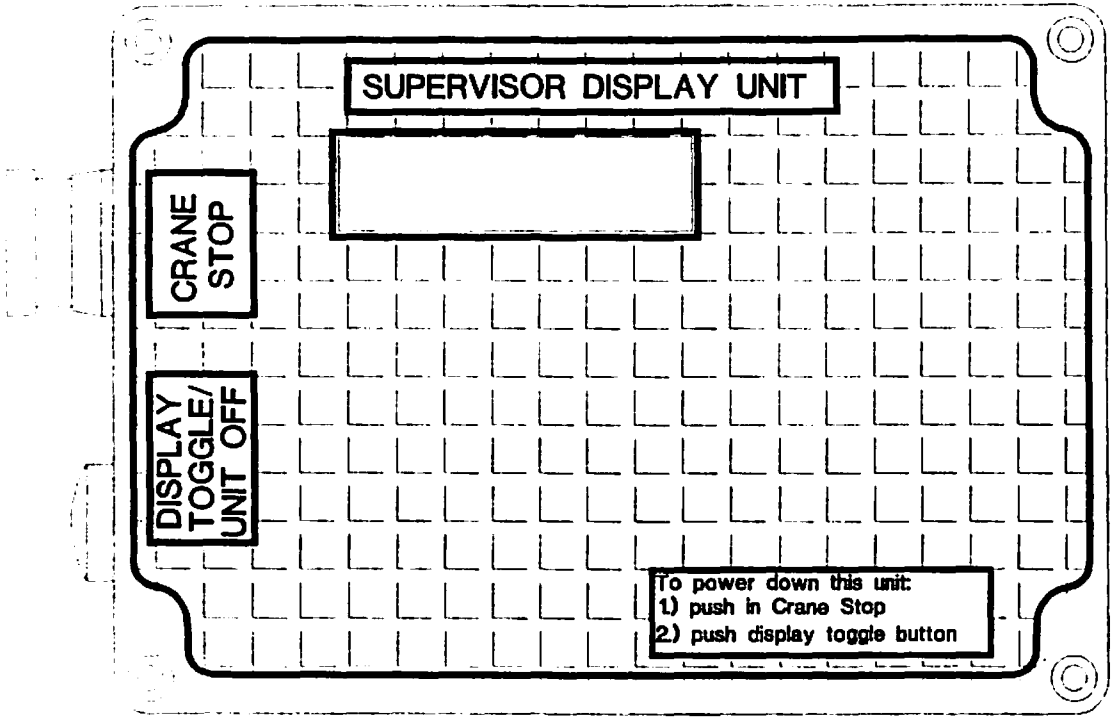
This unit is used for supervison over the base unit of the crane control system. **When necessary for critical lifts.**

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
3-8 = 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

WDS 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

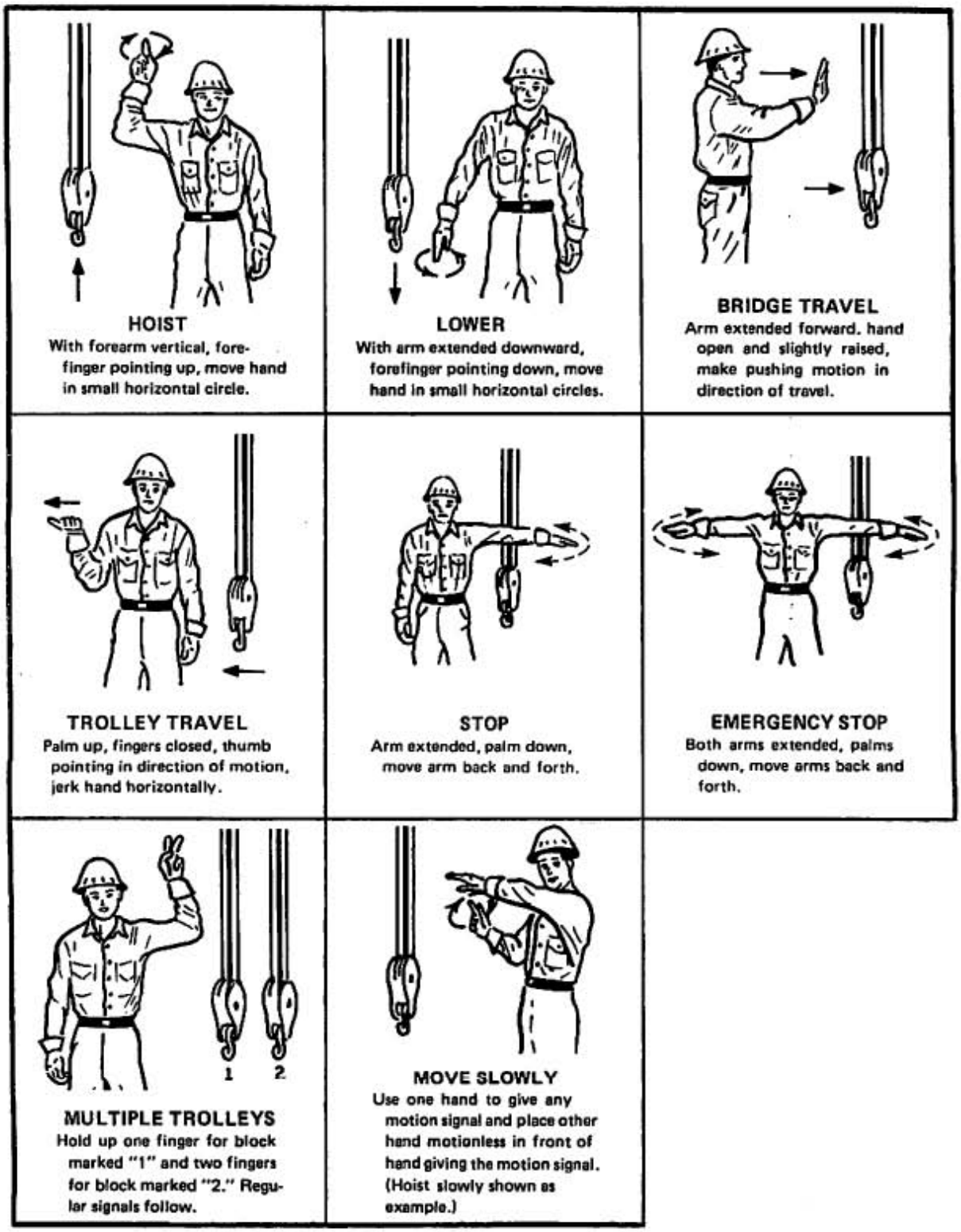
4.) Hoist down direction selected by base unit.
- 8 meassages per second
- watchdog processor indication
- speed indication in feet or inches per minute.
- Current output= 12 amps.

TYPICAL SUPERVISOR DISPLAYS
97100000 ISS.1

APPENDIX C

HAND SIGNALS

Overhead Cranes



3.0 Emergency Operating Procedure

3.1 General

For the purpose of this document, an emergency is defined as any abnormal situation that endangers personnel, flight 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 should know the following in advance of making a lift:

1) Location of emergency equipment near the operational area (fire alarms, extinguishers, blankets, and nearest telephone).
2) The emergency evacuation plan for Building 15.
3) The instructions given below for specific emergency cases.

As soon as the immediate danger has passed, notify the supervisor in charge, the crane maintenance department, the Technical Monitor for that area, the ManTech Safety Officer, and the FOM. These five 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 crane maintenance department to expedite repairs. Finally, assist in preparation of an Engineering Services Division Incident Report (within 24 hours when possible).

3.2 Emergency Cases

1) Brakes Slip, Load Falls Gradually

   a) Push the UP button repeatedly and as often as necessary to hold the load up until the Rigger can place a skid or cushion under it. Never walk under a load in this situation.
   b) Using the same technique, lower the load to the floor as gently as possible.
   c) Shut down the crane as directed above, and lock out and tag the main disconnect. Identify the crane malfunction in the log book and on the lockout tag. Refer to ManTech Safety Directive SD-011.
   d) Notify and report the incident to the proper authorities.

2) Load Falls Suddenly

   a) Move as quickly as possible away from the load. Do not try to intervene and save the load.

b) In case of injury:
   1) Dial 911 and request emergency help. Answer all questions and let the other person hang up their phone first.

   NOTE: The risk of a sudden fall can be greatly reduced by checking for defects before operation, as outlined in Section 2.3. Danger of injury can be greatly reduced by staying out from under a load and by paying constant attention to the status of a load.

c) If the accident causes a minor fire, turn in an alarm.
d) If the accident causes an explosion, major fire, or release of radiation or toxic matter, warn surrounding personnel and evacuate the building as quickly as possible.
e) If the area around the accident is safe, rope it off, shut down the crane, and lock out the main disconnect.
f) Notify the proper authorities and report the incident.

3) Runaway Crane

a) If a crane motion continues after a button is released, push "Emergency Stop" and warn surrounding personnel of the situation.
b) If motion still continues, rush to the individual crane power switch and turn off the power while facing away from the switch. Danger of the box exploding is greater at this time. Then proceed to the main disconnect and turn if off as well.
c) If the runaway condition causes any other problems (collision, fire, etc…), follow the instructions for the appropriate emergency case at this time.
d) Lock out and tag the disconnect.
e) Rope off the area beneath or around the load.
f) Notify the proper authorities and report the incident.

4) Crane Stuck With Elevated Load

a) Push "Emergency Stop."
b) Shut down the crane and lock out the main disconnect.
c) Rope off the area beneath the load.
d) Notify the proper authorities and report the incident.

NOTE: Only qualified technicians from the crane maintenance department shall lower a load manually should this be necessary.

5) Crane Damaged During Lift

a) If the crane incurs damage (e.g., twisted or crossed cable, bent hook, cable out of sheave, derailed truck, etc…) while a lift is underway, push "Emergency Stop."
b) Shut down the crane and lock out the main disconnect.
c) Rope off the area beneath the load.
d) Notify the proper authorities and report the incident.

NOTE: Only qualified technicians from the crane maintenance department shall lower a load manually should this be necessary.

6) Power Outage

a) Push "Emergency Stop."
b) Shut down the crane and lock out the main disconnect.
c) Rope off the area beneath the load.
d) Notify the proper authorities and report the incident.
e) When power is restored, restart the operation.

7) Storm Warnings

a) When there is a "Condition 3" or "Condition 5" storm warning, set the load down at the nearest safe location.
b) Disconnect the crane hook from the payload.
c) Push "Emergency Stop."
d) Shut down the crane and lock out the main disconnect.
e) When conditions return to normal, restart the operation.

8) Fire in Crane

a) Push "Emergency Stop" and warn surrounding personnel of the situation.
b) Rush to the individual power switch and shut off power to the crane. Then go to the main disconnect and shut it off.
c) Dial 911 and request emergency help.
d) If fire is minor, turn in an alarm.
e) If the fire is major, warn surrounding personnel and evacuate the buiding.

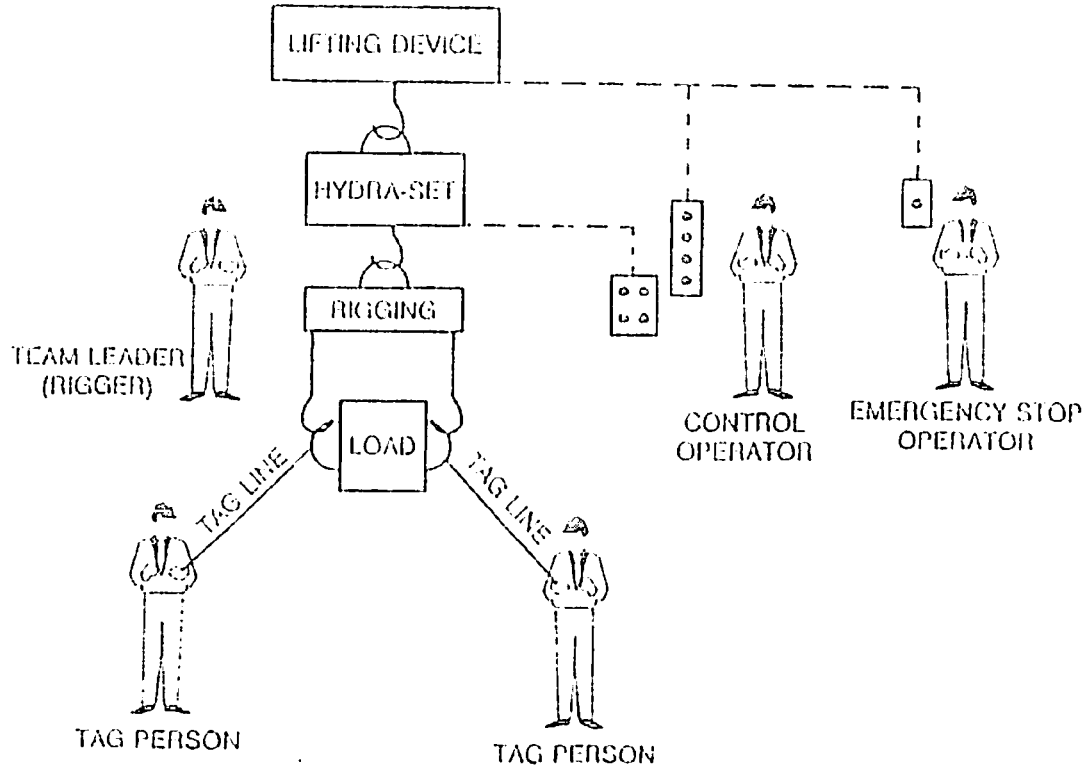
f) When the area around the accident is safe, rope it off and lock out the main disconnect.
g) Notify the proper authorities and report the incident.

9) Fire Alarm Sounds in Building

a) If time permits, lower the load to the floor as quickly as possible without damage.
b) Push "Emergency Stop."
c) If time permits, shut off the individual crane power switch and the main disconnect.
d) Vacate the building through the proper emergency exit.
e) When conditions permit, return to the test area and inspect for any possible damage before continuing with the operation.

LIFT TEAM

LIFT TEAM



Rigger's Worksheet

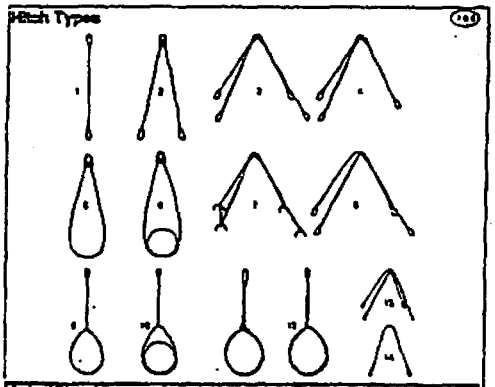
WRRC: We Rig It Right!

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. ■

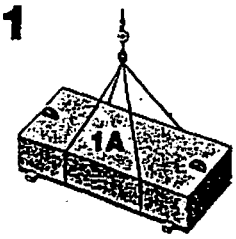
The Rigger's Worksheet is designed to be a personal challenge of your rigging knowledge. It is not to be used as a formal examination for the purpose of certification or qualification. The publishers of CraneWorks *do not accept responsibility for the misuse of this worksheet.*



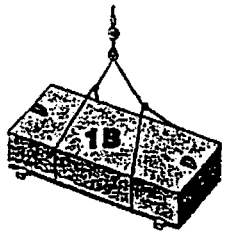
1	Single Vertical	Above	One	Poor	1
3	4-Leg Bridle	Both	Two	Excellent	3
5	Single Wrap Basket	Both*	Two	Average	5
7	Two Single Baskets	Both**	Four	Poor	7
9	Single Wrap Choker	Both*	Single	Average	9
11	Double Choker Right-up	Both*	Two	Good	11
13	Double Inverted Baskets	Above	Four	Poor	13

* [illegible] use as single hitch below CG] ** [pounds loading at pick points]

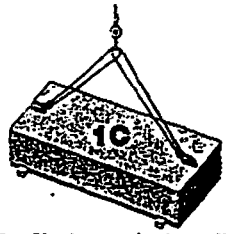
1



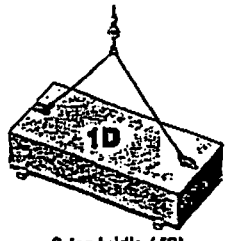
2ea Single wrap baskets (#5)



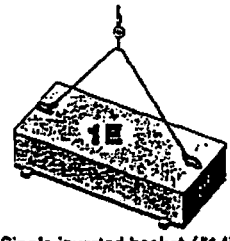
2ea Single wrap chokes (#9)



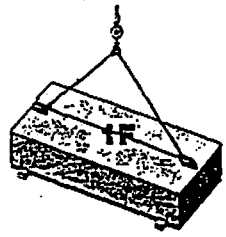
2ea Single wrap baskets (#5) (inverted)



2-leg bridle (#2)

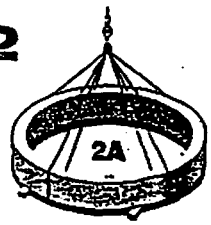


Single inverted basket (#14)

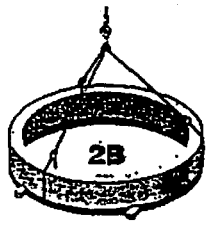


Single basket (#7)

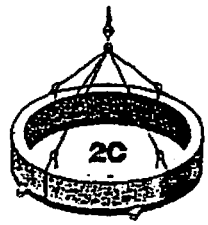
2



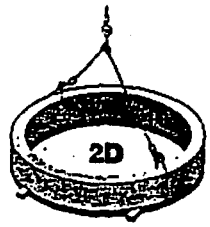
4ea single wrap baskets (#5)



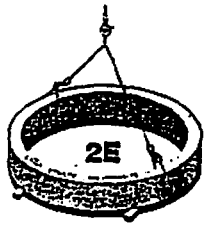
3ea single wrap chokers (#9)



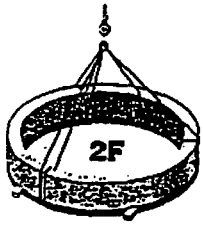
4ea single wrap chokers (#9)



2-leg bridle (#2) + 2ea single wrap baskets (#5)

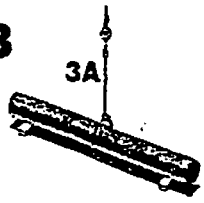


Single inverted basket (#14) + 2ea single wrap baskets (#5)

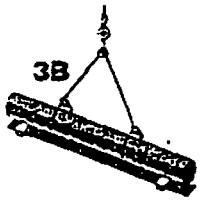


3ea double wrap baskets (#6)

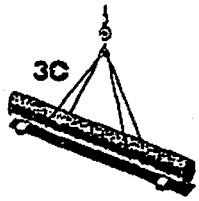
3



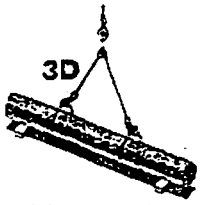
single wrap choker (#9)



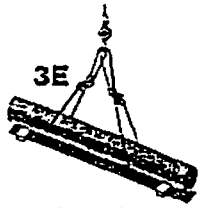
2ea single wrap chokers (#9)



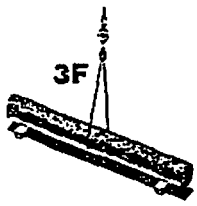
2ea single wrap baskets (#5)



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

SELECTION AND CARE OF RIGGING EQUIPMENT

Final Review

Directions: Circle the answer that **best** completes each of the following statements.

1. Synthetic web slings are characterized by . . .
   A. excellent gripping power.
   B. nonabrasiveness.
   C. resistance to chemical damage.
   D. All of the above answers are correct.

2. Before you use a synthetic web sling in an area where there are strong acid fumes, you should . . .
   A. be sure it has steel end fittings.
   B. check with the manufacturer.
   C. expose the sling directly to some of the acid to see if it will be damaged.
   D. find out what kind of material the sling is made of.

3. Chain must be protected against . . .
   A. crushing.
   B. corrosion.
   C. welding.
   D. All of the above answers are correct.

4. 6 x 19 class wire rope is made up of . . .
   A. 19 strands with 6 wires in each strand.
   B. 6 strands with 19 wires in each strand.
   C. 6 strands with anywhere from 9 to 26 wires in each strand.
   D. 6 wires in the core and 19 wires in each of the outer strands.

(over)

5. Wire rope used for slings is . . .
   A. left lang lay.
   B. left regular lay.
   C. right lang lay.
   D. right regular lay.

6. Compared to 6 x 19 wire rope, 6 x 37 wire rope with the same diameter and rated capacity is more . . .
   A. resistant to abrasion.
   B. flexible.
   C. heat resistant.
   D. All of the above answers are correct.

7. Kinks, dog legs, and bird caging all interfere with a wire rope's . . .
   A. ability to recover from shock loading.
   B. internal adjustments.
   C. gripping ability.
   D. All of the above answers are correct.

8. The number of rope clips required to form an eye in a sling is determined by . . .
   A. the rope manufacturer.
   B. the rope clip manufacturer.
   C. a government regulatory agency.
   D. an industrial safety association.

9. If an eye bolt is used for a lift with less than a 90° load angle, it must . . .
   A. be flush with the surface of the load.
   B. be turned so the eye is in line with the sling.
   C. have a shoulder.
   D. All of the above answers are correct.

10. A routine lift is most likely to make use of . . .
   A. a shackle.
   B. rope clips.
   C. a turnbuckle.
   D. None of the above answers is correct.

SAFE RIGGING

Final Review

Directions: Circle the answer that **best** completes each of the following statements.

1. You do not know whether a sling is adequate for a lift if you do not know the load's...

   A. weight.
   B. composition.
   C. measurements.
   D. All of the above answers are correct.

2. According to the video, an I.D. tag stating its rated capacity is not required for...

   A. metal mesh slings.
   B. synthetic web slings.
   C. chain slings.
   D. wire rope slings.

3. A table of rated capacities for wire rope slings generally lists capacities for different kinds of...

   A. sling angles.
   B. end fittings.
   C. load angle factors.
   D. rope lay.

4. Compared to a single vertical hitch, the rated capacity of a basket hitch with vertical sides is about...

   A. the same.
   B. one-third greater.
   C. two-thirds greater.
   D. two times greater.

5. Decreasing the angle between the sling and the load increases the...

   A. load angle factor.
   B. effective weight of the load.
   C. required sling capacity to lift the load.
   D. All of the above answers are correct.

6. A single choker hitch forms as angle to the load of about...

   A. 30 degrees.
   B. 45 degrees.
   C. 60 degrees.
   D. 90 degrees.

7. If a load is rigged with two basket hitches attached to the same hook, the required capacity of the slings is determined by the...

   A. smallest load angle.
   B. widest load angle.
   C. average of the widest and smallest load angles.
   D. None of the above answers is correct.

8. Whenever possible, a non-uniform load should be rigged with the hoist hook above...

   A. the center of gravity.
   B. the center of the load.
   C. a point between the center of gravity and the center of the load.
   D. a point between the center of gravity and the heaviest edge of the load.

9. Corner buffers are recommended to protect the...

   A. load from the sling.
   B. sling from the load.
   C. sling from excessive bending.
   D. All of the above answers are correct.

10. You can rig a load with wider load angles if you use...

   A. longer slings.
   B. shorter slings.
   C. wider slings.
   D. None of the above answers is correct.

Wire rope sling rated capacities

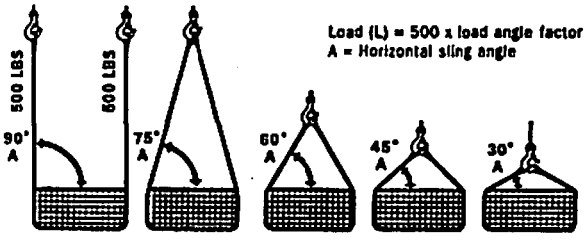
Rated loads[1] for single-legged sling 6 x 19 or 6 x 37 — XIP® IWRC

Rope diameter in inches	Vertical MS	Vertical S	Choker MS & S	Vertical basket MS & S[2]	Rope diameter in inches	Vertical MS	Vertical S	Choker MS & S	Vertical basket MS & S[2]
1/4	0.65	0.68	0.48	1.3	1	9.8	10	7.2	20
5/16	1.0	1.1	0.74	2.0	1 1/8	12	13	9.1	24
3/8	1.4	1.5	1.1	2.9	1 1/4	15	16	11	30
7/16	1.9	2.0	1.4	3.9	1 3/8	18	19	13	36
1/2	2.5	2.7	1.9	5.1	1 1/2	21	23	16	42
9/16	3.2	3.4	2.4	6.4	1 5/8	24	26	18	49
5/8	3.9	4.1	2.9	7.8	1 3/4	28	31	21	57
3/4	5.6	5.9	4.1	11	2	37	40	28	73
7/8	7.6	8.0	5.6	15					

MS = mechanical splice. S = poured socket or swaged socket. [1]These values are based on slings being vertical. If they are not vertical, the rated load shall be reduced. If two or more slings are used, the minimum horizontal angle between the slings shall also be considered. Horizontal sling angles less than 30° shall not be used. [2]These values only apply when the D/d ratio is 25 or greater. D = diameter of curvature around which the body of the sling is bent. d = diameter of rope.

Sling angles

Two-legged sling — wire rope and chain



Load (L) = 500 x load angle factor
A = Horizontal sling angle

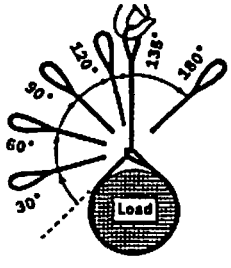
Horizontal sling angle (A) degrees	Load angle factor = L/A
90	1.000
60	1.154
50	1.305
45	1.414
30	2.000

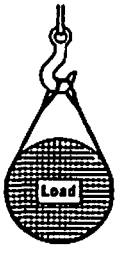
Load on each leg of sling = vertical load x load angle factor

Choker hitches

Wire rope

Angles of choke	Sling rated load Percentage of single leg choker sling capacity
121 - 180°	100%
90 - 120°	87%
60 - 89°	74%
30 - 59°	62%
0 - 29°	49%





Basket hitches

Wire rope

A basket hitch has twice the capacity of a single leg only if D/d ratio is 25/1 or greater and it is vertical.

Web sling rated capacities

Rated capacity in pounds

Eye & Eye-Flat (Type 3) and Eye & Eye-Twist (Type 4)

Stock number	Vertical	Choker	Basket and 2 leg bridle	75°	60°	45°
EE-1-901	1600	1280	3200	3093	2773	2260
EE-2-901	3200	2560	6400	6187	5547	4520
EE-1-902	3200	2560	6400	6187	5547	4520
EE-2-902	6400	5120	12800	12373	11093	9040
EE-1-903	4800	3840	9600	9280	8320	6780
EE-2-903	8880	7104	17760	17168	15392	12543
EE-1-904	6400	5120	12800	12373	11093	9040
EE-2-904	11520	9216	23040	22272	19968	16272
EE-1-906	9600	7680	19200	18560	16640	13560
EE-2-906	16320	13056	32640	31552	28288	23052

NOTE: To figure rated capacities for endless (Type 5) slings, simply multiply the above figures by two and order with an "EN" prefix instead of "EE." Horizontal sling angles less than 30° shall not be used.

Web and wire rope sling inspection and replacement

Inspection and replacement per ASME B30.9

Web and wire rope sling inspection

Before using any new or repaired sling, inspect to see you're using the correct sling to meet the standard requirements for that application.

Frequency of inspection

All slings shall be visually inspected by the person handling the sling each day for any possible damage. Additional inspections should be performed at least annually by a qualified designated person.

Web sling replacement

Remove sling from service if damage such as the following is seen, and return to service only when approved by a designated person.

1. Acid or caustic burns.
2. Melting or charring of any part of the sling.
3. Holes, tears, cuts or snags.
4. Broken or worn stitching in load-bearing splices.
5. Excessive abrasive wear.
6. Knots in any part of the sling.
7. Excessively pitted, corroded, cracked, distorted or broken fittings.
8. Other visible damage that causes doubt as to sling strength.

Wire rope sling replacement

When you see any of the following conditions, it's enough reason to question sling safety and consider replacement:

1. 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.
2. Severe localized abrasion or scraping.
3. Kinking, crushing, birdcaging or any other damage resulting in distortion of the rope structure.
4. Evidence of heat damage.
5. End attachments that are cracked, deformed or worn to the extent that the strength of the sling is substantially affected.
6. Severe corrosion of the rope or end attachments.

Wire rope clips shall not be used to fabricate wire rope slings except where the application of slings prevents the use of prefabricated slings or where the specific application is designed by a qualified person.

Find out more. For additional information on use and limitations of slings, please consult Wire Rope Corporation of America, Incorporated handbooks, the Wire Rope Technical Board's Wire Rope Sling Users Manual and industry specifications.

Operating practices for web and wire rope slings.

1. Select slings with suitable characteristics for the type of load, hitch and environment according to the appropriate charts set by ASME. When D/d ratios on wire rope slings are smaller than those listed in the chart, decrease the sling's rated load.
2. Make sure the load's weight is within the rated load of the sling, including consideration of leg angles.
3. Never use nylon or polyester slings at temperatures above 194° F. (90° C.) or below -40° F. (-40° C.).
4. You can shorten, lengthen or adjust slings only by methods approved by the sling manufacturer, and never shorten slings by knotting.
5. Never use slings that appear to be damaged unless inspected and accepted as usable under ASME guidelines.
6. Hitch sling only in a manner that controls the load.
7. Pad all sharp corners in contact with the sling using material with enough strength to minimize damage to the sling.
8. Always center the load applied to the hook in the base (bowl) of the hook to prevent point loading on the hook unless the hook is designed for point loading.
9. Avoid twisting and kinking the sling's legs.
10. In a basket hitch, always balance the load to prevent slippage.
11. The sling's legs should contain or support the load from the sides above the center of gravity when using a basket hitch.
12. Make sure the slings are long enough so that the rated load is adequate when you consider the angle of the legs.
13. An object engaging the eye of a loop eye sling should not be greater in width than half the length of the loop eye.
14. To prevent injury, keep away from the areas between the sling and load and between the sling and the crane hook or hoist hook.
15. Keep everyone away from the suspended load.
16. Avoid shock loading.
17. Be alert for any possible snagging during lifting, with or without load.

Rigger's Digest

Wire Rope Corporation of America, Incorporated

LESCHEN
Rope Systems WIRE ROPE

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WARNING

Failure to comply with this warning may result in personal injury or death.

Inspection, Care and Use of Synthetic Web Slings

Removal From Service

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

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

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 load 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.
5. Slings used in a basket hitch shall have the load balanced 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.
8. Slings shall not be dragged on the floor or over an abrasive surface.
9. Slings shall not be twisted or tied into knots, or joined by knotting.
10. Slings shall not be pulled from under loads if the load is resting on 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, 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.
15. Personnel shall stand clear of the suspended load.
16. Personnel shall not ride the sling.
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 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 and Polyester slings shall not be used 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.

Inspection

A. Initial Inspection

Before any new or repaired sling is placed in service, it shall be inspected by a designated person 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 made by a qualified person handling the sling each time the sling is used.

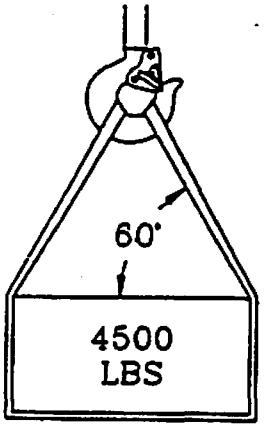
C. Periodic Inspection

This inspection shall be conducted by designated personnel. 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

Sling Angle and Sling Load Chart

SLING ANGLE is the angle measured between a horizontal line and the sling leg or body. This angle is very important and can have a dramatic effect on the rated capacity of the sling. As illustrated, when this angle decreases, the load on each leg increases. This principle applies whether one sling is used to pull at an angle, in a basket hitch or for multi-legged bridle slings. This data is only for equally loaded sling legs. Sling angles of less than 30 degrees are not recommended.



Sling Angle In Degrees	Factor
90	1.000
85	.996
80	.985
75	.966
70	.940
65	.906
60	.866
55	.819
50	.766
45	.707
40	.643
35	.574
30	.500

Actual Sling Capacity = factor X rated capacity

Additional requirements and safe operating practices are outlined in current OSHA and ANSI/ASME B30.9 and/or other regulations as applicable.

THE JAMES WALKER COMPANY

7109 MILFORD INDUSTRIAL ROAD

Off Old Milford Mill Road, Pikesville, Baltimore, MD 21208

PH: (301) 486-3950

FAX (301) 486-5176

WALKER # 105—B

WIRE ROPE SLING

Rated capacities of basket hitches are based on a minimum diameter of curvature of the point of load contact of 40 times the rope diameter for slings ¼" thru 1" diameter and 25 times the rope diameter for slings, 1⅛" diameter and larger.

Wire rope construction

Wire ropes which are regularly used in Walker slings are either 6 x 19 Class or 6 x 37 Class. Generally, ropes with diameters up to 1⅛ in. inclusive are 6 x 19 Class and ropes with larger diameters are 6 x 37 Class. The choice between the two classes may also depend upon the application of the sling, and the characteristics that are most desirable in the sling. For example, if resistance to abrasion is of prime importance, the 6 x 19 Class is chosen because wires of large diameter provide a high degree of wear resistance. On the other hand, if flexibility is desired, the 6 x 37 Class is more satisfactory because of the larger number of smaller wires in the rope.

Rated capacities

Rated capacities suggested for slings are based on sound engineering practices and ample safety factors and are in accordance with Occupation Safety and Health Administration standards. Rated capacities are only applicable for new slings under normal conditions. As a standard practice to avoid confusion, all sling angles are measured from the vertical.

WIRE ROPE SLINGS
CHAIN SLINGS
NYLON SLINGS

THE JAMES WALKER COMPANY

7109 MILFORD INDUSTRIAL ROAD

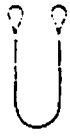
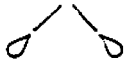
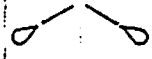
Off Old Milford Mill Road, Pikesville, Baltimore, MD 21208

PH: (301) 486-3950

FAX (301) 486-5176

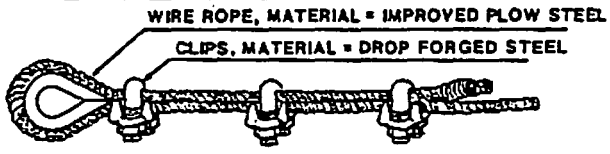
WALKER # 105—B

WIRE ROPE SLING

RATED WORKING LOADS FOR WALKER NO. 105 - B FLEMISH EYE SLINGS						
	SINGLE LEG SLINGS			DOUBLE LEG SLINGS		
	STRAIGHT PULL	CHOKER HITCH	BASKET HITCH	AT 30°	AT 45°	AT 60°
DIAMETER OF WIRE ROPE						
INCHES	TONS - - - (2,000 LBS) IWRC					
1/4	.56	.41	1.12	.97	.79	.56
3/8	1.2	.92	2.4	2.1	1.7	1.2
1/2	2.2	1.6	4.4	3.8	3.1	2.2
5/8	3.4	2.5	6.8	5.9	4.8	3.4
3/4	4.9	3.6	9.8	8.5	6.9	4.9
7/8	6.6	4.8	13.2	11.0	9.3	6.6
1	8.5	6.3	17.0	15.0	12.0	8.5
1 1/8	10.0	7.9	20.0	17.0	14.0	10.0
1 1/4	13.0	9.7	26.0	23.0	18.0	13.0
1 3/8	15.0	12.0	30.0	26.0	21.0	15.0
1 1/2	18.0	14.0	36.0	31.0	25.0	18.0
1 3/4	25.0	19.0	50.0	43.0	35.0	25.0
2	32.0	24.0	64.0	55.0	45.0	32.0
2 1/4	39.0	30.0	78.0	68.0	55.0	39.0

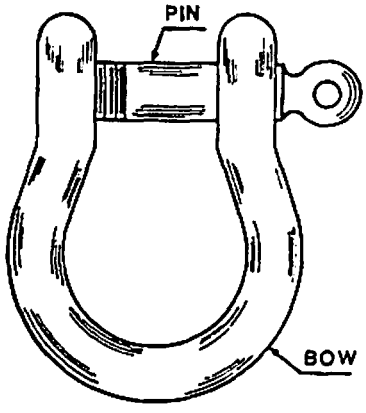
MARSHALL MAINTENANCE
TRENTON, NEW JERSEY

ROPE DIAMETER	3/8"	1/2"	5/8"	3/4"	1"	1-1/4"
No. OF CLIPS FOR EACH ROPE END	2	3	3	4	5	6
MINIMUM CLIP SPACING, INCHES	2-1/4"	3"	3-3/4"	4-1/2"	6"	7-1/2"



NOTE: EYES IN WIRE ROPE SLINGS SHALL NOT BE FORMED BY USING ROPE CLIPS

SAFE WORKING LOAD FOR SHACKLES



PIN DIAMETER	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"
SAFE LOAD TONS (2,000 LBS.)	.5	1.0	1.4	2.2	3.2	4.3	6.7

MARSHALL MAINTENANCE TRENTON, NEW JERSEY

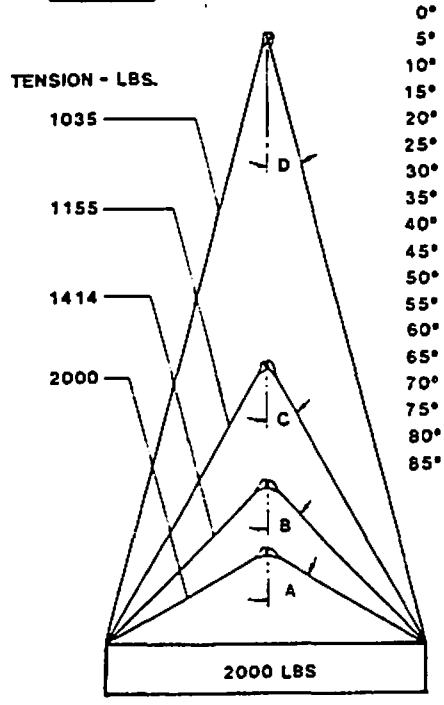
RATED CAPACITIES FOR SINGLE LEG SLINGS
6 X 19 IMPROVED PLOW STEEL GRADE ROPE WITH FIBER CORE
MECHANICAL SPLICE

ROPE DIAMETER	RATED CAPACITIES IN TONS (2,000 LB.)							
	VERTICAL	CHOKER	VERTICAL BASKET*	45° BASKET*	30° BRIDLE	45° BRIDLE	60° BRIDLE	85° BRIDLE
3/8"	1.1	0.85	2.2	1.6	1.9	1.6	1.1	.19
1/2"	2.0	1.5	3.9	2.8	3.4	2.8	2.0	.35
5/8"	3.1	2.3	6.2	4.4	5.3	4.4	3.1	.53
3/4"	4.4	3.3	8.8	6.2	7.6	6.2	4.4	.76
1"	7.7	5.8	15.0	11.0	13.0	11.0	7.7	1.3
1-1/8"	9.5	7.1	19.0	13.0	16.0	13.0	9.5	1.6

* 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 the rope.

MARSHALL MAINTENANCE
TRENTON, NEW JERSEY

LARGEST INCLUDED ANGLE BETWEEN ANY LEG AND VERTICAL	CAPACITY REDUCTION FACTOR (COSINE OF ANGLE)
0°	1.000
5°	.996
10°	.985
15°	.966
20°	.940
25°	.906
30°	.866
35°	.819
40°	.766
45°	.707
50°	.643
55°	.574
60°	.500
65°	.423
70°	.342
75°	.259
80°	.174
85°	.087



VERTICAL ANGLE
A = 60°
B = 45°
C = 30°
D = 15°

Turnbuckle Torque Requirements:

The torque required to turn a turnbuckle under load can be calculated from:

$T = 2(kdW/12)$ ft–lbs

where:
k = Friction factor (.16 for galvanized)
d = Nominal thread diameter (inches)
W = Applied load (lbs)

The torque required for a turnbuckle locknut can be calculated from:

$T = (kdW/12)$ ft–lbs

where:
k = Friction factor (.20 for plated)
d = Nominal thread diameter (inches)
W = Applied load (lbs)

Ft-lbs

Following are the torque values required at WLL:

Turnbuckle	Hook Turnbuckles Torque			Eye and Jaw Turnbuckles Torque		
Size	WLL	To Turn	Locknut	WLL	To Turn	Locknut
1/4	400	2.7	1.7	500	3.3	2.1
5/16	700	5.8	3.6	800	6.7	4.2
3/8	1000	10.0	6.3	1200	12.0	7.5
1/2	1500	20.0	12.5	2200	29.3	18.3
5/8	2250	37.5	23.4	3500	58.3	36.5
3/4	3000	60.0	37.5	5200	104.0	65.0
7/8	4000	93.3	57.3	7200	168.0	105.0
1	5000	133.3	83.3	10000	266.7	166.7
1 1/4	5000	167.7	104.2	15200	506.7	316.7
1 1/2	7500	300.0	187.5	21400	856.0	535.0
1 3/4				28000	1306.6	816.7
2				37000	1973.3	1233.3
2 1/2				60000	4000.0	2500.0
2 3/4				75000	5500.0	3437.5

CHAPTER 5

WIRE ROPE AND RIGGING

A. ROPE CONSTRUCTION AND CLASSIFICATION

1. Strands

A strand consists of a "center" which supports a specified number of wires around it in one or more layers.

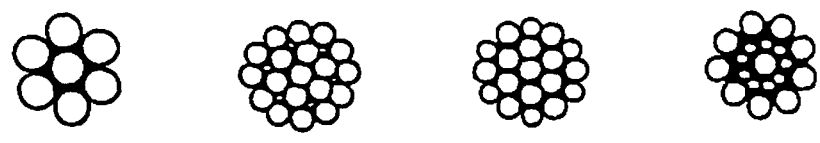
The strands provide all the tensile strength of a fiber core rope, and about 92% of the strength of a IWRC six strand rope.

Such physical characteristics as fatigue resistance and resistance to abrasion are directly affected by the design of strands.

In most strands with two or more layers of wires, inner layers support outer layers in such a manner that all wires slide and adjust freely when the strand flexes.

A strand made up of a small number of large wires will be more abrasion resistant and less fatigue resistant than a strand of the same size made up of many smaller wires.

Illustrated below are the basic strand constructions.



7-wire strand 25-wire FW 19-wire Warr. 19-wire Seale

FIGURE 5-1. BASIC STRAND CONSTRUCTION

2. Standard Rope Classification

Most common wire rope constructions are grouped into five standard classifications, based on the number of strands and wires per strand, as shown in Table 5-1. All ropes of the same size, grade and core in each classification have the same strength and weight ratings. Ropes within each classification differ in working characteristics and these features should be considered whenever a rope is being selected for a specific application.

Table 5-1. Standard Rope Classifications

Classification	Wires Per Strand
6x7	7
6x19	16 through 26
6x37	27 through 49
6x61	50 through 74
8x19	16 through 26

3. Wire Rope Abbreviations

(a) Strand Construction

PRF Preformed
NP Non-preformed
FW Filler Wire

(b) Lays

RRL Right Regular Lay
LRL Left Regular Lay
RLL Right Lang Lay
LLL Left Lang Lay

(c) Type of Core

FC Fiber Rope Core; natural or synthetic fiber
IWRC Independent Wire Rope Core
PPC Polypropylene Rope Core
SC Strand Core

(d) Grade and Finish of Wire

MPS Mild Plow Steel
PS Plow Steel Grade of Wire
IPS Improved Plow Steel
XIP Extra Improved Plow Steel
GISZG Galvanized Iron Grade of Wire for Seizing Strand
BRIGHT Wire without any Coating, such as zinc or tin.

4. Grades of Wire

Grades of wire, lay and preforming all affect wire rope performance and its operation.

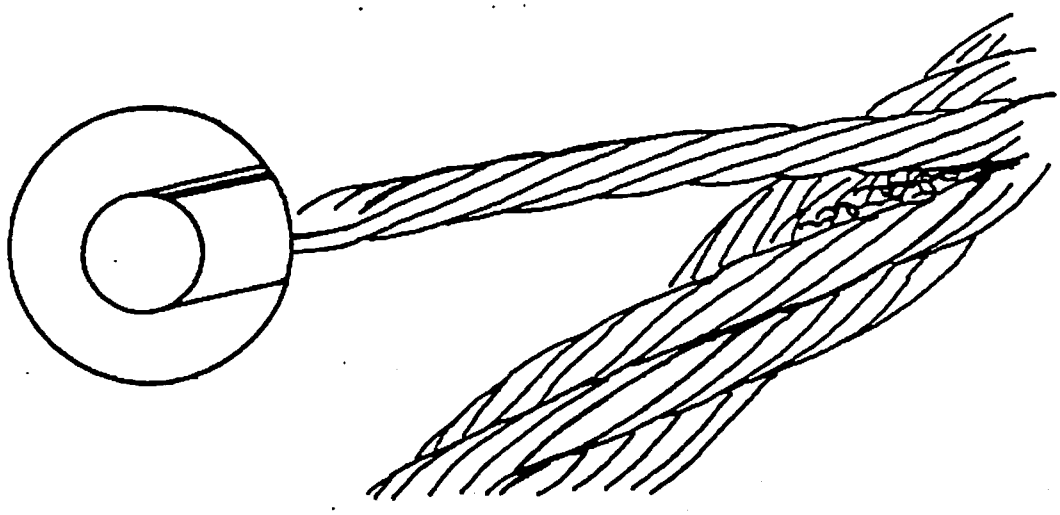


FIGURE 5-2. RIGHT REGULAR LAY

Nearly all rope wire is round, and is "cold drawn" to achieve the design diameter and physical properties desired. Shaped wires are found in special constructions such as locked coil strands where higher concentration of metal within the specified diameter is desired.

The word "plow", applied to steel, dates to early days of wire rope in England, and origin is unclear. Some believe that because steel in a farm plow (then spelled "plough") had to be very high quality, the term "plow steel" was much like "sterling silver" - the best available. Others feel the term dates to a plowing system developed by a John Fowler about 1865, in which wire ropes were essential. A pair of steam engines with winding drums were set at opposite ends of a field, rigged to haul a plow back-and-forth across the field with a wire rope. In either case, plow meant high quality, and when an improved grade was developed in the 1880's, it became known as "improved plow", or IPS.

The basic types of wire used in ropes.

(a) Extra Improved Plow Steel (XIP) - is a special grade of steel that provides approximately 15% greater tensile strength that IPS grade wire.

(b) Improved Plow Steel (IPS) - is a grade of steel developed especially to perform well under a wide variety of operating conditions, and has good bending and abrasion qualities.

(c) Plow Steel - has about a 15% lower tensile strength than IPS, but a somewhat greater resistance to bending fatigue.

5. Lay

The word "lay" has three meanings when applied to wire ropes. The first two are descriptive terms, and are useful in explaining working characteristics as well as in specifying and ordering ropes for specific applications. The third meaning is a measurement established for fabrication of a specific rope, and has significance also to wire rope inspectors.

(a) The direction strands lay in the rope - right or left. When you look along a rope, strands of a Right Lay rope follow a clockwise rotation. Left Lay is counter-clockwise. It makes no difference which direction you look.

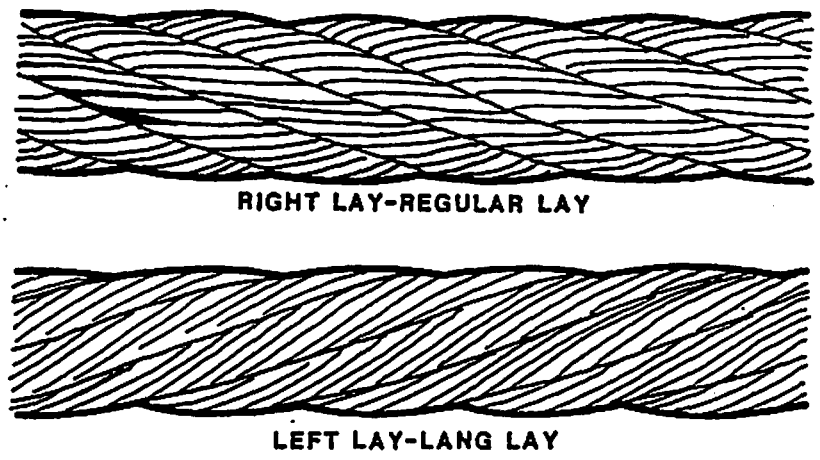


FIGURE 5-3. RIGHT REGULAR LAY/LEFT LANG LAY

(b) The relationship between the direction strands lay in the rope and the direction the wires lay in the strands. In Regular Lay, wires are laid opposite the direction the strands lay in the rope. In Lang Lay, the wires are laid the same direction as the strands lay in the rope. In appearance wires in Regular Lay are parallel to the length of the rope, in the Lang Lay they cross the rope axis at an angle.

Differences in handling characteristics, abrasion and crushing resistance, etc., which distinguish Regular Lay from Lang Lay ropes result from the manner in which the individual wires are laid in the rope. In Regular Lay, less surface of individual wires is exposed to external abrasion, while Lang Lay spreads wear over a greater length of wire exposed on the

exterior of the rope. Regular Lay is more stable and more resistant to crushing than Lang Lay. While Lang Lay is more fatigue resistant and abrasion resistant, its use should be only in accordance with specific recommendations. It should never be used with either end free to rotate...both ends must be securely fastened.

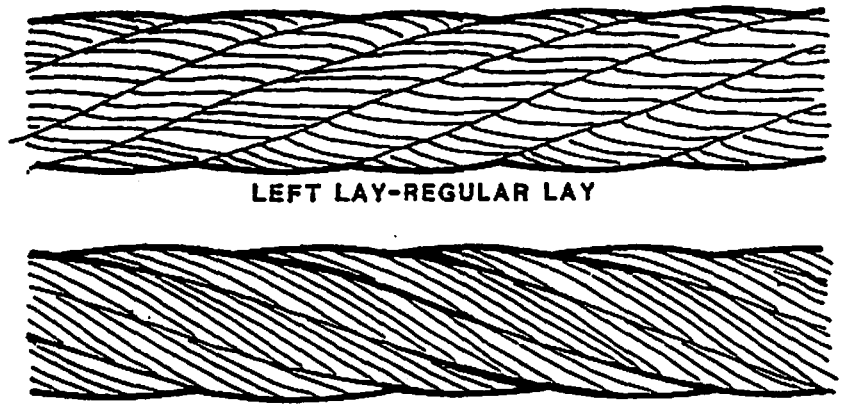


FIGURE 5-4. LEFT REGULAR LAY/RIGHT LANG LAY

(c) The length along the rope which one strand uses to make one complete spiral around the rope core. During closing of a rope, this length is carefully monitored to assure it conforms to engineering specifications established when the rope is designed.

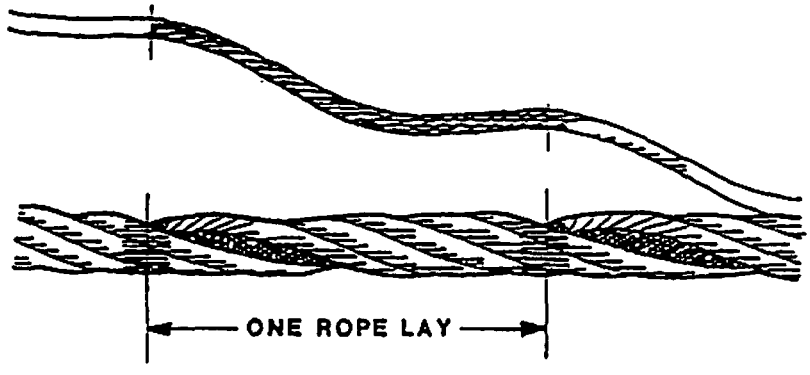


FIGURE 5-5. ROPE LAY

6. Preformed

Preformed, "Pre-shapes" strands before the rope is constructed. As the name implies, preforming is a process by which both individual wires and complete strands are helically formed - prior

to rope closing - into the exact shape they will assume in the finished rope.

Preforming improves fatigue resistance, ease of handling, and resistance to kinking in a rope by equalizing the load among the strands, and among the individual wires of strands.

When a preformed rope is cut, the ends do not unlay; if strands are pulled out and separated, they retain their helical shape. When a non-preformed rope is cut it will open up, or "broom," unless the end has been secured with wire (seized) before cutting.

The superior qualities of preformed ropes result from wires and strands being "at rest" in the rope, which minimizes internal stresses within the rope. Because wires and strands are free to move and slide in relation to each other when the rope bends, the rope can adjust more easily while operating on sheaves or drums.

Because of the many advantages of preforming, the practice is virtually standard in rope manufacture, and non-preformed rope is made only on special order.

FIGURE 5-6. ROPE STRAND

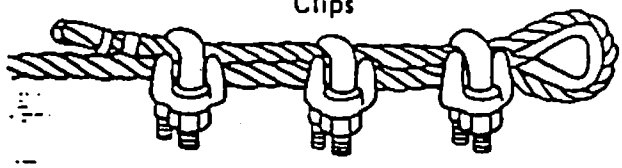
B. ROPE SELECTION

Each characteristic affects other characteristics. The following are characteristics usually considered in selecting wire rope for a specified application.

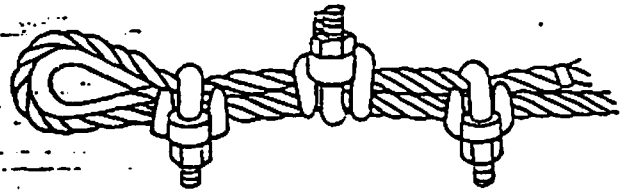
Every wire rope has its own"personality" which is a reflection of its engineering design. Each rope construction has been established to produce a desired combination of operating characteristics which will best meet the performance requirements of the work for which that design is intended...and each rope construction is, therefore, a design compromise.

The best illustration of a design compromise - or best combination of desired characteristics - is the inter-relationship between Resistance to Abrasion and Fatigue Resistance. See Fig. 5-7 on following page.

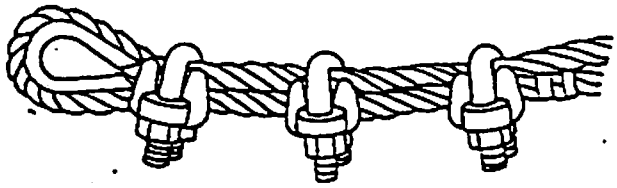
Right/Wrong Ways of Using Cable Clips



Correct
U-Bolt of all clips on dead end of rope

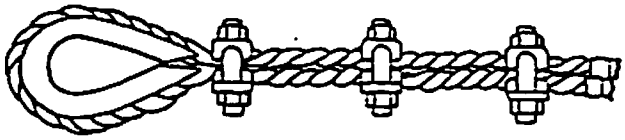


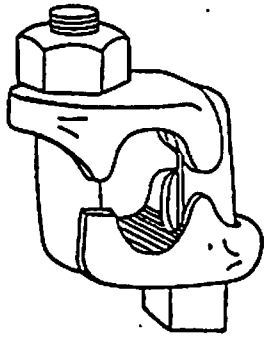
Incorrect
Do not stagger clips



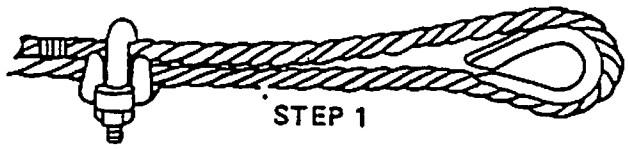
Incorrect
U-Bolt of all clips on live end of rope

Double Saddle Clips (Fist Grip Clips)



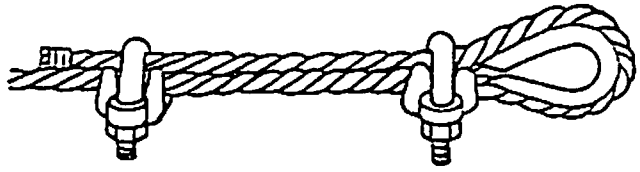


Proper Method of Installing Cable Clips



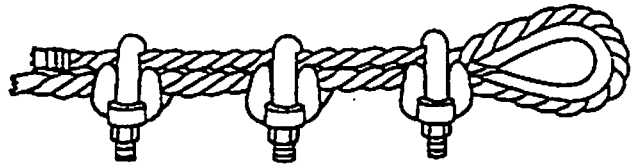
APPLY FIRST CLIP – one base width from dead end of wire rope – U-Bolt over dead end – live end rests in clip saddle. Tighten nuts evenly to recommended torque.

STEP 2



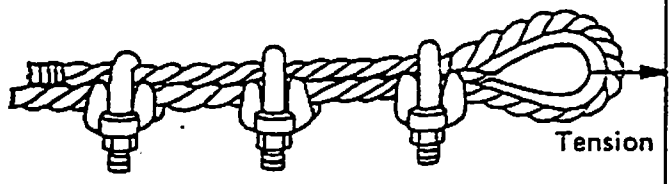
APPLY SECOND CLIP – nearest loop as possible – U-Bolt over dead end – turn on nuts firm but DO NOT TIGHTEN.

STEP 3



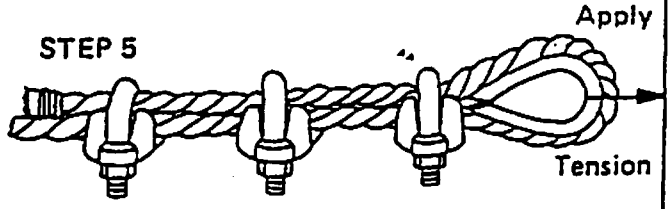
ALL OTHER CLIPS – Space equally between first two.

STEP 4



Apply tension and tighten all nuts to recommended torque.

STEP 5



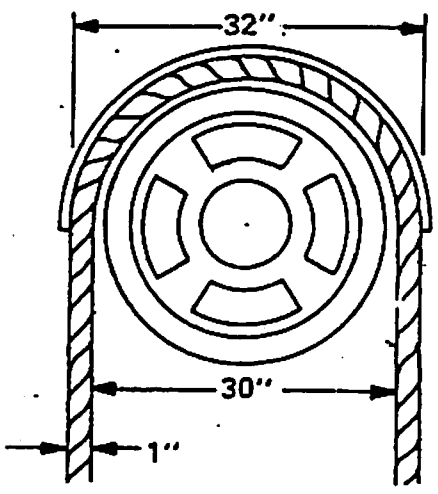
Recheck nut torque after rope has been in operation.

FIGURE 5-13. METHODS OF INSTALLING CABLE CLIPS, USING CABLE CLIPS, AND DOUBLE SADDLE CLIPS

INSTALLATION OF WIRE ROPE CLIPS			
Rope Diameter (Inches)	Minimum No. of Clips	Amount of Rope Turn Back From Thimble (Inches)	Torque in Foot Pounds Unlubricated Bolts
1/8	2	3 1/4	-------
1/16	2	3 3/4	-------
1/4	2	4 3/4	15
5/16	2	5 1/2	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
7/8	4	19	225
1	5	26	225
1 1/8	6	34	225
1 1/4	6	37	360
1 3/8	7	44	360
1 1/2	7	48	360
1 5/8	7	51	430
1 3/4	7	53	590
2	8	71	750
2 1/4	8	73	750
2 1/2	9	84	750
2 3/4	10	100	750
3	10	106	1200

INSTALLATION OF DOUBLE SADDLE CLIPS			
Rope Diameter (Inches)	Minimum No. of Clips	Amount of Rope Turn Back From (Inches)	Torque in Foot Pounds Unlubricated Bolts
3/16	2	4	30
1/4	2	4	30
5/16	2	5	30
3/8	2	5 1/2	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
7/8	4	26	225
1	5	37	225
1 1/8	5	41	360
1 1/4	6	55	360
1 3/8	6	62	500
1 1/2	6	66	500

FIGURE 5-14. TABLES FOR INSTALLATION OF "WIRE ROPE CLIPS" AND "DOUBLE SADDLE CLIPS"



Circumference = π x Diameter
C = 3.1416 x 32 = 100.5312
C = 3.1416 x 30 = 94.2490
6.2822 ÷ 2 = 3.14

Fig. 5-9

FIGURE 5-15. 1-INCH ROPE OVER A 30-INCH SHEAVE

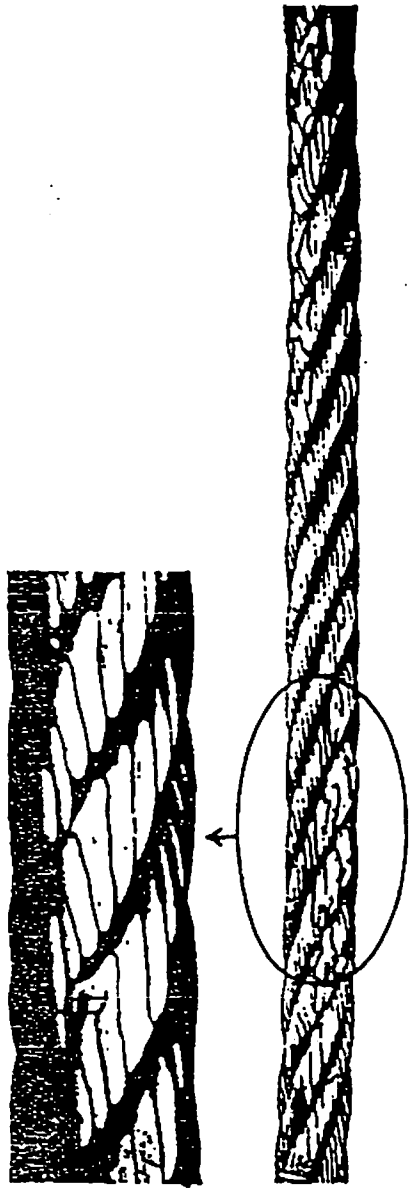
The mathematics are simple: Just subtract half the circumference of a 30-inch circle from half the circumference of a 32-inch circle.

Snagged wires resulting from drum crushing.

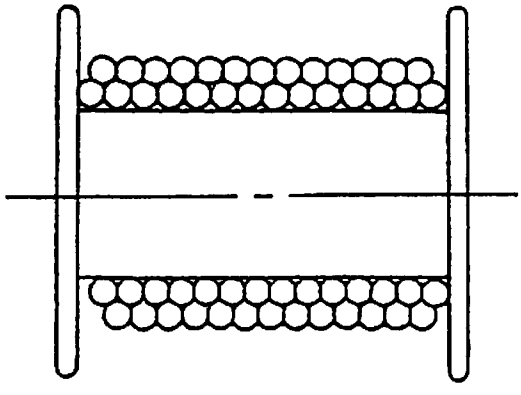
A rope that has been jammed after jumping off a sheave.

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

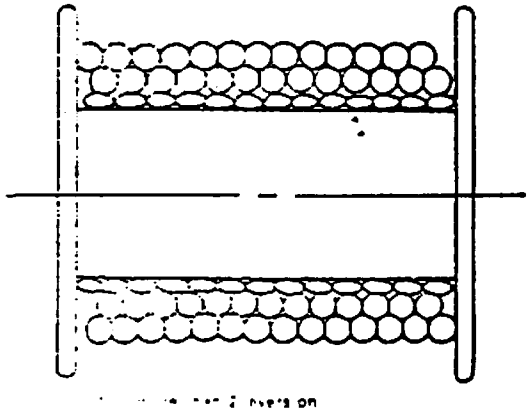
Localized Crushing of Rope



Drum Crushing



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



[illegible] layers on [illegible] danger of crushing — [illegible] larger wired rope [illegible]

FIGURE 5-35. CRUSHED, JAMMED AND FLATTENED STRANDS

to prevent crushing. This can also occur if the hoist rope becomes slack and cross-coiled on the drum or trapped in the machinery. No further operations should be carried out until the rope has been payed out, examined for possible damage by a competent person and correctly re-spooled.

10. High Stranding and Unlaying (Figure 5-36)

Replace the rope or renew the end connection to reset the rope lay. In cases such as this, excessive wear and crushing take place and the other strands become overloaded.

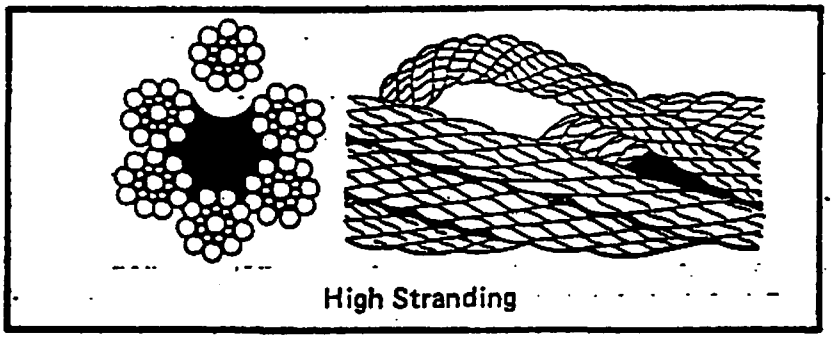


Figure 5-36. High Stranding

11. Bird Caging (Figure 5-37)

Replace the rope or the affected section of the rope.

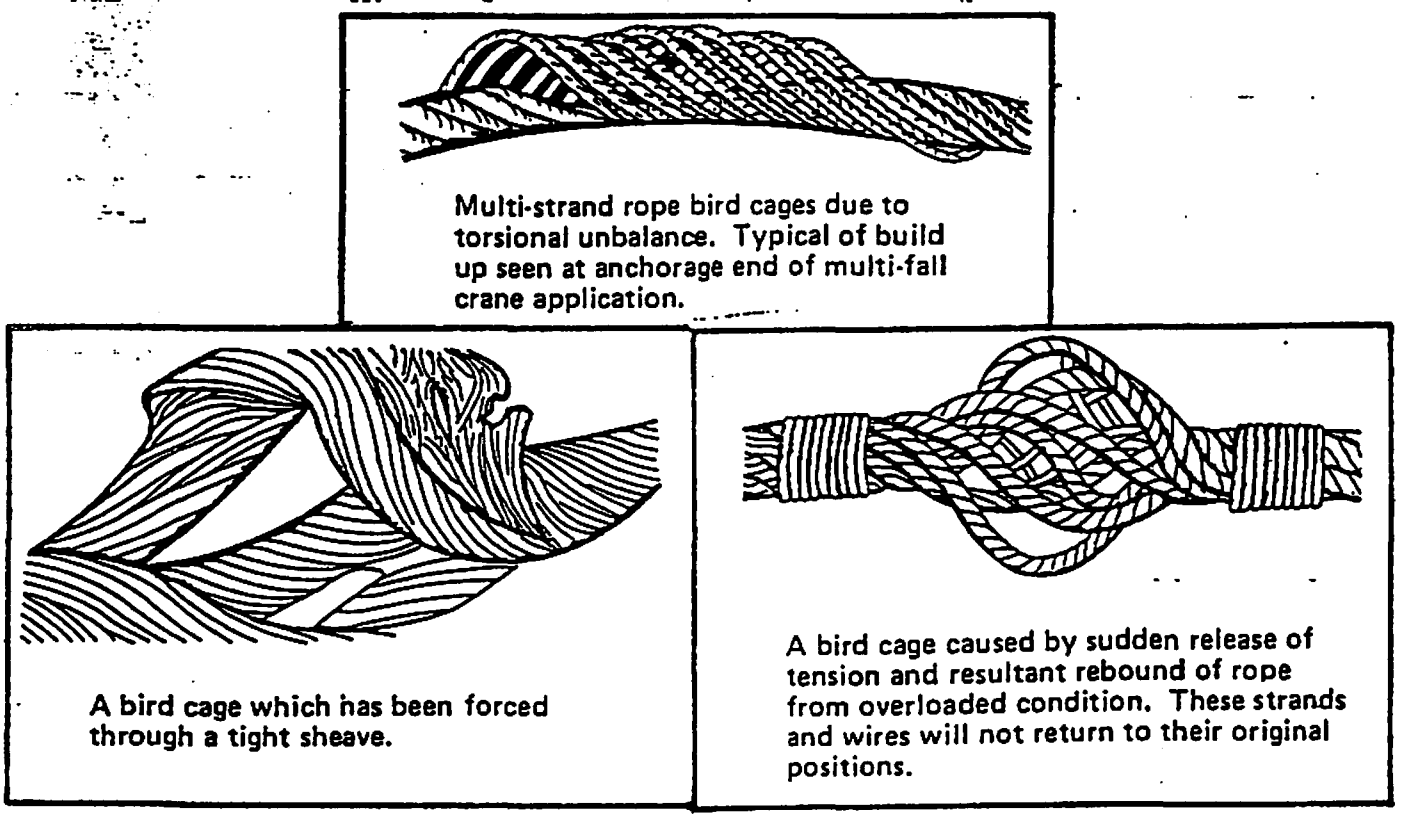


Figure 5-37. Bird Cages

12. Kinks (Figure 5-38)

Replace the rope or the affected section of the rope. They are usually caused by faulty handling or reeving. The strands become dog-legged and where running on sheaves are subject to excessive wear at the kink.

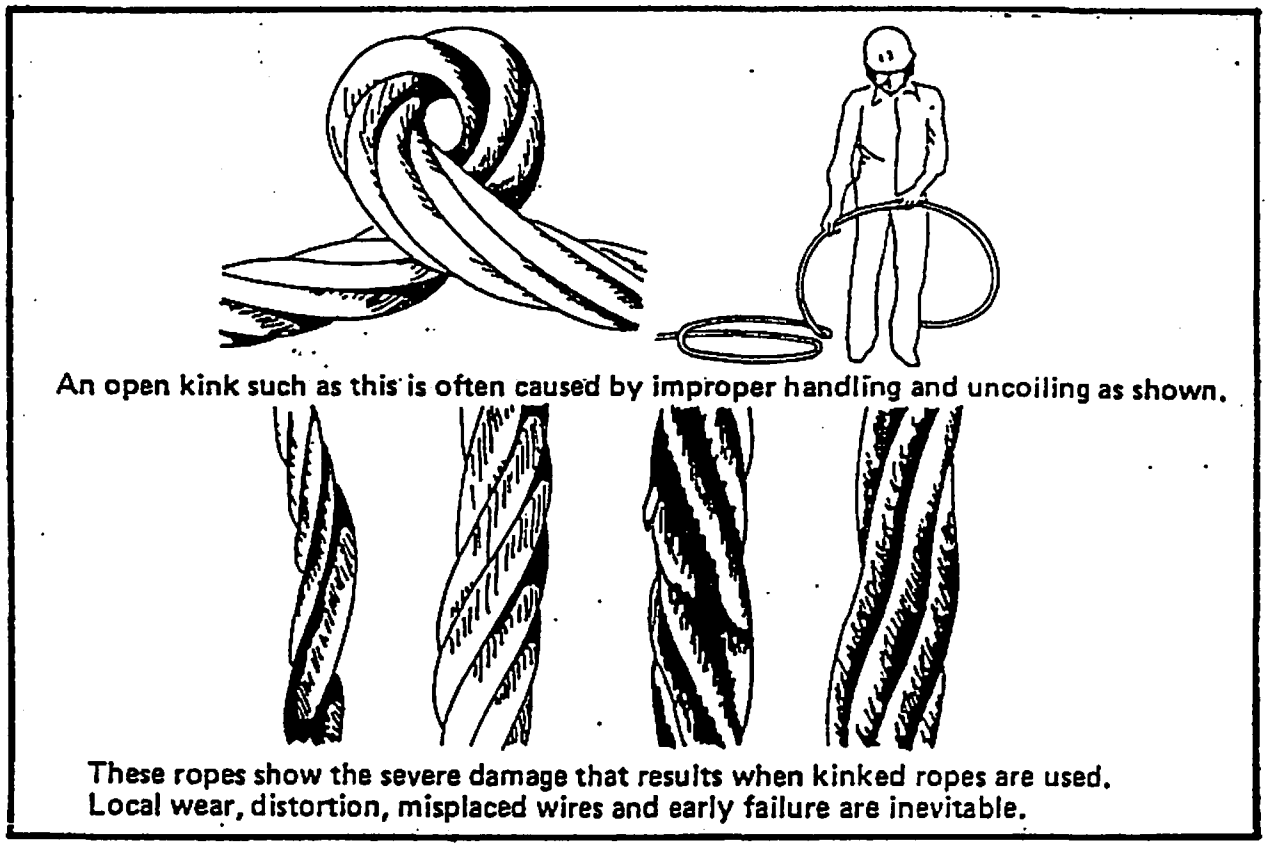


FIGURE 5-38. ROPE KINKS

13. Bulges in Rope

Replace the rope, particularly if it is of a non-rotating construction. This is indicative of core slippage or "turns" being put into or taken out of the rope.

14. Gaps or Excessive Clearance Between Strands

Replace the rope.

15. Core Protrusion (Figure 5-39)

Replace the rope.

16. Unbalanced Severely Worn Areas (Figure 5-40)

Remove the affected section.

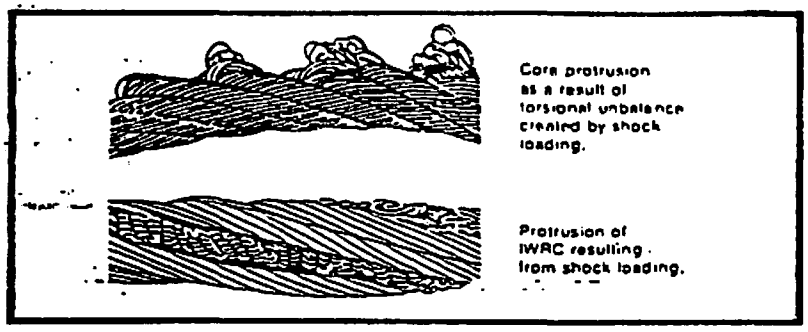


FIGURE 5-39. CORE PROTRUSION

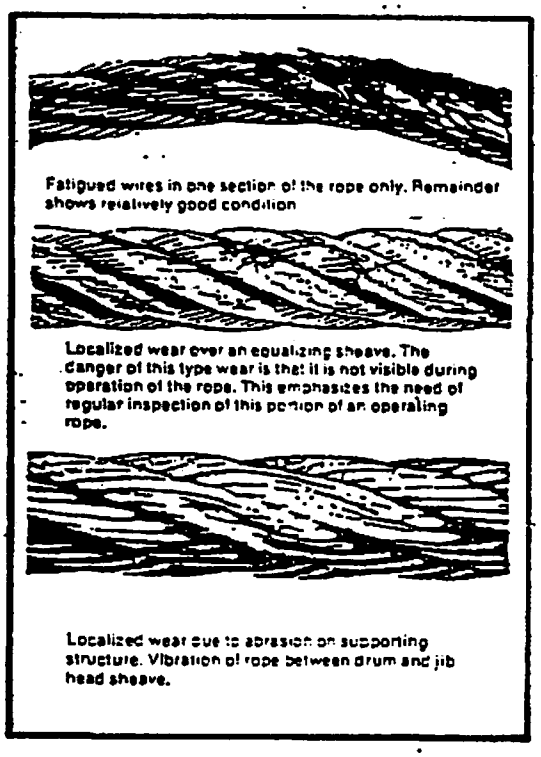


FIGURE 5-40. UNBALANCED SEVERELY WORN AREAS

17. <u>Heat Damage, Torch Burns, Electric Arc Strikes</u>

Remove either the affected area or the rope.

When inspecting a rope remember that the rope speed has a bearing on the life of a rope. The life expectancy of a high speed rope, due to increased impact effects at sheaves and drums, friction and abrasion, is less than a slow speed rope. Due consideration must be given to this aspect and inspections made accordingly.

If the rope being inspected comprises multi-layers of strands, open it up and examine the inner strands. See Figure 5-41.

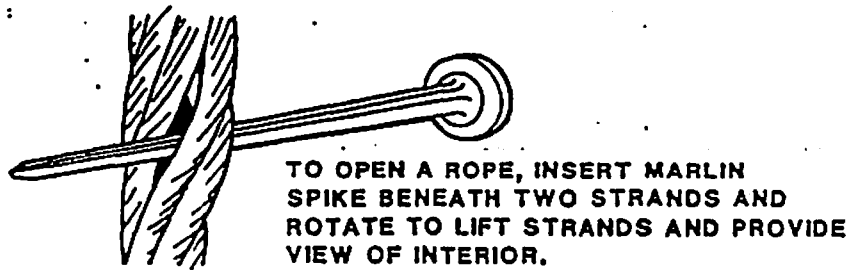


Figure 5-41. Proper Method of Opening up a Rope

Particular attention should be paid to those areas close to the terminal fittings. Where multi-layer drums are used, examine not only that part of the rope which is in constant use, but also the rope which may remain spooled and inoperative on the drum. Examine all ropes, including standing ropes. for possible defects caused by corrosion, abrasive dust, and erection and dismantling procedures.

Permanent damage and deformation such as kinks, crushed, flattened, and distorted strands and unbalanced wear locations are the conditions which make a rope extremely susceptible to failure.

When replacing a rope, make certain that the replacement rope is of the correct size and construction. One of the most useful aids in selecting the proper wire rope is to examine the worn ropes that are to be replaced. Knowing what caused the deterioration of the old rope may indicate a direction of change. Figure 5-42 and Table 5-4 may aid in this determination.

The manner in which the individual wires of a rope break can also give an indication of the probable cause of failure. See Figure 5-43.

Like a chain, the weakest part of a rope determines the strength of the rope. This weak point may be where the rope is badly worn, where it has a number of broken wires, where the stresses are unequal in the strands, where the local stresses due to bending the rope over a sheave are excessive, or where the rope is attached to the equipment upon which it is used. It is only by inspection that potential hazards can be detected - and accidents avoided.

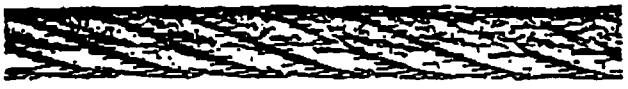
Narrow path of wear resulting in fatigue fractures, caused by working in a grossly oversize groove, or over small support rollers.

Break up of IWRC resulting from high stress application. Note nicking of wires in outer strands.

Two parallel paths of broken wires indicative of bending through an undersize groove in the sheave.

Wire fractures at the strand, or core interface, as distinct from crown fractures, caused by failure of core support.

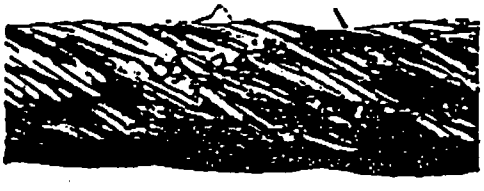
An example of fatigue failure of a wire rope which has been subjected to heavy loads over small sheaves. The usual crown breaks are accompanied by breaks in the valleys of the strands, these breaks being caused by strand nicking resulting from the heavy loads.



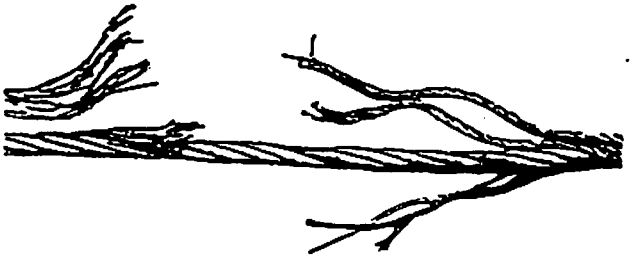
Wire rope that shows severe wear & fatigue from operating over small sheaves with heavy load and severe abrasion

A rope failing from fatigue after bending over small sheaves.

A wire rope which has jumped a sheave. The rope itself is deformed into a "cuff" as if bent around a round shaft. Close examination of the wires show two types of breaks — normal tensile "cup and cone" breaks and shear breaks which give the appearance of having been cut at an angle with a cold chisel.

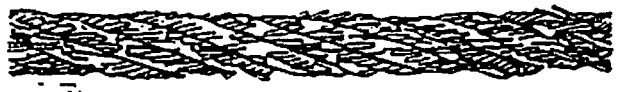


Mechanical damage due to rope movement over sharp edge projection while under load.



Rope break due to excessive strain

FIGURE 5-42. TYPICAL ROPE DAMAGE



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.

FIGURE 5-42. TYPICAL ROPE DAMAGE (CONTINUED)

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

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

TABLE 5-4. FAULT/POSSIBLE CAUSE OF ROPE DAMAGE

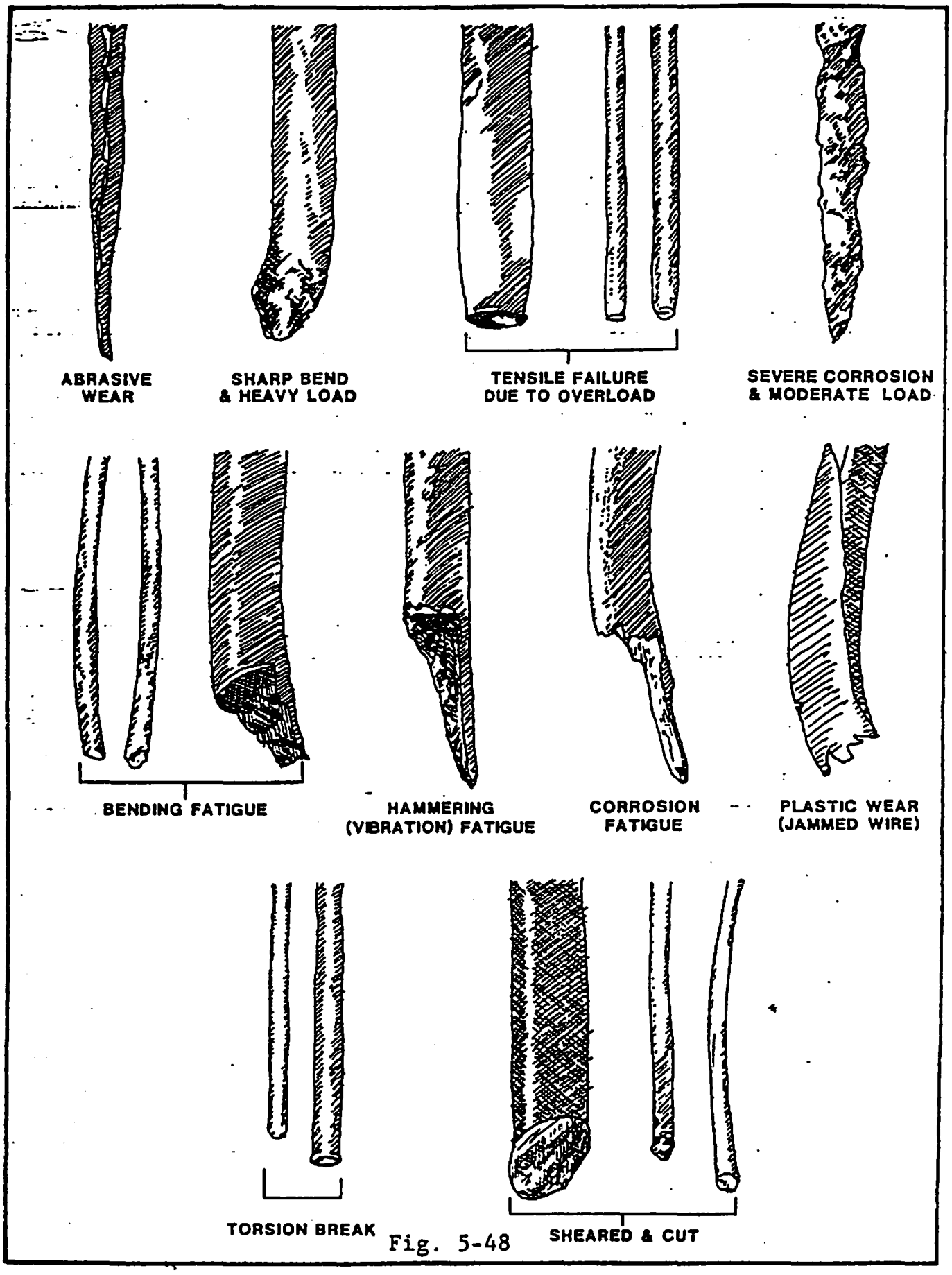
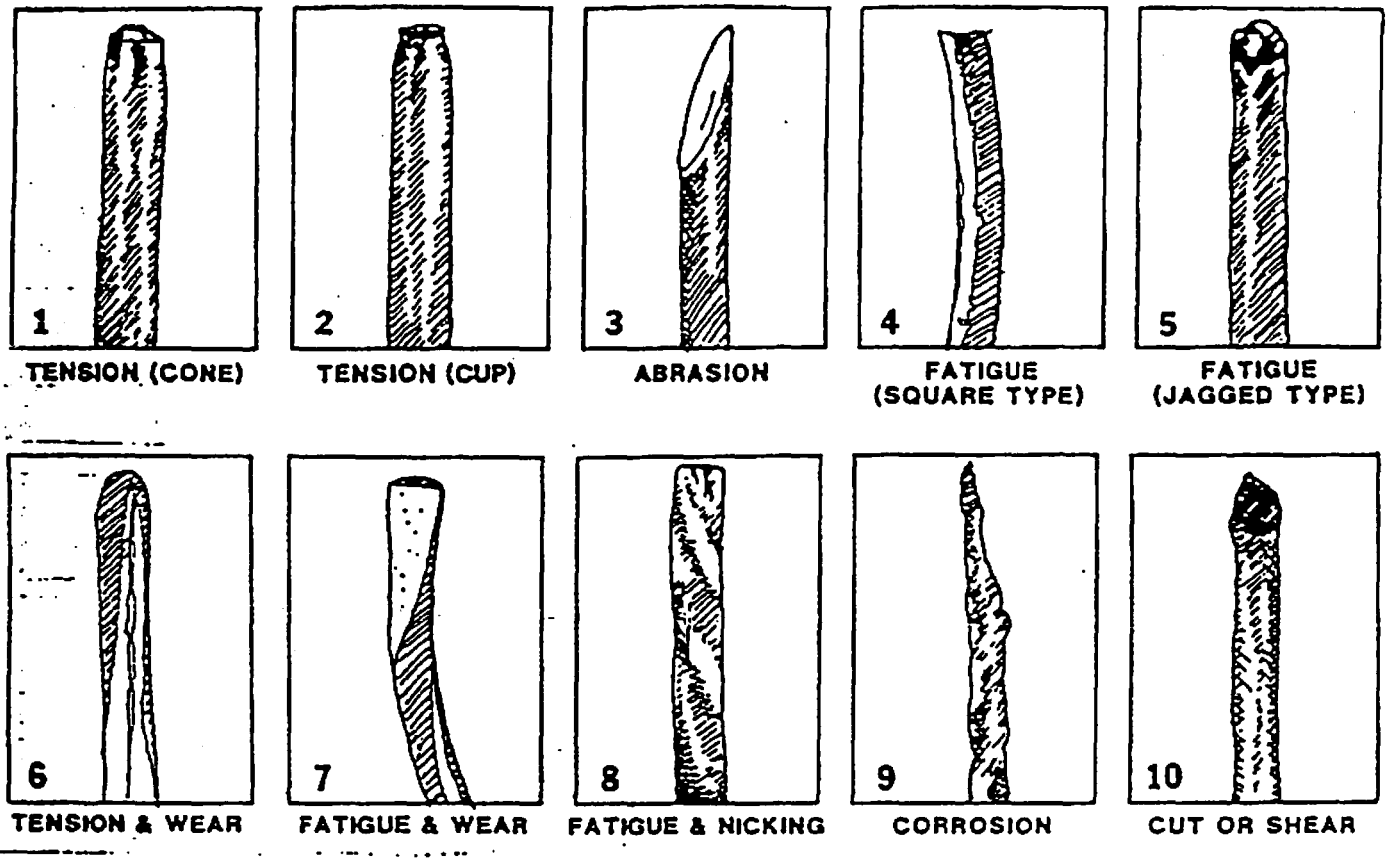


FIGURE 5-43. TYPICAL WIRE FAILURES



Typical Characteristics and Causes of Broken Wires in Wire Rope

Type of Break	*Characteristics*	*Cause*
TENSION	Wire break shows one end of broken wire coned, the other cupped. Necking down of the broken ends is typical of this type of break. (See illustrations 1 and 2.)	Where tension breaks are found, rope has been subjected to too great a strain, either for its original strength or for the strength remaining in it after other factors of deterioration have weakened it. (See No. 6 where wire is weakened by abrasion, but still shows characteristics of tension break.) Frequently tension breaks are caused by suddenly applying a load to a slack rope, thereby setting up incalculable impact stresses.
ABRASION	Wire break will show broken ends worn to a knife-edge thinness. (See No. 3.)	Abrasive wear obviously will be concentrated at points at which the rope is rubbed most constantly. These points usually are the grooves of sheaves and drums and other objects with which the rope comes into contact. Unwarranted abrasive wear indicates improperly grooved sheaves and drums, or other localized abrasive condition.
FATIGUE	Wire breaks are usually transverse or square showing granular structure (see No. 4). Often these breaks will develop a shattered fracture (No. 5). Both of the above characteristics depend upon conditions of operation.	Where fatigue breaks occur, rope has repeatedly been bent around too small a radius. Whipping, vibration, pounding, and torsional stresses will cause fatigue. This action is accelerated by abrasion (illustration 7) and nicking (illustration 8).
CORROSION	Can easily be noted by pitted surface of wire, with break usually showing evidence of one of the three foregoing factors. (See illustration 9.)	Indicates improper lubrication. Extent of damage by corrosion to interior of rope is extremely difficult to determine; consequently, corrosion is one of the most insidious and dangerous causes of rope deterioration. If fiber core of wire rope is not lubricated and is allowed to dry out, it will collapse and fail to afford proper support for strands, thereby causing marked reduction in rope diameter and extreme internal wear.
CUT or SHEAR	Wire will be pinched down and cut at broken ends, or will show evidence of a shear-like cut. (No. 10).	This condition is evidence of mechanical abuse caused by agents outside the installation, or by something abnormal or accidental on the installation itself.

FIGURE 5-44. WIRE INSPECTION GUIDE

TABLE 5-5

WEIGHTS OF MATERIALS (Based On Volume)			
Material	Approximate Weight Lbs. Per Cubic Foot	Material	Approximate Weight Lbs. Per Cubic Foot
METALS		**TIMBER, AIR-DRY**	
Aluminum	165	Cedar	22
Brass	535	Fir, Douglas, seasoned	34
Bronze	500	Fir, Douglas, unseasoned	40
Copper	560	Fir, Douglas, wet	50
Iron	480	Fir, Douglas, glue laminated	34
Lead	710	Hemlock	30
Steel	490	Pine	30
Tin	460	Poplar	30
MASONRY		Spruce	28
Ashlar masonry	140-160	**LIQUIDS**	
Brick masonry, soft	110	Alcohol, pure	49
Brick masonry, common (about 3 tons per thousand)	125	Gasoline	42
Brick masonry, pressed	140	Oils	58
Clay tile masonry, average	60	Water	62
Rubble masonry	130-155	**EARTH**	
Concrete, cinder, haydite	100-110	Earth, wet	100
Concrete, slag	130	Earth, dry (about 2050 lbs. per cu. yd.)	75
Concrete, stone	144	Sand and gravel, wet	120
Concrete, stone, reinforced (4050 lbs. per cu. yd.)	150	Sand and gravel, dry	105
ICE AND SNOW		River sand (about 3240 lbs. per cu. yd.)	120
Ice	56	**VARIOUS BUILDING MATERIALS**	
Snow, dry, fresh fallen	8	Cement, portland, loose	94
Snow, dry, packed	12-25	Cement, portland, set	183
Snow, wet	27-40	Lime, gypsum, loose	53-64
MISCELLANEOUS		Mortar, cement-lime, set	103
Asphalt	80	Crushed rock (about 2565 lbs. per cu. yd.)	90-110
Tar	75		
Glass	160		
Paper	60		

TABLE 5-6

WEIGHTS OF MATERIALS (Based on Surface Area)			
Material	Approximate Weight Lbs. Per Square Foot	Material	Approximate Weight Lbs. Per Square Foot
CEILINGS		**FLOORING**	
(Per Inch of Thickness)		(Per Inch of Thickness)	
Plaster board	5	Hardwood	5
Acoustic and fire resistive tile	2	Sheathing	2.5
Plaster, gypsum-sand	8	Plywood, fir	3
Plaster, light aggregate	4	Wood block, treated	4
Plaster, cement sand	12	Concrete, finish or fill	12
ROOFING		Mastic base	12
Three-ply felt and gravel	5.5	Mortar base	10
Five-ply felt and gravel	6.5	Terrazzo	12.5
Three-ply felt, no gravel	3	Tile, vinyl 1/8 inch	1.5
Five-ply felt, no gravel	4	Tile, linoleum 3/16 inch	1
Shingles, wood	2	Tile, cork, per 1/16 inch	0.5
Shingles, asbestos	3	Tile, rubber or asphalt 3/16 inch	2
Shingles, asphalt	2.5	Tile, ceramic or quarry 3/4 inch	11
Shingles, 1/4 inch slate	10	Carpeting	2
Shingles, tile	14	**DECKS AND SLABS**	
PARTITIONS		Steel roof deck 1 1/2" — 14 ga.	5
Steel partitions	4	— 16 ga.	4
Solid 2" gypsum-sand plaster	20	— 18 ga.	3
Solid 2" gypsum-light agg. plaster	12	— 20 ga.	2.5
Metal studs, metal lath, 3/4" plaster both sides	18	— 22 ga.	2
Metal or wood studs, plaster board and 1/2" plaster both sides	18	Steel cellular deck 1 1/2" — 12/12 ga.	11
Plaster 1/2"	4	— 14/14 ga.	8
Hollow clay tile 2 inch	13	— 16/16 ga.	6.5
3 inch	16	— 18/18 ga.	5
4 inch	18	— 20/20 ga.	3.5
5 inch	20	Steel cellular deck 3" — 12/12 ga.	12.5
6 inch	25	— 14/14 ga.	9.5
Hollow slag concrete block 4 inch	24	— 16/16 ga.	7.5
6 inch	35	— 18/18 ga.	6
Hollow gypsum block 3 inch	10	— 20/20 ga.	4.5
4 inch	13	Concrete, reinforced, per inch	12.5
5 inch	15.5	Concrete, gypsum, per inch	5
6 inch	16.5	Concrete, lightweight, per inch	5-10
Solid gypsum block 2 inch	9.5	**MISCELLANEOUS**	
3 inch	13	Windows, glass, frame	8
MASONRY WALLS		Skylight, glass, frame	12
(Per 4 Inch of Thickness)		Corrugated asbestos 1/4 inch	3.5
Brick	40	Glass, plate 1/4 inch	3.5
Glass brick	20	Glass, common	1.5
Hollow concrete block	30	Plastic sheet 1/4 inch	1.5
Hollow slag concrete block	24	Corrugated steel sheet, galv.	
Hollow cinder concrete block	20	— 12 ga.	5.5
Hollow haydite block	22	— 14 ga.	4
Stone, average	55	— 16 ga.	3
Bearing hollow clay tile	23	— 18 ga.	2.5
		— 20 ga.	2
		— 22 ga.	1.5
		Wood Joists — 16" ctrs. 2 x 12	3.5
		2 x 10	3
		2 x 8	2.5
		Steel plate (per inch of thickness)	40

J. CENTER OF GRAVITY

It is always important in rigging practice to rig the load so that it is stable. A stable load is one in which the center of gravity of the load is directly below the main hook and below the lowest point of attachment of the slings.

The center of gravity of an object is that point at which the object will balance. The entire weight may be considered as concentrated at this point. A suspended object will always move so that the center of gravity is below the point of support. In order to make a level or stable lift, the crane or hook block must be directly above this point. Thus a load which is slung above and through the center of gravity will be stable and will not tend to topple or slide out of the slings. (See Figure 5-45.)

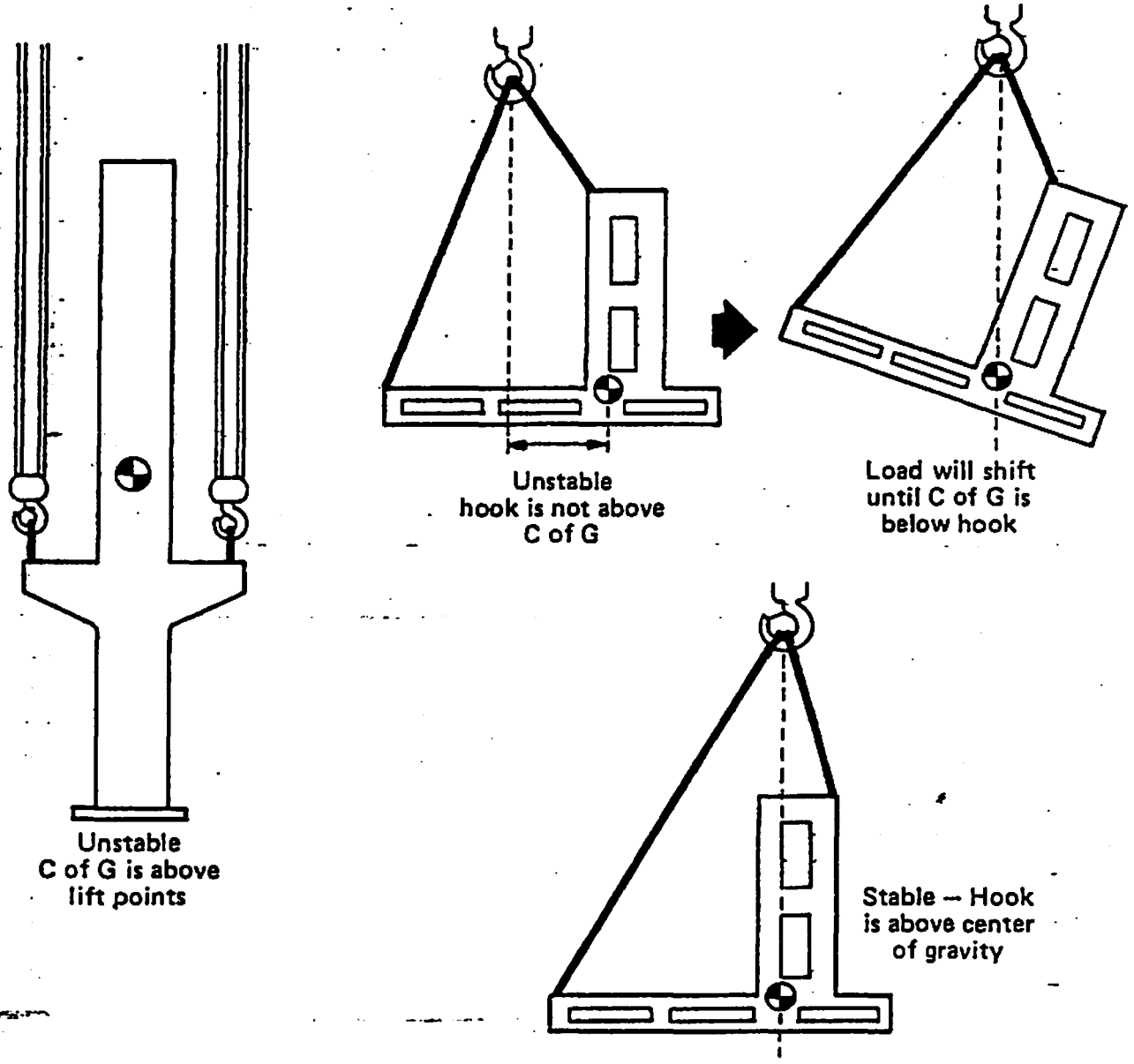


Figure 5-45. Effect of Location of Loads Center of Gravity on the Lift

On objects having uniform shapes and compositions there is no problem in determining where the center of gravity lies since it is at the center of the shape or object, but on odd shaped bodies where it cannot be easily determined, the rigger must guess where it lies, try to lift with the hook over that point and then correct it by trial and error methods, moving the hook, load and sling suspension a little at a time until a satisfactory result is obtained. The object will usually tilt until the center of gravity is directly beneath the load hook, so there is an indication of the direction in which to shift the slings. Remember too that when the center of gravity is closer to one point of sling attachment than to the other, the slings legs will have to be of unequal length which means that their angles and loads will also be unequal. (See Figure 5-46.)

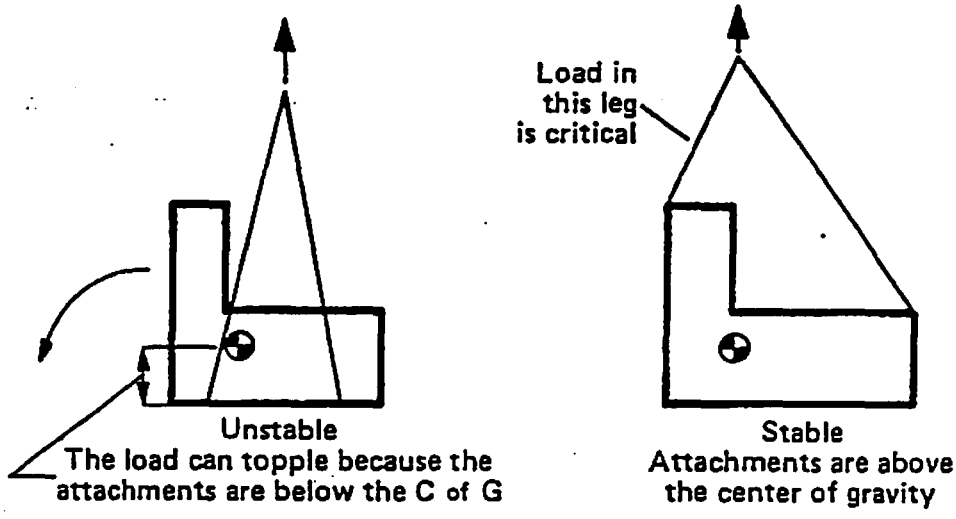


Figure 5-46. Location of the Loads Center of Gravity on the Lift, Attachments

If a load tilts when it is lifted and it is not corrected then one leg of the sling will see a large load increase and the load on the other will decrease. If any load tilts more than five degrees after it is lifted clear of the ground it should be landed and re-rigged.

It is equally important to ensure that the points of support of a load (i.e., where the slings are attached to the load) lie above the center of gravity and not below it for the center of gravity will always tend to move to the lowest point possible below the point of support. This precaution is especially applicable whenever lifting from pallets, skids or the base of any object since they all have a tendency to topple. The greatest stability will be achieved when the sling angles are very much larger than the angle formed between the plane of support and the line through the center of gravity. (See Figure 5-47.)

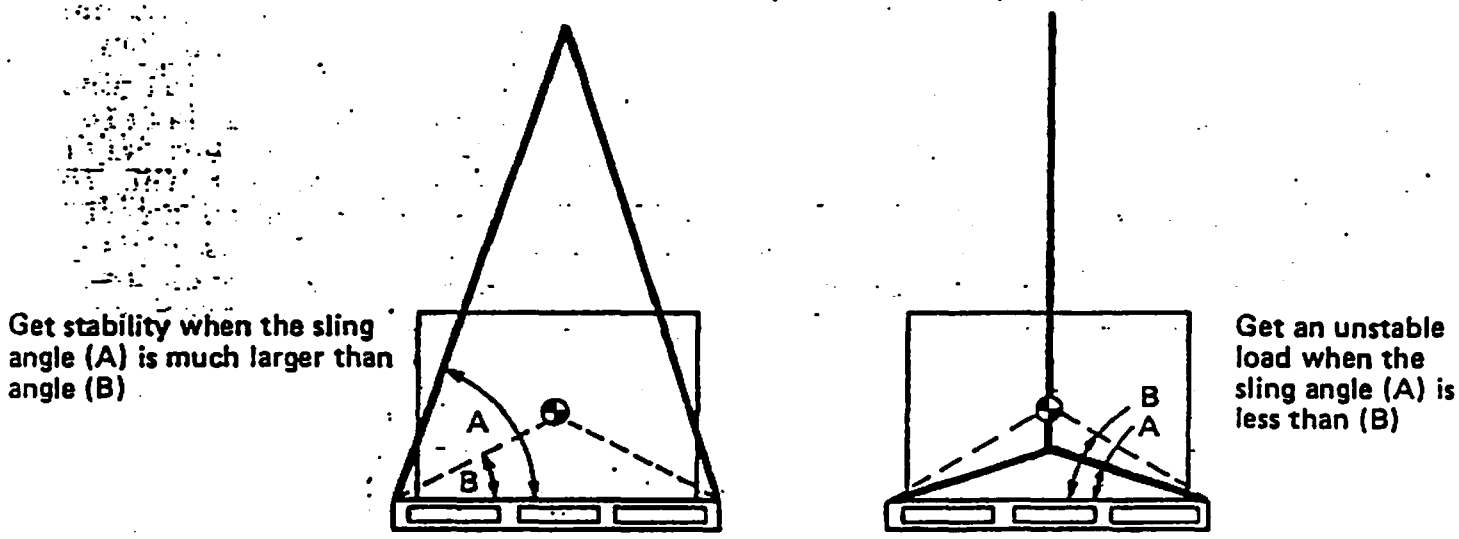


Figure 5-47. Relationship between Load Stability and (A) Location of Loads Center of Gravity and (B) Sling Angle

Shock Loads Shorten Wire Rope Life

If operating conditions for rope were always ideal...if nothing went wrong to throw unexpected stresses on wire rope...if there weren't any "ifs", there would not be many unexplained things happening to wire rope.

1. Avoid Shock Loads

Wire rope will continue to meet unexpected and unforeseen stresses, but shock loads that obviously overstress the rope should be avoided.

2. What are Shock Loads?

Wire ropes are made to a specified catalog breaking strength. All hoisting equipment is designed with a predetermined line pull or load at drum for loads the equipment is made to handle. Any sudden load can develop into a shock load.

For example, see Figure 5-48 on page 5-53. Here you see what happens when a given load is applied suddenly to a slack rope. The given load (in this case 6,375 lbs.) remains the same BUT the sudden impact to the rope the second that slack is taken up creates a shock load that may exceed the rope's elastic limit.

The result may not be an immediate break, but because the rope is overstressed, it may fail on another operating shift, with another operator, who does not know about the overstressed condition of the rope. When the slack to be taken up is 12", for instance, the stress on the rope at impact is 15,675 lbs. . . or more than twice the total load at rest.

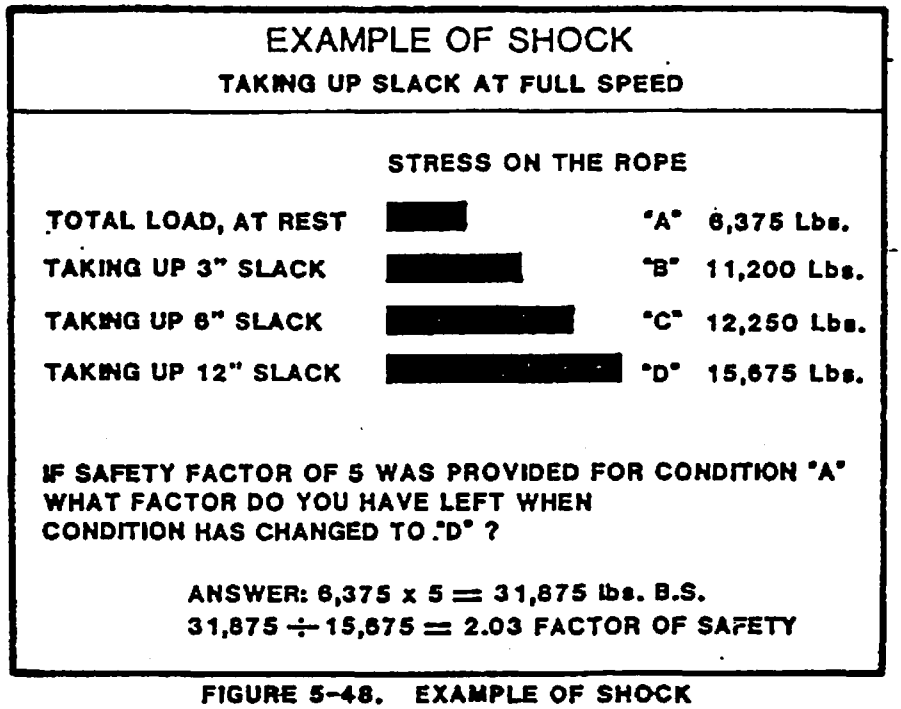


FIGURE 5-48. EXAMPLE OF SHOCK

3. <u>How Can You Avoid Shock Loads?</u>

(a) Make sure there is no slack and no jerking of the rope at the start of the loading.

(b) Watch carefully the weight of the loads hoisted to see that they are not beyond the rope's proper working load.

(c) Do not allow rope to become fouled or jammed either on the drum or by jumping a sheave.

(d) Start load carefully - accelerating too fast overloads the rope. Watch how the rope "takes it" on the pick-up. Apply power smoothly and steadily.

4. <u>Operator All Important!</u>

With the equipment in good condition and the correct rope properly installed, the responsibility lies with the operator to avoid shock loads. A good operator is a rope's best friend. An operator can "make or break" a wire rope. There is no substitute for experience in handling rope and a desire to get the most out of it.

SAFETY BULLETIN

Crane & Rigging Safety Information

BULLETIN: 120A	NO.: 110	SUBJECT: Slings	DATE:

CALCULATING SLING LOADS

Safe crane operation requires detailed attention to the selection of equipment, setup, maintenance, and most importantly operation.

In addition to the crane itself, other factors contribute to the overall safety of any lift operation.

When slings are used, it is of utmost importance that each sling be selected for the loads involved, with detailed inspection prior to each use.

Calculating sling loads can mean the difference between a safe lift or failure, which can involve the crane itself.

The sling angle formed by a leg and the horizontal has a definite effect on the rated capacity of the sling. As the angle decreases from the vertical (straight pull), the amount of lifting capacity decreases. The tension in each leg increases without an increase in the load lifted.

Never overload a sling. When using a three or four leg sling, ensure that the load is equalized on each leg. When lifting loads, take up the slack slowly to minimize shock loading. Protect the sling over sharp corners or edges with padding. Pulling slings from under loads will result in abrasion and kinking; dropping loads on slings or running over them will cause crushing when lifting loads; sudden starts and stops will increase the stresses in slings; improper storage will result in deterioration.

Sling angles of less than 45° should be avoided because of the increased stresses on the slings.

The sharp increase in sling stress which occurs at low sling angles is emphasized in the following illustrations.

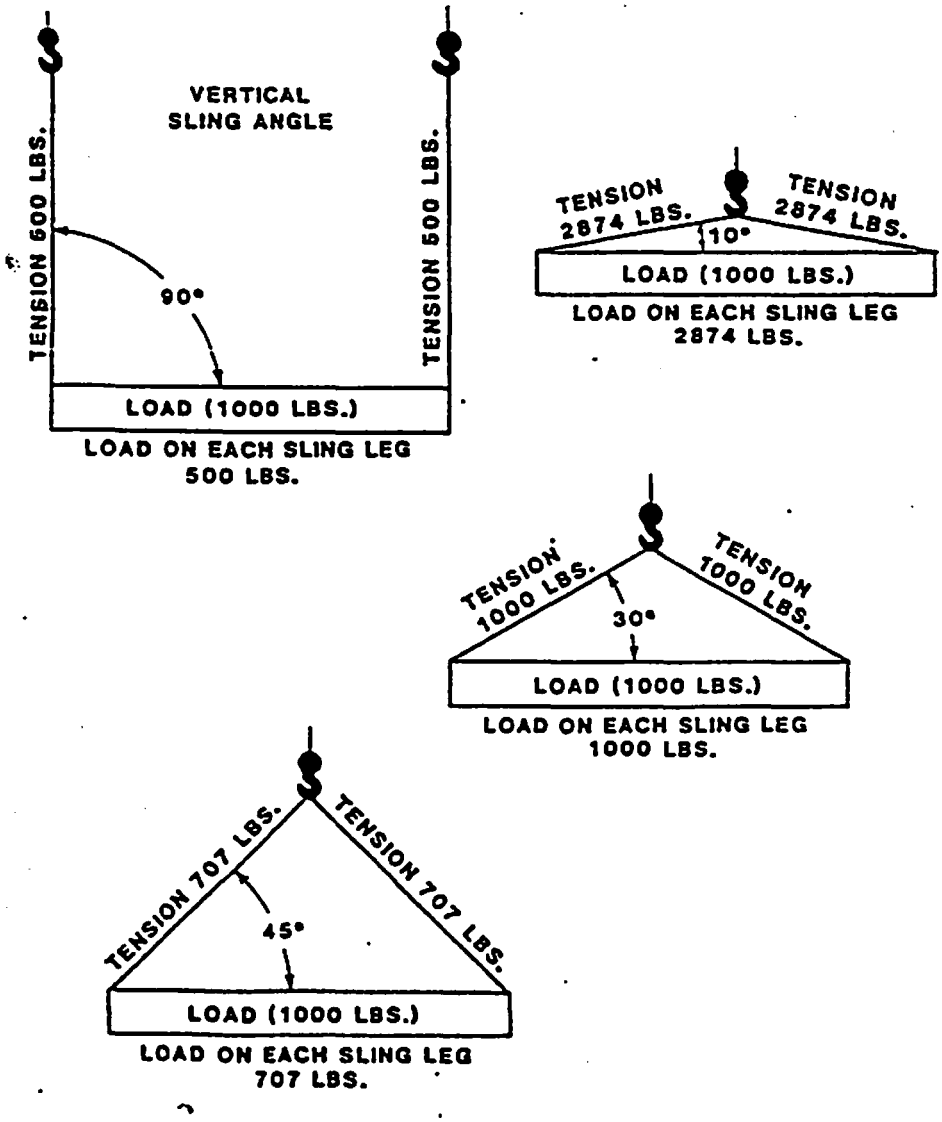
The following is an example of selecting a sling using the load angle factor, as shown on the chart below - Figure 5-49.

Sling = 2 legged bridle - load 1,000 lbs.

Angle with horizontal 45°

Load angle factor from the chart = 1.414

Each of the two legs would lift 500 pounds if a vertical pull were used. However, there is a 45° sling angle involved. Therefore, the 500 pound load would be multiplied by the load angle factor in the chart (1.414), giving a total of 707 lbs. (500 lbs x 1.414 = 707 lbs.) Tension in each leg. Therefore, each leg must have a safe working load of 707 lbs.



SLING ANGLE	LOAD ANGLE FACTOR
90°	1.000
85°	1.004
80°	1.015
75°	1.035
70°	1.064
65°	1.104
60°	1.155
55°	1.221
50°	1.305
45°	1.414
40°	1.555
35°	1.742
30°	2.000
25°	2.364
20°	2.924
15°	3.861
10°	5.747
5°	11.490

FIGURE 5-49. LOAD ANGLE FACTORS

unless repaired, reconditioned and proof tested by the sling manufacturer or an equivalent entity.

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

(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.

(9) *Deformed attachments.* (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°)
¼	3,250	5,650	4,550	3,250	6,400	6,800	4,900
⅜	6,600	11,400	9,300	6,600	17,000	14,000	9,900
½	11,250	19,500	15,900	11,250	29,000	24,000	17,000
⅝	16,500	28,500	23,300	16,500	43,000	35,000	24,500
¾	23,000	39,800	32,500	23,000	59,500	48,500	34,500
⅞	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
1⅛	44,500	77,000	63,000	44,500	115,500	94,500	66,500
1¼	57,500	99,500	61,000	57,500	149,000	121,500	86,000
1⅜	67,000	116,000	94,000	67,000	174,000	141,000	100,500
1½	80,000	138,000	112,900	80,000	207,000	169,000	119,500
1¾	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
¼	13/64
⅜	19/64
½	25/64
⅝	31/64
¾	19/32
⅞	45/64
1	13/16
1⅛	29/32
1¼	1
1⅜	1 3/32
1½	1 9/16
1¾	1 13/32

(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.

(f) *Wire rope slings.* (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.

(2) *Minimum sling lengths.* (i) Cable laid and 6 × 19 and 6 × 37 slings shall have a minimum clear length of wire rope 10 times the component rope diameter between splices, sleeves or end fittings.

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

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

(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°F. When nonfiber core wire rope slings of any grade are used at temperatures above 400°F or below minus 60°F, recommendations of the sling manufacturer regarding use at that temperature shall be followed.

(4) *End attachments.* (i) Welding of end attachments, except covers to thimbles, shall be performed prior to the assembly of the sling.

(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

6×19 and 6×37 Classification Improved Plow Steel Grade Rope With Fiber Core (FC)

Rope		Rated capacities, tons (2,000 lb)								
		Vertical			Choker			Vertical basket [1]		
Dia (inches)	Constr	HT	MS	S	HT	MS	S	HT	MS	S
¼	6×19	0.49	0.51	0.55	0.37	0.38	0.41	0.99	1.0	1.1
9/16	6×19	0.76	0.79	0.85	0.57	0.59	0.64	1.5	1.6	1.7
⅜	6×19	1.1	1.1	1.2	0.80	0.85	0.91	2.1	2.2	2.4
11/16	6×19	1.4	1.5	1.6	1.1	1.1	1.2	2.9	3.0	3.3
½	6×19	1.8	2.0	2.1	1.4	1.5	12.6	3.7	3.9	4.3
9/16	6×19	2.3	2.5	2.7	1.7	1.9	2.0	4.6	5.0	5.4
⅝	6×19	2.8	3.1	3.3	2.1	2.3	2.5	5.6	6.2	6.7
¾	6×19	3.9	4.4	4.8	2.9	3.3	3.6	7.8	8.8	9.5
⅞	6×19	5.1	5.9	6.4	3.9	4.5	4.8	10.0	12.0	13.0
1	6×19	6.7	7.7	8.4	5.0	5.8	6.3	13.0	15.0	17.0
1⅛	6×19	8.4	9.5	10.0	6.3	7.1	7.9	17.0	19.0	21.0
1¼	6×37	9.8	11.0	12.0	7.4	8.3	9.2	20.0	22.0	25.0
1⅜	6×37	12.0	13.0	15.0	8.9	10.0	11.0	24.0	27.0	30.0
1½	6×37	14.0	16.0	15.0	10.0	12.0	13.0	28.0	32.0	35.0
1⅝	6×37	16.0	18.0	21.0	12.0	14.0	15.0	33.0	27.0	41.0
1¾	6×37	19.0	21.0	24.0	14.0	16.0	18.0	38.0	43.0	48.0
2	6×37	25.0	28.0	31.0	18.0	21.0	23.0	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.

[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

6×19 and 6×37 Classification Improved Plow Steel Grade Rope With Independent Wire Rope Core (IWRC)

Rope		Rated capacities, tons (2,000 lb)								
		Vertical			Choker			Vertical basket [1]		
Dia (inches)	Constr	HT	MS	S	HT	MS	S	HT	MS	S
¼	6×19	0.53	0.56	0.59	0.40	0.42	0.44	1.0	1.1	1.2
9/16	6×19	0.81	0.87	0.92	0.61	0.65	0.69	1.6	1.7	1.8
⅜	6×19	1.1	1.2	1.3	0.86	0.93	0.98	2.3	2.5	2.6
11/16	6×19	1.5	1.7	1.8	1.2	1.3	1.3	3.1	3.4	3.5
½	6×19	2.0	2.2	2.3	1.5	1.6	1.7	3.9	4.4	4.6
9/16	6×19	2.5	2.7	2.9	1.8	2.1	2.2	4.9	5.5	5.6
⅝	6×19	3.0	3.4	3.6	2.2	2.5	2.7	6.0	6.8	7.2
¾	6×19	4.2	4.9	5.1	3.1	3.6	3.8	8.4	9.7	10.0
⅞	6×19	5.5	6.6	6.9	4.1	4.9	5.2	11.0	13.0	14.0
1	6×19	7.2	8.5	9.0	5.4	6.4	6.7	14.0	17.0	18.0
1⅛	6×19	9.0	10.0	11.0	6.8	7.8	8.5	18.0	21.0	23.0
1¼	6×37	10.0	12.0	13.0	7.9	9.2	9.9	21.0	24.0	26.0
1⅜	6×37	13.0	15.0	16.0	8.6	11.0	12.0	25.0	29.0	32.0
1½	6×37	15.0	17.0	19.0	11.0	13.0	14.0	30.0	35.0	38.0
1⅝	6×37	18.0	20.0	22.0	13.0	15.0	17.0	35.0	41.0	44.0
1¾	6×37	20.0	24.0	26.0	15.0	18.0	19.0	41.0	47.0	51.0

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

6×19 and 6×37 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						3-Leg bridle slings					
Dia (in.)	Constr	30° (60°)		45° angle		60° (30°)		30° (60°)		45° angle		60° (30°)	
		HT	MS	HT	MS	HT	MS	HT	MS	HT	MS	HT	MS
¼	6×19	0.92	0.97	0.75	0.79	0.53	0.56	1.4	1.4	1.1	1.2	0.79	0.84
5/16	6×19	1.4	1.5	1.1	1.2	0.81	0.87	2.1	2.3	1.7	1.8	1.2	1.3
⅜	6×19	2.0	2.1	1.6	1.6	1.1	1.2	3.0	3.2	2.4	2.6	1.7	1.9
7/16	6×19	2.7	2.9	2.2	2.4	1.5	1.7	4.0	4.4	3.3	3.6	2.3	2.5
½	6×19	3.4	3.6	2.8	3.1	2.0	2.2	5.1	5.7	4.2	4.6	3.0	3.3
9/16	6×19	4.3	4.8	3.5	3.9	2.5	2.7	6.4	7.1	5.2	5.8	3.7	4.1
⅝	6×19	5.2	5.9	4.2	4.8	3.0	3.4	7.8	8.8	6.4	7.2	4.5	5.1
¾	6×19	7.3	8.4	5.9	6.9	4.2	4.9	11.0	13.0	8.9	10.0	6.3	7.3
⅞	6×19	9.6	11.0	7.8	9.3	5.5	6.6	14.0	17.0	12.0	14.0	8.3	9.9
1	6×19	12.0	15.0	10.0	12.0	7.2	8.5	19.0	22.0	15.0	18.0	11.0	13.0
1⅛	6×19	16.0	18.0	13.0	15.0	9.0	10.0	23.0	27.0	19.0	22.0	13.0	16.0
1¼	6×37	18.0	21.0	15.0	17.0	10.0	12.0	27.0	32.0	22.0	26.0	16.0	18.0
1⅜	6×37	22.0	25.0	18.0	21.0	13.0	15.0	33.0	38.0	27.0	31.0	19.0	22.0
1½	6×37	26.0	30.0	21.0	25.0	15.0	17.0	39.0	45.0	32.0	37.0	23.0	26.0
1⅝	6×37	31.0	35.0	25.0	29.0	18.0	20.0	46.0	53.0	38.0	43.0	27.0	31.0
1¾	6×37	35.0	41.0	29.0	33.0	20.0	24.0	53.0	61.0	43.0	50.0	31.0	35.0
2	6×37	46.0	53.0	37.0	43.0	26.0	30.0	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

7×7×7 and 7×7×19 Constructions Galvanized Aircraft Grade Rope

7×6×19 IWRC Construction Improved Plow Steel Grade Rope

[Horizontal angles shown in parentheses]

Rope		Rated capacities, tons (2,000 lb)					
		2-Leg bridle sling			3-Leg bridle sling		
Dia (inches)	Constr	30° (60°)	45° angle	60° (30°)	30° (60°)	45° angle	60° (30°)
¼	7×7×7	0.87	0.71	0.50	1.3	1.1	0.75
⅜	7×7×7	1.9	1.5	1.1	2.8	2.3	1.6
½	7×7×7	3.2	2.6	1.8	4.8	3.9	2.8
⅝	7×7×7	4.8	3.9	2.8	7.2	5.9	4.2
¾	7×7×7	6.6	5.4	3.8	9.9	8.1	3.7
⅜	7×7×19	5.0	4.1	2.9	7.5	6.1	4.3
½	7×7×19	7.0	5.7	4.1	10.0	8.6	6.1
⅝	7×7×19	9.3	7.6	5.4	14.0	11.0	8.1
1	7×7×19	12.0	9.7	6.9	18.0	14.0	10.0
1⅛	7×7×19	14.0	12.0	8.2	21.0	17.0	12.0
1¼	7×7×19	17.0	14.0	9.9	26.0	21.0	15.0
¾	7×6×19 IWRC	6.6	5.4	3.8	9.9	8.0	5.7
⅞	7×6×19 IWRC	8.7	7.1	5.0	13.0	11.0	7.5
1	7×6×19 IWRC	11.0	9.0	6.4	17.0	13.0	9.6
1⅛	7×6×19 IWRC	13.0	11.0	7.7	20.0	16.0	11.0
1¼	7×6×19 IWRC	16.0	13.0	9.2	24.0	20.0	14.0
1 5/16	7×6×19 IWRC	17.0	14.0	10.0	26.0	21.0	15.0
1⅜	7×6×19 IWRC	19.0	15.0	11.0	28.0	23.0	16.0
1½	7×6×19 IWRC	22.0	18.0	13.0	33.0	27.0	19.0

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.

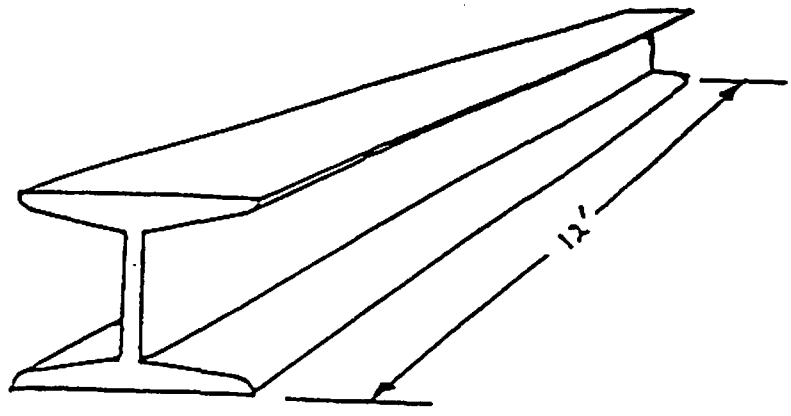
To determine the volume of a box-shaped object, multiply the length times the width times the height. This is the simplest volume formula:

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:

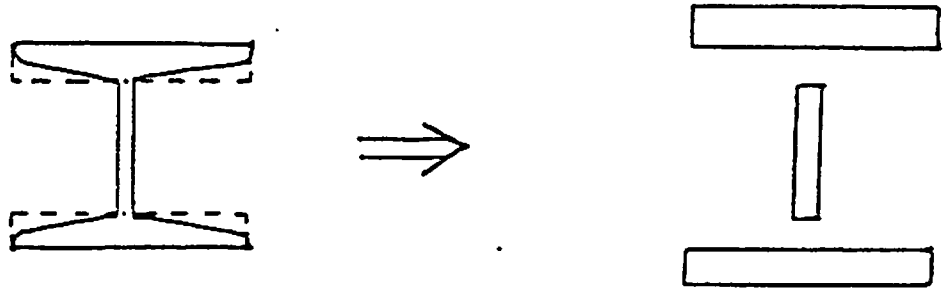
You have to lift a 12 ft. I-beam. Nobody seems to know what it weighs, and the weight charts for I-beams have all been lost. (Typical situation.) So the first step is to determine the volume.



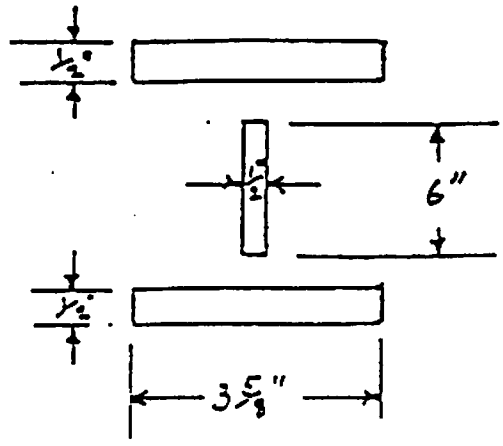
Solution >>>

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.

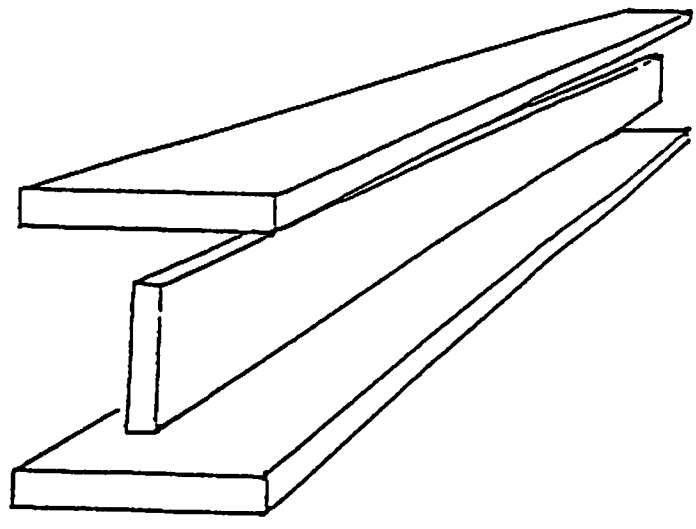


Measure the rectangles and convert the measurements into feet with decimals:



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.

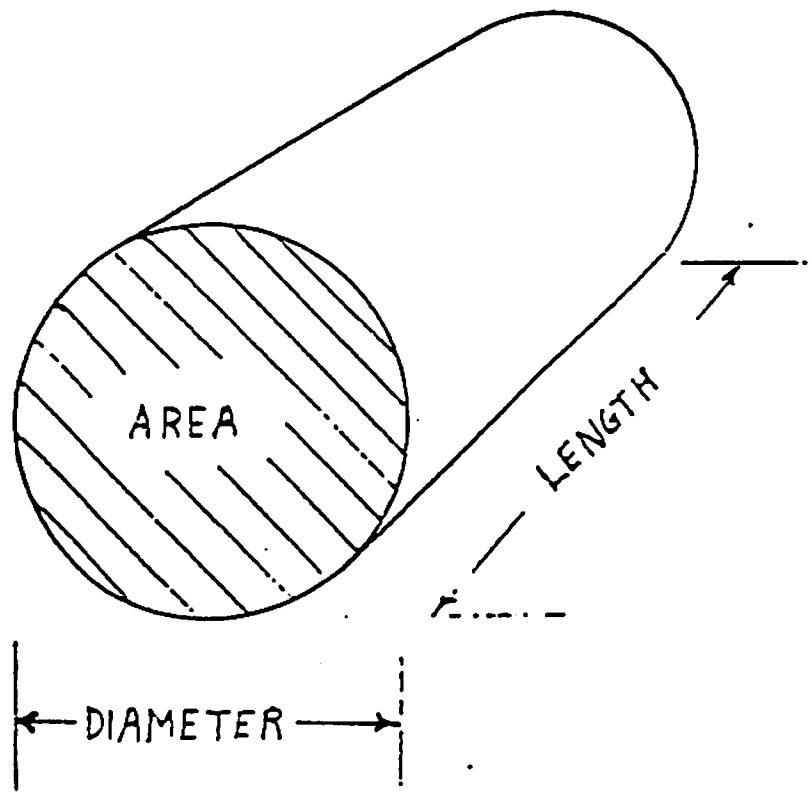
Use this formula to find the area of the cross section:

Cross sectional area = .79 X Diameter X Diameter

(This is the old "πr^2" formula rearranged for convenience.)

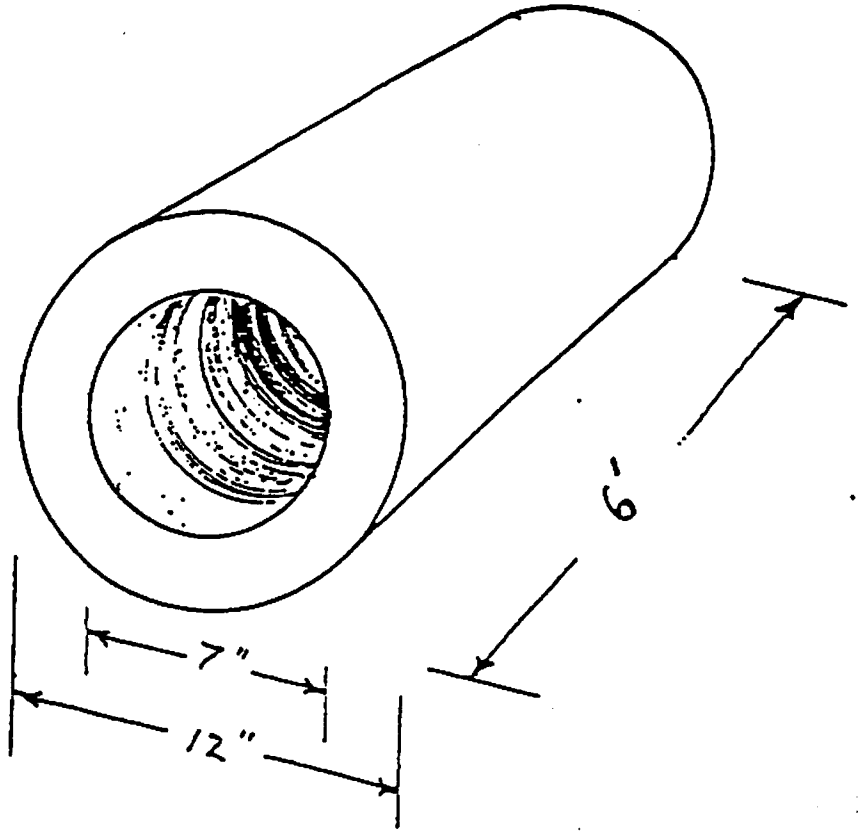
Then take that result and stick it into this formula:

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.

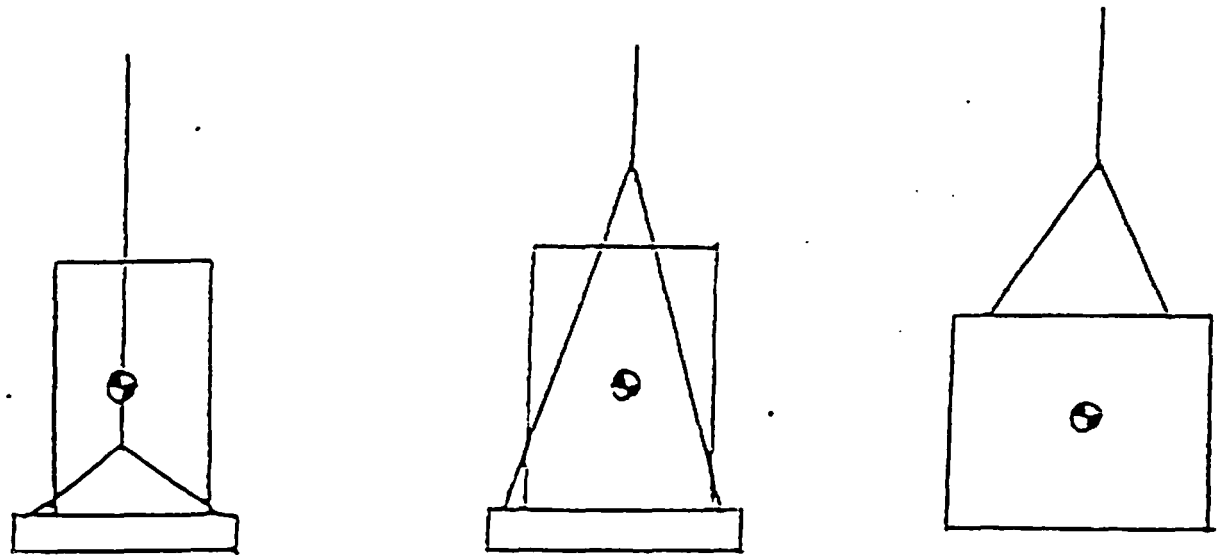
Symbol: CG = ⊕

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.



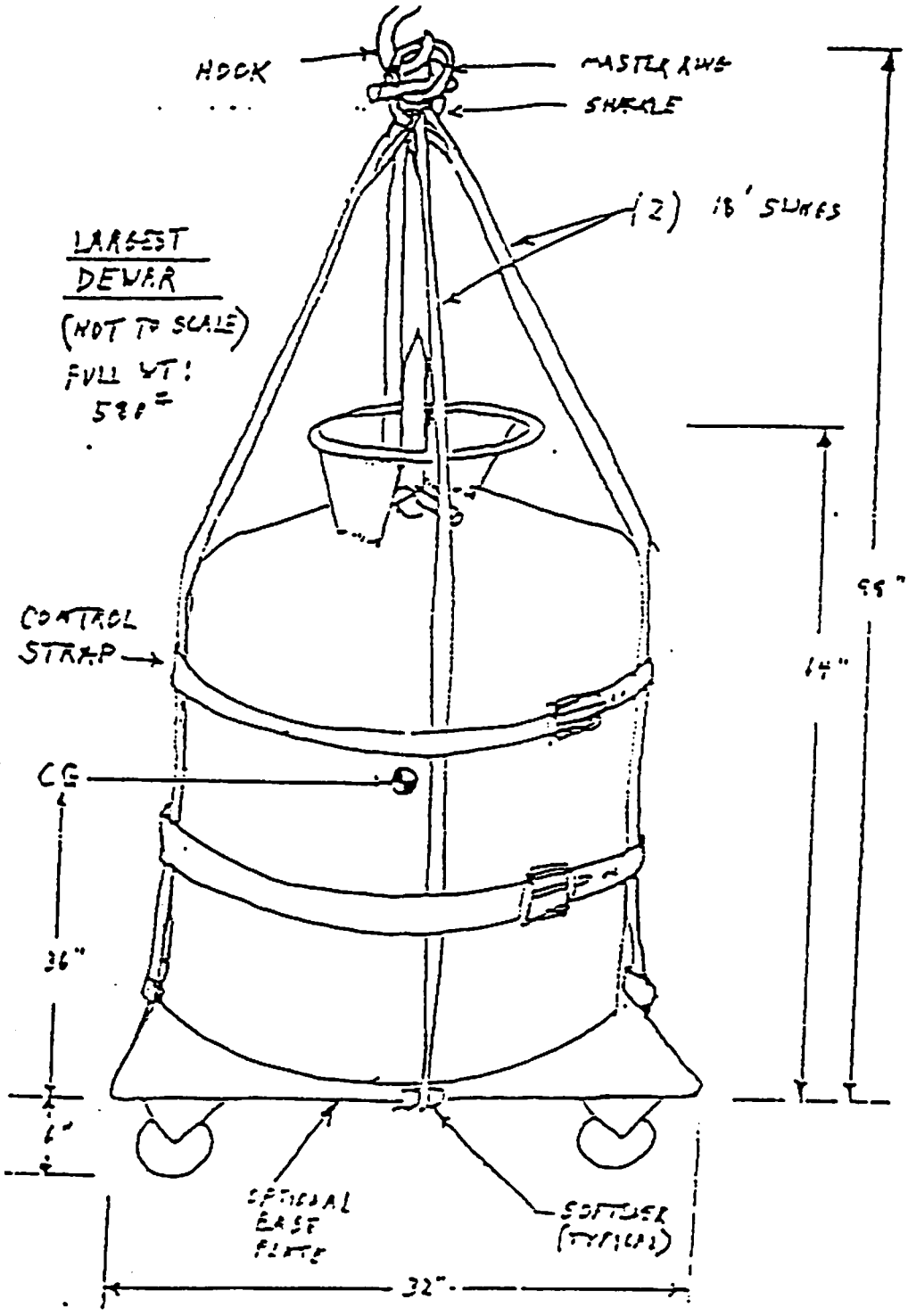
Unstable | Partially Stable | Completely Stable

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:

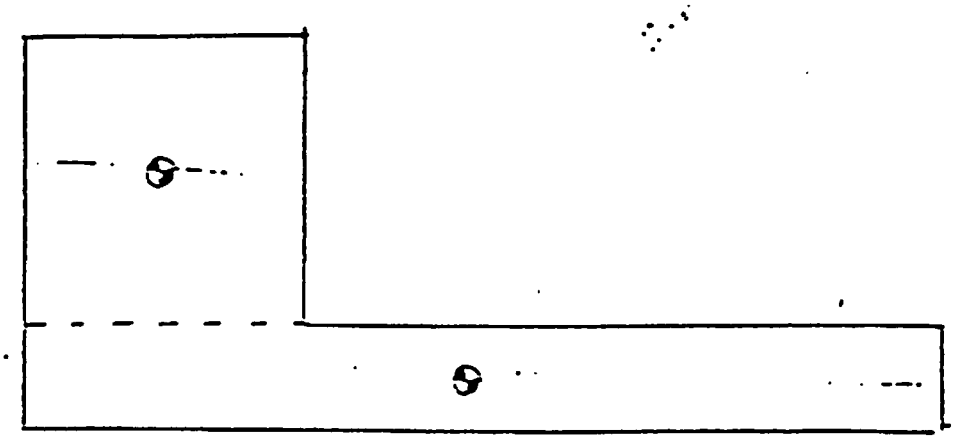
- Find the CG's of two adjacent simple segments.
- Determine the weight of both segments.
- Draw a line connecting the CG's of both segments.
- The total CG will be on this line, closer to the heavier segment by a distance proportional to its percentage of the total weight.
- Repeat the process until all segments have been included.

Example:

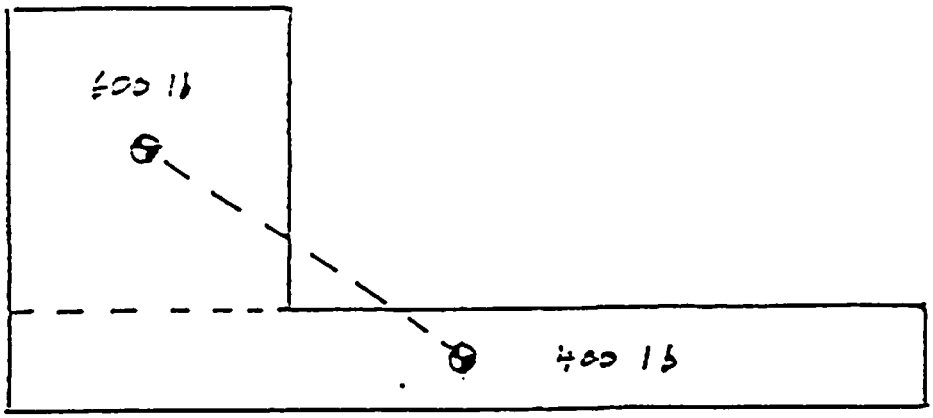
Find the CG of an L-shaped load.

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.

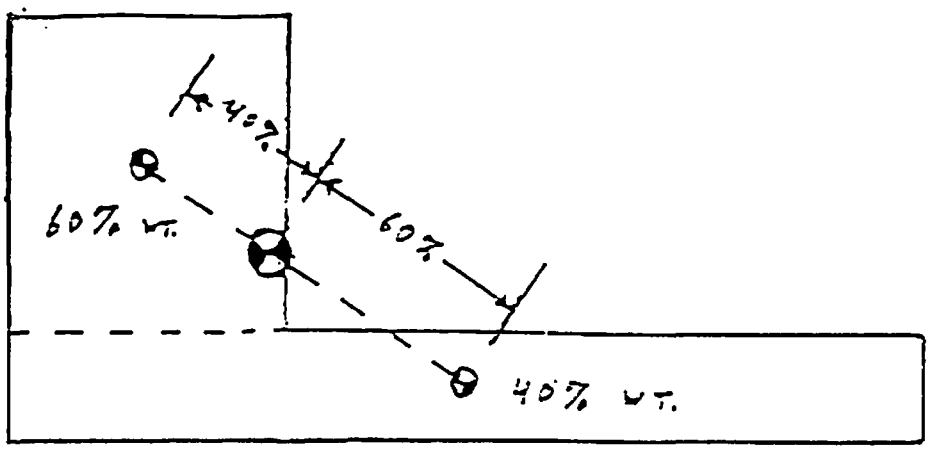


Determine what percentage of the total weight the heavier segment is.

$$\frac{\text{Heavier Segment}}{\text{Total Weight}} \quad \frac{600 \text{ lbs.}}{1000 \text{ lbs.}} \quad .60$$

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)

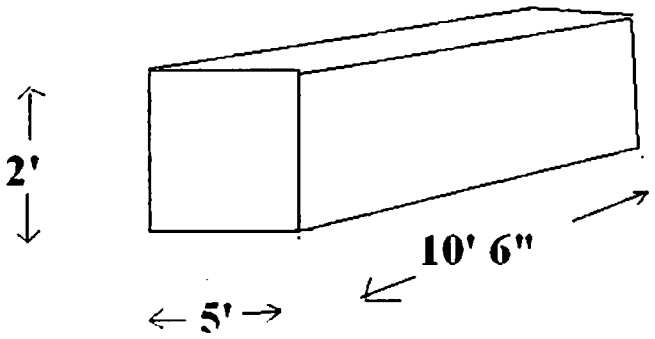
- Don't place your pride ahead of your knowledge.

Load Weight Estimation

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

Exercise #1

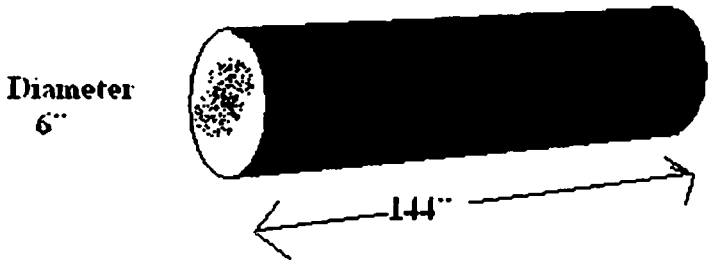
(Concrete Block) **Concrete = (150 Pounds per Cubic Foot)**



Volume_____ Weight _____

Exercise #2

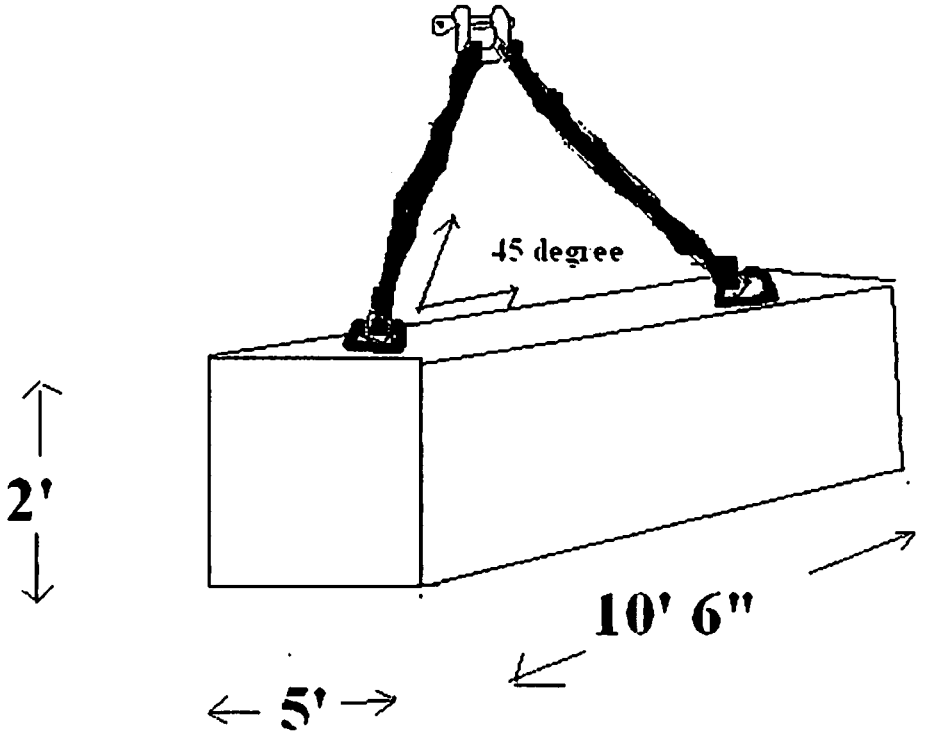
(Steel Shaft) **(Steel = 490 LBS per Cubic Foot)**



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)

Load Weight Estimation

Common Rigging Problems

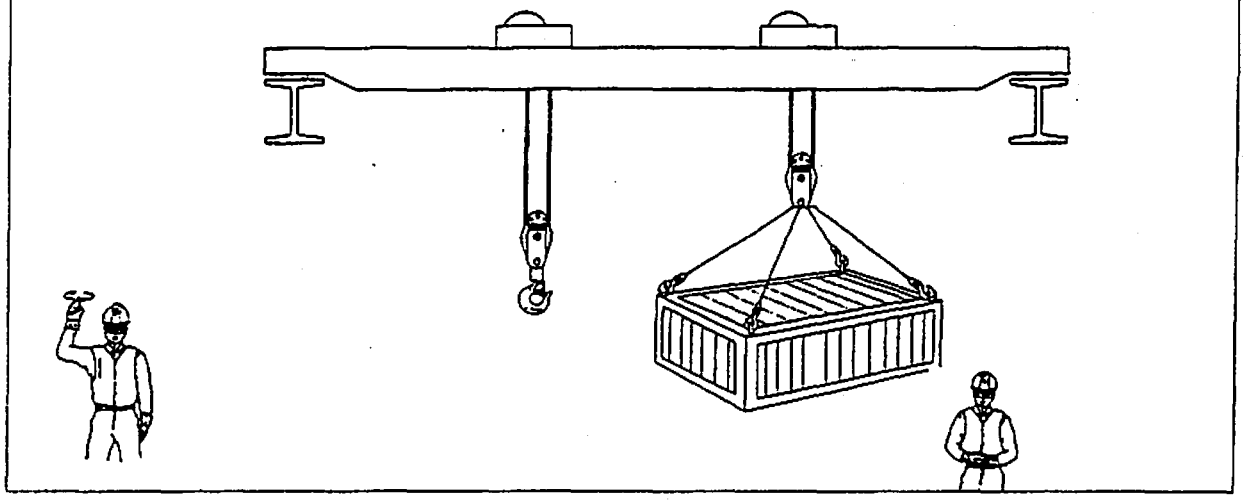
- D/d ratio: Three Cases.
- Beating down a choker hitch.
- Basket hitch legs not vertical.
- Capacity of sling not adjusted for angle.
  - If not vertical, must consider Load Angle Factor.
- Choker and basket hitch sling angle's smaller than 60°.
  - As the sling angle decreases, the load increases in each leg.

THE RIGGING PLAN

Improper connection of the slings to the load hook or the load itself can cause misloading, overloading, and even poor load control. To pull together these various considerations, it is useful to identify the elements of a good rigging plan: a structure that can be used to develop a specific set of requirements for each job.

It is said that a picture is worth a thousand words. In rigging, this is especially true. Make sure you consider the following elements of a basic rigging plan before your next job.

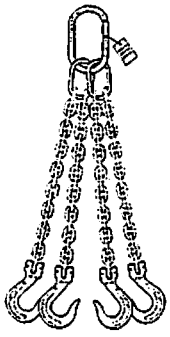
Elements of a Basic Rigging Plan



1. Who is responsible (competent) for the rigging and have communications been properly established?

2. Is the equipment in acceptable condition?

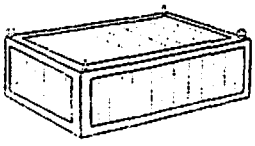
3. Is the equipment the appropriate type with proper identification?



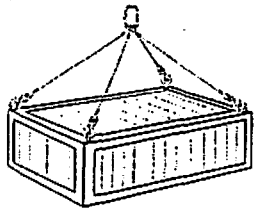
4. Are the working load limits adequate?

5. Are the working load limits known?

6. What is the weight of the load?



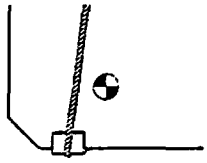
7. Where is the center of gravity?



8. What is the sling angle?

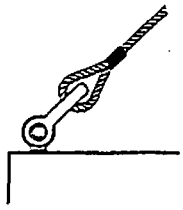
9. Is the load rigged to the center of gravity?

10. Is a tag line needed?



11. Will the load be under control?

12. Are the slings padded against sharp edges?



13. Will there be any side loading?

14. Is there any possibility of the gear or load fouling on an obstruction?

15. Are personnel clear of the load to be suspended? ▮

Common Rigging Problems

- Not inspecting gear
- Not knowing what to look for in an inspection
- Missing or illegible tags
- Capacity not known
- Not able to read rigging charts
- Improperly made below the hook devices
- Wire rope slings formed with clips
- Improper connections to sling eyes
- Beating down choker hitch
- Basket hitch over small diameter
- Basket hitch legs not vertical
- Capacity of sling not adjusted for angle
- Choker and basket hitches at sling angle smaller that 60°

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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Crosby USER'S GUIDE LIFTING

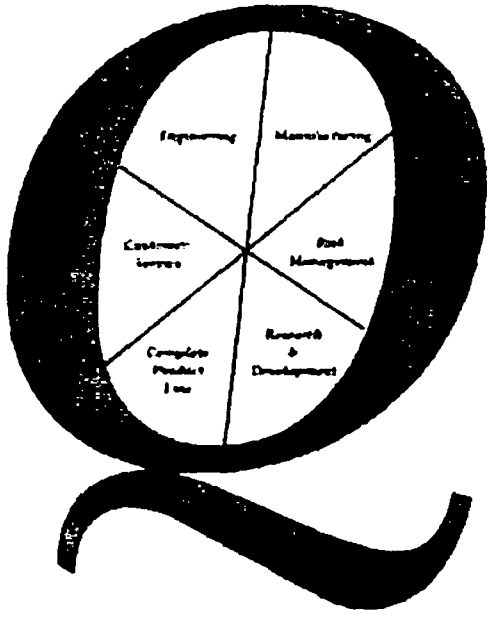
VERSION (9/00)

RISK MANAGEMENT

DEFINITION

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

Crosby Quality Continuum



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

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Tulsa Oklahoma 74101
Phone: (918) 834-4611
Fax: (918) 832-0940
1-800-777-1555
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crosbygroup@thecrosbygroup.com

BLOCKS & FITTINGS FOR WIRE ROPE & CHAIN

CROSBY® FITTINGS

LEBUS® McKISSICK®

WESTERN NATIONAL

THE BASIC RIGGING PLAN

1. WHO IS RESPONSIBLE (COMPETENT) FOR THE RIGGING? COMMUNICATION ESTABLISHED?
2. IS THE EQUIPMENT IN ACCEPTABLE CONDITION? APPROPRIATE TYPE, PROPER IDENTIFICATION?
3. ARE THE WORKING LOAD LIMITS ADEQUATE?
   CAPACITY OF GEAR KNOWN?
   WHAT IS THE WEIGHT OF LOAD?
   WHERE IS THE CENTER OF GRAVITY?
   WHAT IS THE SLING ANGLE?
   WILL THERE BE ANY ANGULAR OR SIDE LOADING?
   ARE THE SLINGS PADDED AGAINST SHARP CORNERS?
4. WILL THE LOAD BE UNDER CONTROL?
   IS THE LOAD RIGGED TO THE CENTER OF GRAVITY?
   IS THE HITCH APPROPRIATE?
   TAG LINE NEEDED?
   IS THERE ANY POSSIBILITY OF FOULING?
   CLEAR OF PERSONNEL?
5. ARE THERE ANY UNUSUAL LOADING OR ENVIRONMENTAL CONDITIONS?
   WIND, TEMPERATURE, OTHER?
6. SPECIAL REQUIREMENTS?

QUIC-CHECK®

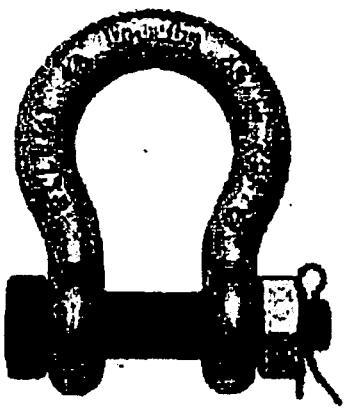
RESPONSIBILITY

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.

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



INSPECTION OF HARDWARE

DEFORMATION

REMOVE FROM SERVICE IF ANY SIGNIFICANT DEFORMATION. CHECK THROAT OPENING OF HOOKS.

WEAR

REMOVE FROM SERVICE IF EXCESSIVE WEAR. WEAR IS EXCESSIVE IF:

- MORE THAN 5 % WEAR IN THROAT OR EYE OF HOOK AND OTHER CRITICAL AREAS OF HARDWARE.
- MORE THAN 10% WEAR IN OTHER AREAS.

CRACKS, NICKS, GOUGES

REMOVE FROM SERVICE IF CRACKS, NICKS, OR GOUGES ARE DETECTED.

MODIFICATION

DO NOT WELD, DO NOT SUBSTITUTE SHACKLE PINS OR OTHER COMPONENTS, DO NOT HEAT, BEND OR MODIFY IN ANY MANNER

PROPER FUNCTION

IMPROPERLY INSTALLED HARDWARE OR MALFUNCTION IS CAUSE FOR REMOVAL. CHECK FOR LATCHES, SWIVEL BEARINGS, LOCKING DEVICES, AND INSTALLATION OF WIRE ROPE CLIPS AND WEDGE SOCKETS.

INSPECTION OF WIRE ROPE SLINGS 3

PER ANSI B30.9

ALL SLINGS AND ATTACHMENTS SHALL BE VISUALLY INSPECTED BY THE PERSON HANDLING THE SLING EACH DAY THEY ARE USED. IN ADDITION, A PERIODIC INSPECTION SHALL BE PERFORMED BY A DESIGNATED PERSON, AT LEAST ANNUALLY, AND SHALL INCLUDE A RECORD OF THE INSPECTION.

INSPECTION CRITERIA

- KINKING
- CRUSHING
- UNSTRANDING
- BROKEN OR CUT STRANDS
- STRANDING DISPLACEMENT
- CORE PROTRUSION
- CORROSION
- BIRDCAGING
- BROKEN WIRES

BROKEN WIRES

REMOVE FROM SERVICE STRAND LAID AND SINGLE PART SLINGS IF TEN OR MORE RANDOMLY DISTRIBUTED WIRES IN ONE ROPE LAY, OR FIVE BROKEN WIRES IN ONE ROPE STRAND IN ONE ROPE LAY.

DISTORTION OF WIRE ROPE

REMOVE FROM SERVICE WIRE ROPE SLINGS THAT HAVE ANY DAMAGE RESULTING IN DISTORTION OF THE WIRE ROPE STRUCTURE SUCH AS KINKING, CRUSHING, UNSTRANDING, BIRDCAGING, STRAND DISPLACEMENT OR CORE PROTRUSION.

INSPECTION OF CHAIN SLINGS

PER ANSI B30.9

ALL SLINGS AND ATTACHMENTS SHALL BE VISUALLY INSPECTED BY THE PERSON HANDLING THE SLING EACH DAY THEY ARE USED. IN ADDITION, A PERIODIC INSPECTION (NORMAL SERVICE: YEARLY, SEVERE SERVICE: MONTHLY) SHALL BE PERFORMED BY A DESIGNATED PERSON, AT LEAST ANNUALLY, AND SHALL INCLUDE A RECORD OF THE INSPECTION.

INSPECTION CRITERIA

WEAR
NICK, CRACKS, BREAKS
GOUGES, STRETCH, BENDS
WELD SPLATTER
EXCESSIVE TEMPERATURE
THROAT OPENING OF HOOK

CHAIN LINKS

REMOVE SLING FROM SERVICE IF LINKS ARE WORN EXCESSIVELY (MORE THAN 10% OR REFER TO MANUFACTURER'S INFORMATION), SHARP TRANSVERSE NICKS AND GOUGES SHOULD BE ROUNDED OUT BY GRINDING (DO NOT EXCEED WEAR ALLOWANCE). CHAIN LINKS AND ATTACHMENTS SHOULD HINGE FREELY TO ADJACENT LINKS.

IDENTIFICATION

CHAIN SLINGS SHALL HAVE PERMANENTLY AFFIXED IDENTIFICATION STATING: SIZE, GRADE, RATED LOAD, NUMBER OF LEGS AND MANUFACTURER.

INSPECTION OF SYNTHETIC SLINGS

PER ANSI B30.9

ALL SLINGS AND ATTACHMENTS SHALL BE VISUALLY INSPECTED BY THE PERSON HANDLING THE SLING EACH DAY THEY ARE USED. IN ADDITION, A PERIODIC INSPECTION SHALL BE PERFORMED BY A DESIGNATED PERSON, AT LEAST ANNUALLY, AND SHALL INCLUDE A RECORD OF THE INSPECTION.

INSPECTION CRITERIA

ACID OR CAUSTIC BURNS
MELTING OR CHARRING
HOLES, CUTS
TEARS, SNAGS
BROKEN STITCHES
WORN STITCHES
EXCESSIVE ABRASION
KNOTS

ROUND SLING NOTES

REMOVE FROM SERVICE ROUND SLINGS THAT HAVE CORE FIBER EXPOSED BY HOLES, TEARS, CUTS, EMBEDDED PARTICLES, WEAR OR SNAGS.

REMOVE FROM SERVICE ROUND SLINGS THAT HAVE MELTING, CHARRING OR WELD SPLATTER ON ANY PART OF SLING.

IDENTIFICATION

WEB SLINGS AND ROUND SLINGS SHALL BE PERMANENTLY MARKED INDICATING: MANUFACTURER'S TRADEMARK AND CODE (OR STOCK NUMBER), RATED LOADS FOR THE THREE HITCHES AND MATERIAL.

WIRE ROPE SLING CAPACITIES (LBS.) - FLEMISH EYE - ANSI B30.9

6 X 19 AND 6 X 37 IMPROVED PLOW STEEL - IWRC 5/1 DESIGN FACTOR

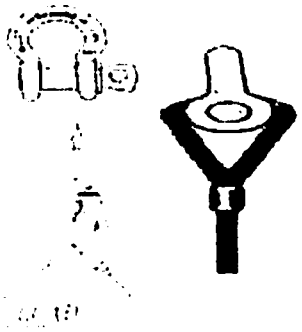
WIRE ROPE SIZE	Crosby Q & T CARBON SHACKLE MINIMUM SHACKLE SIZE FOR A D/d>1 AT LOAD CONNECTION SHACKLE SIZE	VERTICAL (SINGLE LEG)	ANGLE 120 CHOKER	TWO LEG OR BASKET HITCH	60 DEGREE SLING ANGLE	45 DEGREE SLING ANGLE	30 DEGREE SLING ANGLE
1/4	5/16	1120	820	2200	1940	1500	1120
5/16	3/8	1740	1280	3400	3000	2400	1740
3/8	7/16	2400	1840	4800	4200	3400	2400
7/16	1/2	3400	2400	6800	5800	4800	3400
1/2	5/8	4400	3200	8800	7600	6200	4400
9/16	5/8	5600	4000	11200	9600	7900	5600
5/8	3/4	6800	5000	13600	11800	9600	6800
3/4	7/8	9800	7200	19600	16900	13800	9800
7/8	1	13200	9600	26400	22800	18600	13200
1	1-1/8	17000	12600	34000	30000	24000	17000
1-1/8	1-1/4	20000	15800	40000	34600	28300	20000
1-1/4	1-3/8	26000	19400	52000	45000	36700	26000
1-3/8	1-1/2	30000	24000	60000	52000	42400	30000

- RATED CAPACITIES BASED ON PIN DIAMETER OR HOOK NO LONGER THAN THE NATURAL EYE WIDTH (1/2 X EYE LENGTH) OR LESS THAN THE NOMINAL SLING DIAMETER

REFER TO ANSI B30.9 FOR FULL DETAILS

HORIZONTAL SLING ANGLES OF LESS THAN 30 DEGREES ARE NOT RECOMMENDED

WIRE ROPE SLINGS AND CONNECTIONS TO FITTINGS

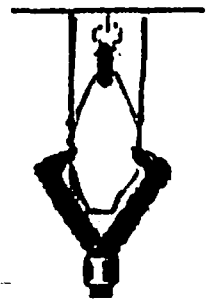


USE A THIMBLE TO PROTECT SLING AND INCREASED/D

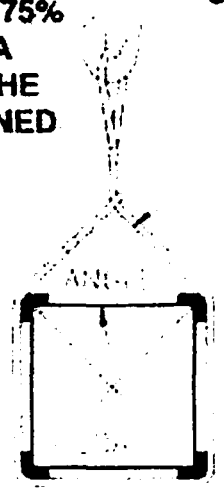
NEVER PLACE EYE OVER A FITTING SMALLER DIAMETER OR WIDTH THAN THE ROPE'S DIAMETER.

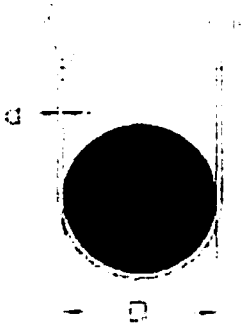
WIRE ROPE SLINGS AND CONNECTIONS TO FITTINGS

NEVER PLACE A SLING EYE OVER A FITTING WITH A DIAMETER OR WIDTH GREATER THAN ONE HALF THE NATURAL LENGTH OF THE EYE.

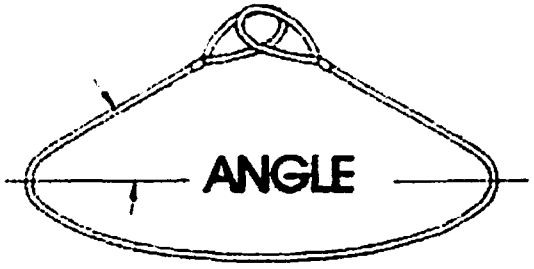


A CHOKER HITCH HAS 75% OF THE CAPACITY OF A SINGLE LEG ONLY IF THE CORNERS ARE SOFTENED AND THE HORIZONTAL ANGLE IS GREATER THAN 30 DEGREES. USE A BLOCK OF WOOD UNDER CHOKE TO INSURE ANGLE IS PROPER.

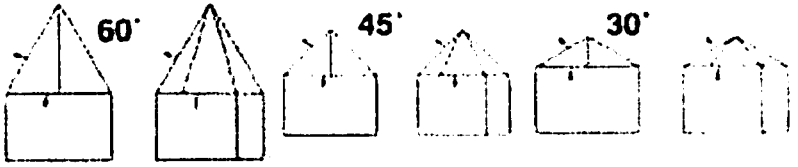




A BASKET HITCH HAS TWICE THE CAPACITY OF A SINGLE LEG ONLY IF D/d RATIO IS 25/1 AND THE LEGS ARE VERTICAL.



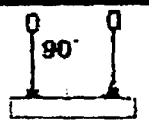
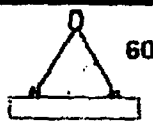
ANGLE	CAPACITY % OF SINGLE LEG
90	200 %
60	170 %
45	140 %
30	100 %

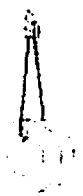


TRIPLE LEG SLINGS HAVE 50% MORE CAPACITY THAN DOUBLE LEG ONLY IF THE CENTER OF GRAVITY IS IN CENTER OF CONNECTION POINT AND LEGS ARE ADJUSTED PROPERLY (EQUAL SHARE OF THE LOAD)

QUAD LEG SLINGS OFFER IMPROVED STABILITY BUT DO NOT PROVIDE INCREASED LIFTING CAPACITY.

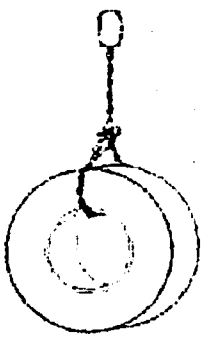
CHAIN SLING CAPACITIES (LBS.) - ANSI B30.9 DESIGN FACTOR 4/1

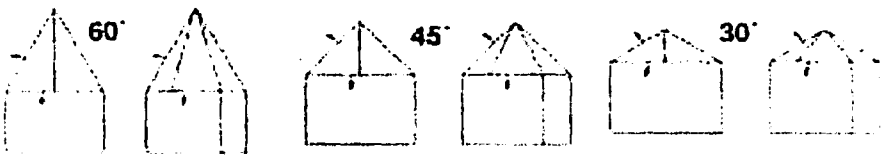
CHAIN SIZE						Crosby QT ALLOY	
CHAIN GR - 8 DESIGN FACTOR 4/1	VERTICAL (SINGLE LEG)	TWO LEG OR BASKET HITCH	60 DEGREE SLING ANGLE	45 DEGREE SLING ANGLE	30 DEGREE SLING ANGLE	SINGLE LEG MASTER LINK SIZE	DOUBLE LEG MASTER LINK SIZE
¼ - (9/32)	3500	7000	6050	4900	3500	1/2	1/2
3/8	7100	14200	12200	10000	7100	3/4	3/4
1/2	12000	24000	20750	16950	12000	7/8	1
5/8	18100	39200	31350	25500	18100	1	1-1/4
3/4	28300	56600	49000	40000	28300	1-1/4	1-1/2
7/8	34200	68400	59200	48350	34200	1-1/2	1-3/4
1	47700	95400	82600	67450	47700	—	—
1-1/4	72300	144600	125200	102200	72300	—	—



HORIZONTAL ANGLE	CAPACITY % OF SINGLE LEG
90	200 %
60	170 %
45	140 %
30	100 %

A CHOKER HITCH HAS 80% OF THE CAPACITY OF A SINGLE LEG IF THE CORNERS ARE SOFTENED AND THE HORIZONTAL ANGLE IS GREATER THAN 30 DEGREES. USE A BLOCK OF WOOD UNDER CHOKE TO INSURE ANGLE IS PROPER.





TRIPLE LEG SLINGS HAVE 50% MORE CAPACITY THAN DOUBLE LEG ONLY IF THE CENTER OF GRAVITY IS IN CENTER OF CONNECTION POINT AND LEGS ARE ADJUSTED PROPERLY (EQUAL SHARE OF THE LOAD)

QUAD LEG SLINGS OFFER IMPROVED STABILITY BUT DO NOT PROVIDE INCREASED LIFTING CAPACITY.

PRICE $4.20

theCrosby group, inc.

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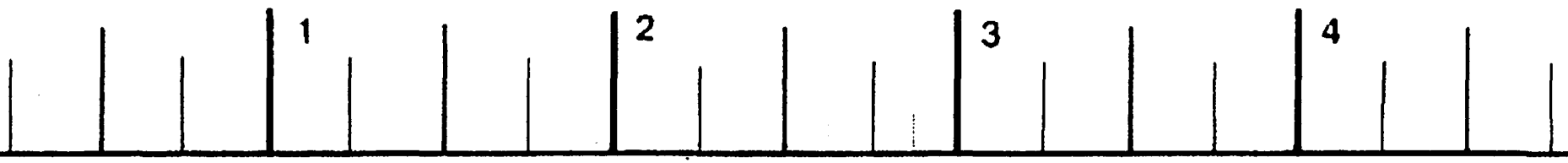


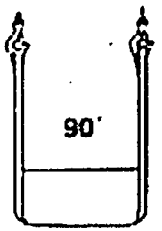
WEB SLING CAPACITIES - ANSI B30.9 - DESIGN FACTOR 5/1

VERTICAL (SINGLE LEG)

100% OF SINGLE SINGLE LEG

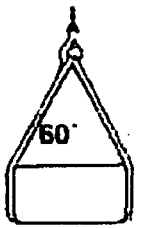
CHOKER

80% OF SINGLE LEG



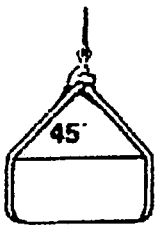
TWO LEG OR BASKET

200% OF SINGLE LEG



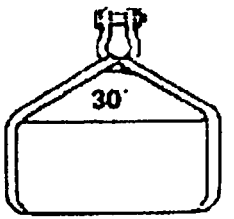
60 DEGREE SLING ANGLE

170% OF SINGLE LEG



45 DEGREE SLING ANGLE

140% OF SINGLE LEG

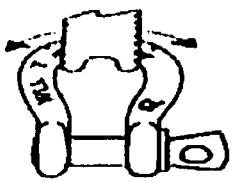


30 DEGREE SLING ANGLE

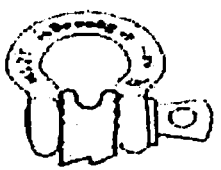
SAME AS SINGLE LEG

SYNTHETIC SLINGS RATED LOAD

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

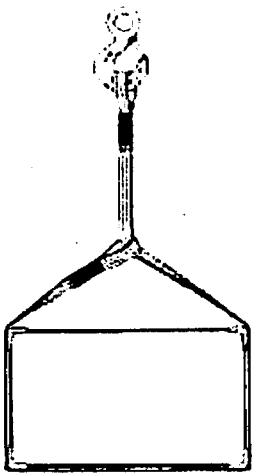


BUNCHING



PINCHING

A CHOKER HITCH HAS 80% OF THE CAPACITY OF A SINGLE LEG IF THE CORNERS ARE SOFTENED AND THE HORIZONTAL ANGLE IS GREATER THAN 30 DEGREES. USE A BLOCK OF WOOD UNDER CHOKE TO INSURE ANGLE IS PROPER.



60° 45° 30

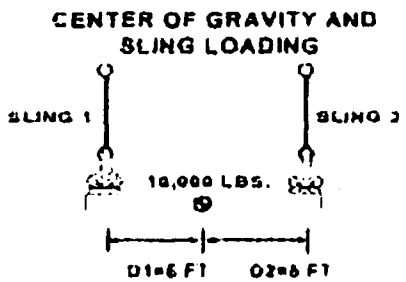
TRIPLE LEG SLINGS HAVE 50% MORE CAPACITY THAN DOUBLE LEG ONLY IF THE CENTER OF GRAVITY IS IN CENTER OF CONNECTION POINT AND LEGS ARE ADJUSTED PROPERLY (EQUAL SHARE OF THE LOAD)

QUAD LEG SLINGS OFFER IMPROVED STABILITY BUT DO NOT PROVIDE INCREASED LIFTING CAPACITY.

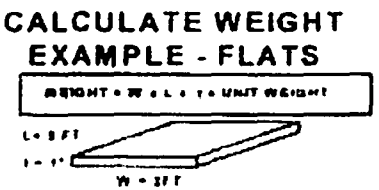
CENTER OF GRAVITY AND SLING LOADING

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.



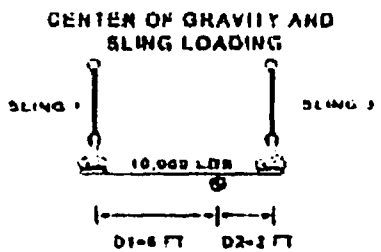
CALCULATE WEIGHT EXAMPLE - FLATS



IF STEEL
UNIT WEIGHT IS 490 LBS/FT^3
WEIGHT = 2' X 5' X 1/12' X 490 LBS/FT^3 = 408 LBS.
IF ALUMINUM
UNIT WEIGHT IS 165 LBS/FT^3
WEIGHT = 2' 5' X 1/12' X 165LB/FT^3 = 138LBS.
IF CONCRETE
UNIT WEIGHT IS 150 LBS/FT^3

CENTER OF GRAVITY AND SLING LOADING

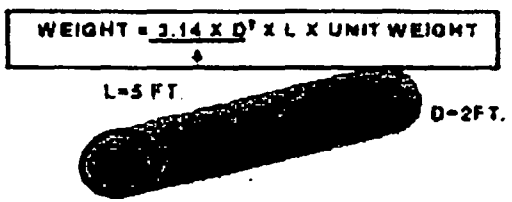
WHEN THE CENTER OF GRAVITY IS NOT EQUALLY SPACED BETWEEN THE PICK POINTS, THE SLING AND FITTINGS WILL NOT CARRY AN EQUAL SHARE OF THE LOAD. THE SLING CONNECTED TO THE PICK POINT CLOSEST TO THE CENTER OF GRAVITY WILL CARRY THE GREATEST SHARE OF THE LOAD.



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.

CALCULATE WEIGHT EXAMPLE - SOLID CYLINDER

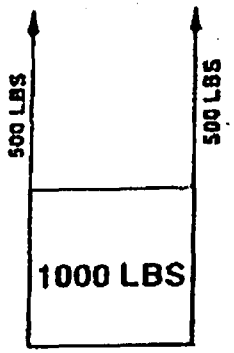


IF STEEL
UNIT WEIGHT IS 490 LBS/FT^3
WEIGHT = 3.14 (2' X 2') X 5' X 490 LBS/FT^3 = 7693 LBS.

IF CONCRETE
UNIT WEIGHT IS 150 LBS/FT^3
WEIGHT = 3.14 (2' X 2') X 5' X 150 LBS/FT^3 = 2355 LBS.

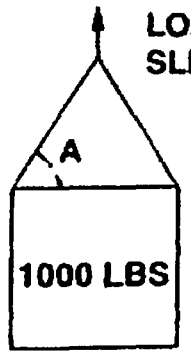
SLING ANGLES

TWO LEGGED SLING - WIRE ROPE, CHAIN, SYNTHETICS

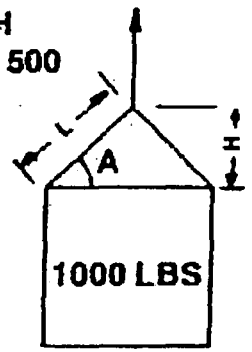


LOAD = 500 X LOAD ANGLE FACTOR

A = HORIZONTAL

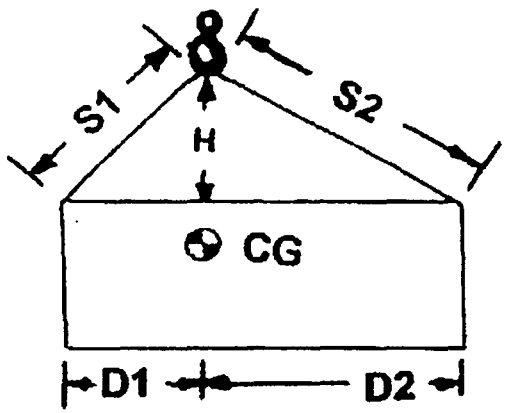


LOAD IN EACH SLING = L/H X 500



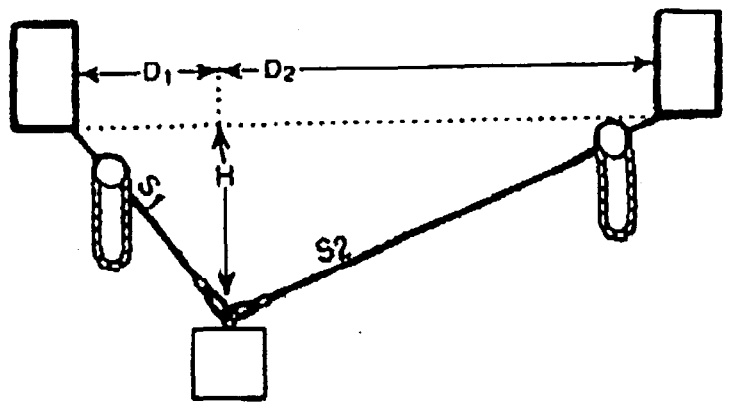
HORIZONTAL SLING ANGLE (A) DEGREE	LOAD ANGLE FACTOR = L/H
90	1.000
60	1.155
50	1.305
45	1.414
30	2.000

LOAD ON EACH LEG OF SLING = VERTICAL 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 RIGGING HARDWARE

Crosby SHACKLES — QUENCHED & TEMPERED

SCREW PIN AND BOLT TYPE

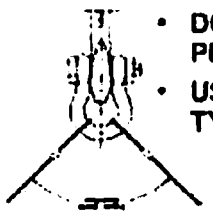
CARBON SHACKLE DESIGN FACTOR 6/1

ALLOY SHACKLE DESIGN FACTOR 5/1

QUIC-CHECK

NOMINAL SIZE (IN) DIAMETER OF BOW	CARBON MAXIMUM WORKING LOAD TONS	ALLOY MAXIMUM WORKING LOAD TONS	INSIDE WIDTH AT PIN (INCHES)	DIAMETER OF PIN
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

- INSURE SCREW PIN TIGHT BEFORE EACH LIFT
- USE BOLT TYPE SHACKLE FOR PERMANENT INSTALLATION



- DO NOT SIDE LOAD ROUND PIN SHACKLE
- USE SCREW PIN OR BOLT TYPE TO COLLECT SLINGS.

MAXIMUM INCLUDED ANGLE 120 DEGREES

Crosby HOOKS — DESIGN FACTOR — QUENCHED & TEMPERED

SHANK HOOK
SWIVEL HOOK
EYE HOOK

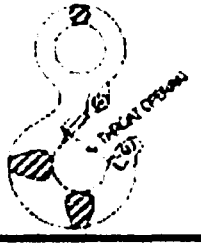
- EYEHOOKS - 5/1 (EXCEPT ALLOY 30 TON AND LARGER ARE 4-1/2 TO 1)
- SHANK AND SWIVELS ARE 4-1/2 TO 1.

QUIC-CHECK

CARBON MAXIMUM WORKING LOAD TONS	CODE	ALLOY MAXIMUM WORKING LOAD TONS	CODE	THROAT OPENING (INCHES)	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

MAXIMUM INCLUDED ANGLE 90 DEGREES



- DO NOT SIDE LOAD
- DO NOT TIP LOAD
- DO NOT BACK LOAD

FOR ADDITIONAL INFORMATION REFER TO THE Crosby PRODUCT WARNINGS

Crosby RIGGING HARDWARE

Crosby LINKS AND RINGS WITH WIRE ROPE AND SYNTHETIC SLINGS 5/1 DESIGN FACTOR

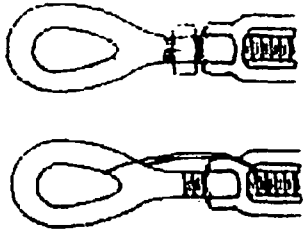
SIZE INCHES	WORKING LOAD LIMIT POUNDS G-341	A-341	A-342
1/2	2900	7000	7000
5/8	4200	9000	9000
3/4	6000	12300	12300
7/8	—	14000	14000
1	10800	24360	24360
1-1/8	N/A	30600	N/A
1-1/4	16750	36000	36000
1-3/8	20500	43000	N/A
1-1/2	—	54300	54300
1-5/8	—	62600	N/A
1-3/4	—	84900	84900
2	—	102600	102600

WORKING LOAD LIMITS ARE FOR USE WITH WIRE ROPE AND SYNTHETIC SLINGS, NOT FOR CHAIN SLINGS. WORKING LOAD LIMITS ARE BASED ON SINGLE LEG (IN-LINE), OR RESULTANT LOAD ON MULTIPLE LEGS WITH AN INCLUDED ANGLE LESS THAN OR EQUAL TO 120 DEGREES.

Crosby TURNBUCKLE

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

THE USE OF LOCKNUTS OR MOUSING IS AN EFFECTIVE METHOD OF PREVENTING TURNBUCKLES FROM ROTATING.



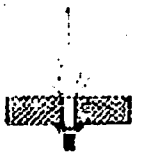
FOR ADDITIONAL INFORMATION REFER TO THE Crosby PRODUCT WARNING

Crosby RIGGING HARDWARE

Crosby SHOULDER EYE BOLTS

QUENCHED& TEMPERED DESIGN FACTOR 5/1

QUIC-CHECK



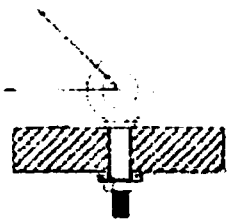
Crosby SWIVEL HOIST RING

DESIGN FACTOR 5/1

SHANK DIAMETER	WORKING LOAD LIMIT IN LINEPULL (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.)	WORKING LOAD LIMIT FULL 180 DEGREE PIVOT (LBS.)	THREAD SHANK SIZE U.N.C.	TORQUE FT - (LBS)
1/4	650	420	195	160	800	5/16	7
5/16	1200	780	360	300	1000	3/8	12
3/8	1550	1000	465	380	2500	1/2	28
1/2	2600	1690	780	650	4000	5/8	60
5/8	5200	3380	1560	1300	7000	3/4	100
3/4	7200	4680	2160	1800	8000	7/8	160
7/8	10600	6890	3180	2650	10000	1	230
1	13300	8645	3990	3325	15000	1-1/4	470
1-1/4	21000	13600	6300	5250	24000	1-1/2	800
1-1/2	24000	15600	7200	6000	30000	2	1100

SHOULDER EYE BOLTS | SWIVEL HOIST RING

- 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.



- 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.

REFER TO THE Crosby GROUP WARNING FOR ADDITIONAL INFORMATION

OPERATING PRACTICES - ANSI B30.9

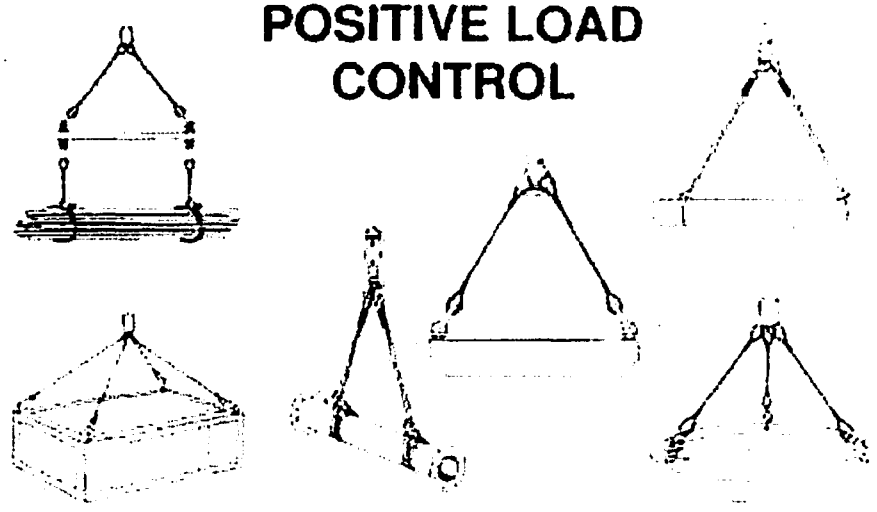
WHENEVER ANY SLING IS USED, THE FOLLOWING PRACTICES SHALL BE OBSERED.

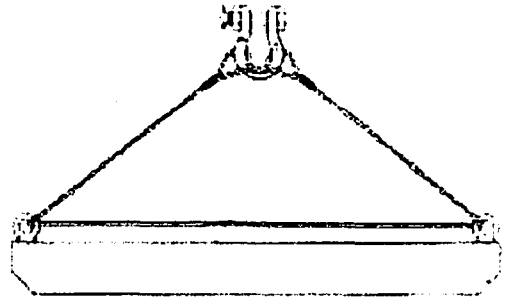
1. SLINGS THAT ARE DAMAGED OR DEFECTIVE SHALL NOT BE USED.
2. SLINGS SHALL NOT BE SHORTENED WITH KNOTS OR BOLTS OR OTHER MAKESHIFT DEVICES.
3. SLING LEGS SHALL NOT BE KINKED.
4. SLINGS SHALL NOT BE LOADED IN EXCESS OF THEIR RATED CAPACITIES.
5. SLINGS USED IN A BASKET HITCH SHALL HAVE THE LOADS BALANCED 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

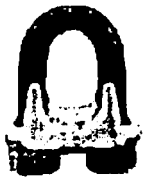




REEVING THROUGH CONNECTIONS TO LOAD INCREASES LOAD ON CONNECTION FITTINGS BY AS MUCH AS TWICE.

DO NOT REEVE!

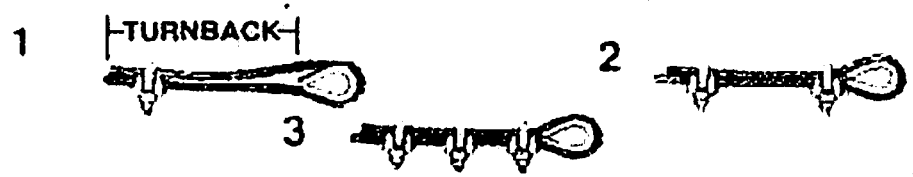
Crosby
WIRE ROPE
CLIPS

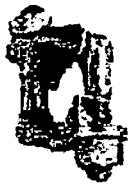


G450
U-Bolt Clip

SIZE	EFFICIENCY	NUMBER OF CLIPS	TURNBACK LENGTH (IN.)	TORQUE FT-LBS.
1/8	80%	2	3-1/4	4.5
3/16	80%	2	3-3/4	7.5
1/4	80%	2	4-3/4	15
5/16	80%	2	5-1/4	30
3/8	80%	2	6-1/2	45
7/16	80%	2	7	65
1/2	80%	3	11 - 12	65
9/16	80%	3	12	95
5/8	80%	3	12	95
3/4	80%	4	18	130
1	80%	5	26	225

APPLY U-BOLT OVER DEAD END OF THE WIRE ROPE. LIVE END OF THE ROPE RESTS IN THE SADDLE. A TERMINATION IS NOT COMPLETE UNTIL IT HAS BEEN RETORQUED A SECOND TIME. NEVER SADDLE A DEAD HORSE!





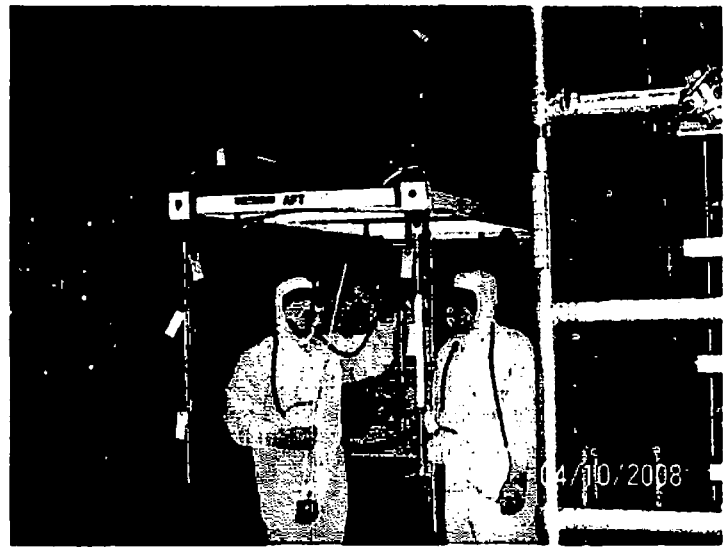
G-429
Fist Grip
Clip

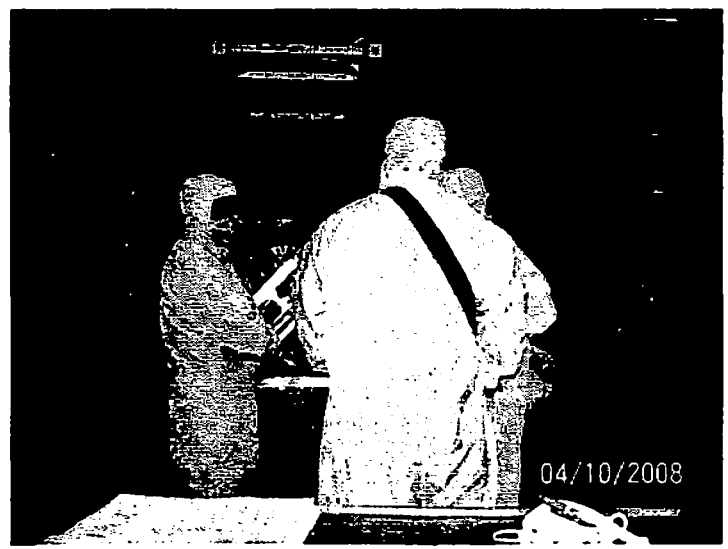
SIZE	NUMBER OF CLIPS	TURNBACK LENGTH (IN.)	TORQUE FT-LBS.
3/16	2	4	30
1/4	2	4	30
5/16	2	5	30
3/8	2	5-1/4	45
7/16	2	6-1/2	65
1/2	3	11	65
9/16	3	12-3/4	130
5/8	3	13-1/2	130
3/4	3	16	225
1	5	37	225

THE NUMBER OF CLIPS SHOWN IS BASED ON USING RRL OR RLL WIRE ROPE, 6X19 OR 6X37 CLASS, FC OR IWRC: IPS OR XIP. IT ALSO APPLIES TO ROTATION RESISTANT RRL WIRE ROPE, 8X19 CLASS, IPS, XIP, SIZES 1-1/2 INCH AND SMALLER, AND TO ROTATION RESISTANT RRL WIRE ROPE, 19X7 CLASS, IPS, XIP, SIZES 1-3/4 INCH AND SMALLER. FOR ELEVATOR, PERSONNEL HOIST, AND SMALLER,FOR ELEVATOR, PERSONNEL HOIST, AND SCAFFOLD APPLICATIONS REFER TO ANSI A17.1 AND ANSI A10.4. THESE STANDARDS DO NOT RECOMMEND THE USE OF U-BOLT STYLE WIRE ROPE CLIPS.

Mishaps & Close Calls – COS Lift

- April 1, 2008: HST COS was being lifted from its handling dolly into RAS/HOMS using SSDIF Crane 29-1 (lower crane). The lift was an "Off Load Operation with Constraint" (OLOC) employing 2 load cells.
- The instruction was given to take the slack out of the sling with the crane in "Micro" mode.
- The load cell readouts went rapidly to read 50 lbs to 500 lb and then to 1060 lb. The target weight was 925 lbs.
- Luckily, no damage occurred, but it was a close call.



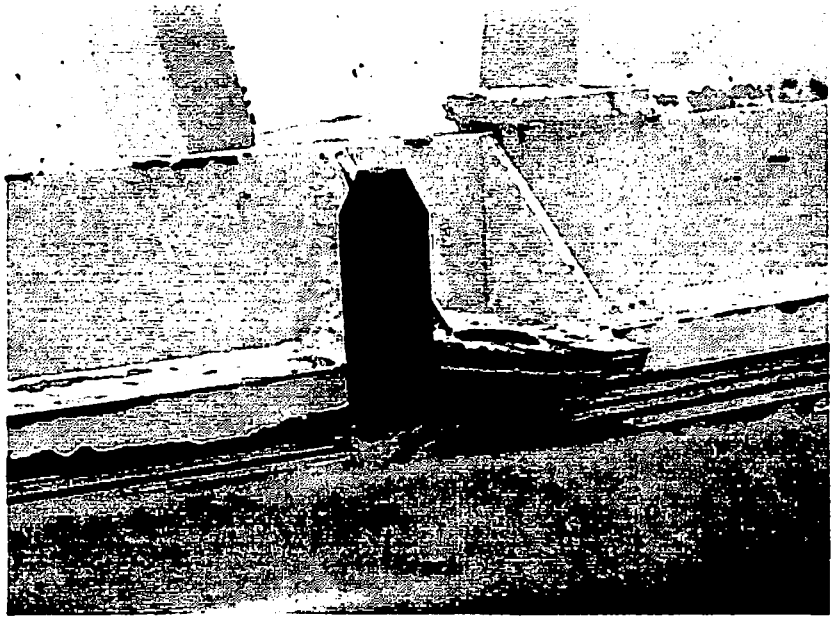


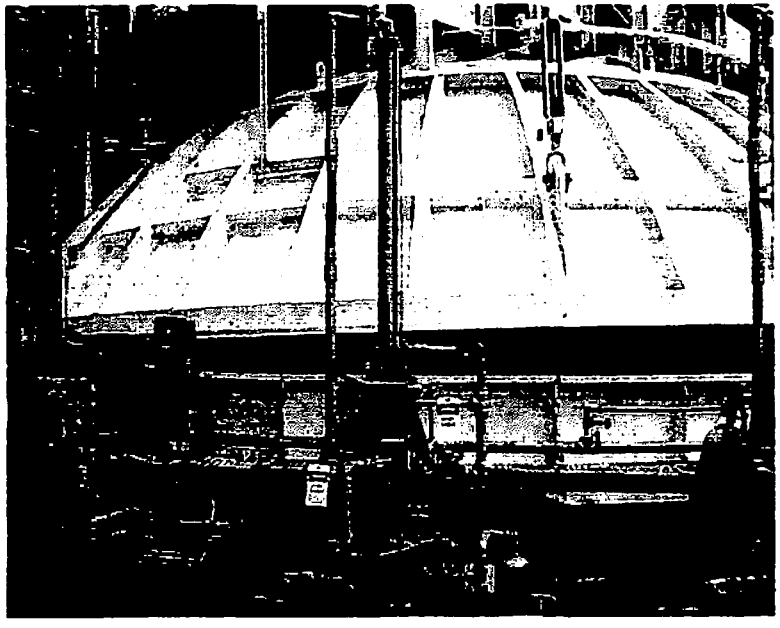
Mishaps & Close Calls – COS Lift

Root Cause	Corrective Actions
•**Proximate Cause:** Due to the lack of compliance in the load line (short length of wire rope in the lift sling, and the relatively light load), even in micro mode the crane operator could not react fast enough to stop the crane before an overload occurred. •**Root Cause:** Insufficient controls in place to prevent an overload situation under all conditions.	1. **Interim Measure:** Recert Manager ordered all GSFC crane operators not to perform "Off Load Operations with Constraints (OLOCs)" (GPR 8834.1A) without using a hydroset. Using a hydroset for the lift greatly increases the time required to apply the load thereby giving the operators time to evaluate the amount of load applied and stop prior to an overload. 2. **Investigation Team Conclusion:** Load can be controlled with precision even with very stiff system compliance only when crane is in "creep" mode **(0.75"/minute).** 3. **Pending GPR 8834.1 Change:** Unless the available constant crane speed is less than 0.75"/minute* (hereafter called creep), a hydra set must be used for an OLOC.

Building 32 Crane Incident Executive Summary

- East and west 50 ton cranes were being used to lower Building 32 Chamber B lid in to place on September 5
- East crane failed to hold the 70K lbs load as the lid was being positioned for final placement
  - Crane was commanded "up" and load slowly descended (eddy current brake)
- East edge of lid settled on chamber wall from a height of about 18"





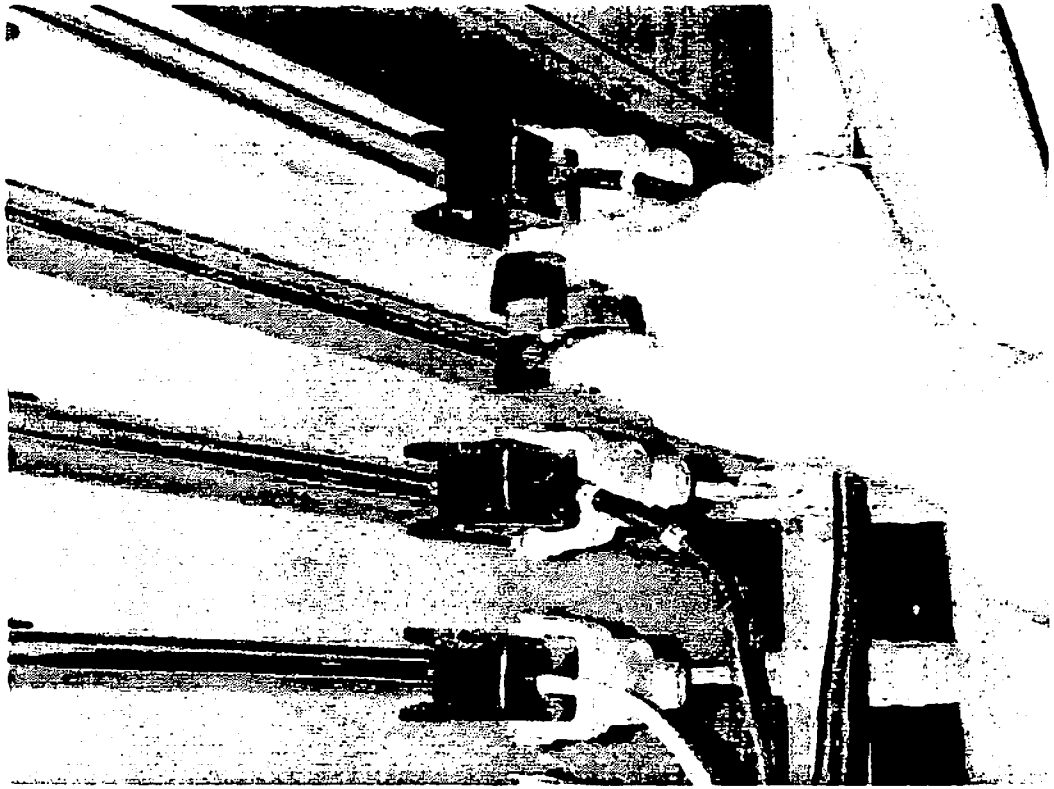
JSC-NS / S. Nakamura (281) 483-4345

Building 32 Crane Incident (con't)

- Cause of failure determined to be **gouged section of insulation** on power rail at a section joint which caused the **electrical shoe to bind and derail resulting in a loss of one phase of electrical power to the hoist motor**
  - Confirmed with field test of crane on October 15 that replicated the incident
  - Crane would not hold the test load without full power to the hoist motor
  - When "up" button is depressed, "brake releases" and then "up" motor activates – with "up" motor electrical power failed, load descended in "power off slow mode"
  - Had operator let go of the "up" button, the crane would have stopped in place (full power loss emergency stop)
- Corrective action plan developed based on recommendations from the investigation team

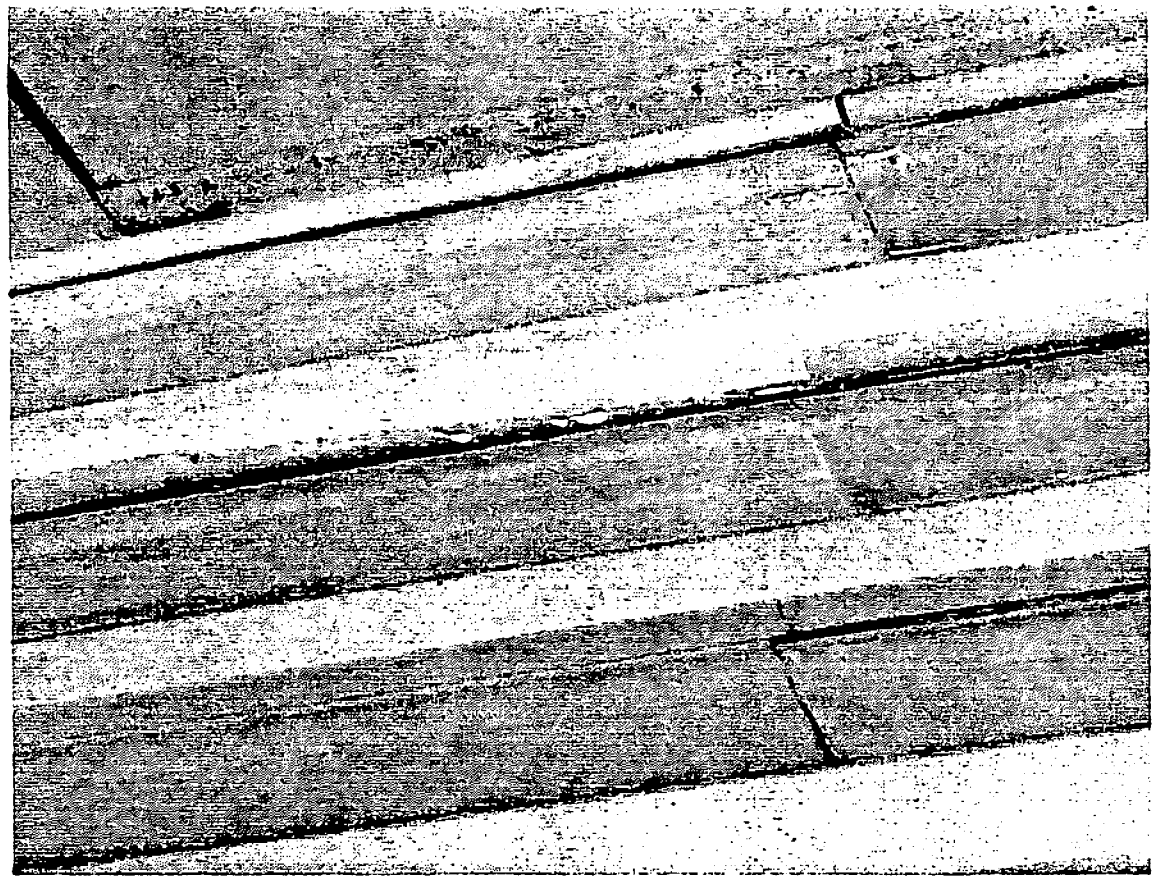
Investigation

- Derailed shoe > Lost 1 of 3 AC power phases to hoist motor



Crane Inspection

- Damaged electrical connector rails



Crane Inspection

- Damaged electrical connector rails
- Derailed shoe occurred again
- Stiff shoe wiring
- Misaligned shoe bracket

NSI-IR-17-004

Mechanical Systems Center
INCIDENT REPORT

Date:	Time:	Location:
2/13/01	0900	SSDIF Cleanroom

Personnel Involved:

Name	Affiliation	Injury
Andy Kneale	ManTech	None
Melonie Scofield	ManTech	None

Equipment Involved/Resulting Damage:

Upper bridge crane impacted a light diffuser.

Narrative:

The ManTech crane operator was checking the crane limit switches prior to start of the day operation. While trolleying to the east the crane bridge handrails impacted the ceiling light diffuser, which had come loose, hanging down. When the crane hit the diffuser, glass showered personnel and equipment on and near the VEST and surrounding area. Operations were secured and a plan for cleanup was determined and agreed to by HST.

Corrective Action is/will be taken: ☐ Closed Out ☒ Follow-up Memo Required

After cleanup each light fixture will be inspected to verify they are secure. Additional securing devices will be designed and installed.

Distribution:

Chief, Mechanical Systems Center/540
Associate Chief, Mechanical Systems Center/540
Assistant Chief for Operations, Mechanical Systems Center/540
Safety and Environmental Branch/205.2
Chairperson, Safety Committee/540
Branch/NSI Function
All 540 Section Supervisors
Project Management/Safety (if applicable)

Eye Witness
Larry Ghtsihet, HST QA

Originator
Original Signature M. Scofield, M. Yachmetz, S. Wojnar on File
M. Scofield
Senior Administrator
Safety & Health Dept.

NSI-IR-17-008

Mechanical Systems Center
INCIDENT REPORT

Find rewrite Geer

Date:	Time:	Location:
2/21/01	6:30 PM	BLDG 29 / SSDIF

Personnel Involved:

Name	Affiliation	Injury
Keith Brenza	MIC/NSI	None

Equipment Involved/Resulting Damage:

(2) Turnbuckles on a lift sling were slightly bent during the rotation/lift of the NCS radiator

Narrative:

To support the SM-3B crew familiarization schedule, the activity to rotate/lift the radiator panel began around 6:00PM. The panel was horizontal, resting on blocks placed on the floor. To rotate it to vertical, a (4) leg sling is attached to one end of the panel. Initially, only (2) legs of the sling were in tension, progressing to (4) legs in tension as the load moves to vertical. The (2) legs that were not in tension hung up on some fasteners on the panel spreader bar and experienced some side loading, slightly bending the (2) turnbuckles. This was immediately noticed and the panel was lowered back to the floor.

Corrective Action is/will be taken: ☒ Closed Out ☐ Follow-up Memo Required

The lift was completed the following morning (2/22/01) using (4) straps instead of (4) slings/turnbuckles. Straps will be used for this lift from now on. Additionally, engineers and technicians involved with lifts of this type will be surveyed and advised to monitor the lift very closely.

Distribution:

Chief, Mechanical Systems Center/540
Associate Chief, Mechanical Systems Center/540
Assistant Chief for Operations, Mechanical Systems Center/540
Safety and Environmental Branch/205.2
Chairperson, Safety Committee/540
Branch/NSI Function
All 540 Section Supervisors
Project Management/Safety (if applicable)

Eye Witness

Joe Yablonsky

Originator

Wayne Geer
Systems Integration Supervisor

Lesson Info

- **Lesson Number:** 1368
- **Lesson Date:** 29-aug-2002
- **Submitting Organization:** JSC
- **Submitted by:** Ronald A. Montague

Subject/Title/Topic(s):

Implementation and Verification of Lockout/Tagout Procedures

Abstract:

An employee received an electrical injury after coming in contact with an energized electrical circuit while wiring a relocated emergency generator; the employee subsequently died of the injury. The subsequent investigation revealed three central themes involved in the mishap:

1. Implementation and Verification of Lockout / Tagout Procedures (the subject of this lesson),
2. Accurate Drawings of Facility Systems as a Prerequisite to Project Implementation, and
3. Demand and Ensure High-Quality Safety Performance from all Contractors.

Each theme is published as a separate lesson. (A fourth lesson underscores the successful implementation of the preliminary investigation, which was critical to performing a successful, formal mishap investigation.)

Description of Driving Event:

An employee received an electrical injury after coming in contact with an energized electrical circuit while wiring a relocated emergency generator; the employee subsequently died of the injury.

Finding A: Employees must personally verify, prior to starting work on a potentially energized system, that the system is de-energized and their personal lock and tag are in place. Do not take the word of a co-worker or supervisor. If the employee leaves the work site for any reason, re-verify the system is still de-energized before resuming work. The following evidence supports this finding:

1. At the beginning of the day, the foreman improperly checked the voltage at the junction box where the mishap occurred. The improper check was a result of using a painted surface as a ground reference.
2. After this initial check by the foreman, the circuit was not re-checked by any of the electricians working on the generator circuits. All the electricians working at the site assumed the circuits were de-energized.
3. The contractor did not pursue understanding of the circuits or request NASA assistance in identifying circuit breakers that would de-energize circuits.

4. The NASA-delegated safety and quality inspectors on the site throughout the day did not question whether the circuits associated with the generator had been de-energized, locked, and tagged.

Finding B: It is unacceptable to work on any energized system without proper permits and personal protective equipment (PPE). One of the causes of this mishap was a risk-taking decision based on past experience and the perception of a low risk situation. Managers should verify that their employees know and are implementing the applicable safety policies and procedures. The following evidence supports this finding:

1. It is a common practice for some electricians to work on energized circuits without PPE and without the proper permits. Both NASA and the contractor have policies that prohibit work on energized circuits, except for a few circumstances that were not applicable in this case.
2. Although the contractor has adequate policies and procedures, implementation is weak or lacking. For example, LO/TO training for contractor employees consisted of a contractor-provided "Electric" brochure handed out to each employee explaining the company's policy and procedure; the employee was expected to sign in the back of the brochure indicating that the employee had read the booklet.

Lesson(s) Learned:

Lockout/Tagout policies and procedures must be followed and systems verified to be de-energized before beginning work.

Recommendation(s):

1. NASA should implement a rigorous random safety inspection process. NASA should institute Mandatory Safety Inspection Points (MSIP), e.g., prior to work on electrical circuits and other energized systems. NASA should assess the on-site inspection responsibilities and determine if changes are necessary to make the process more robust. If changes are deemed necessary, augmented duties should be clarified to all safety and quality inspectors.
2. NASA should closely evaluate contractor safety and health plans relative to employee training and implementation of policies for equivalence with NASA's Safety and Health Program. Continue to offer NASA in-house safety training as an option.
3. NASA should require Pre-Project Safety Reviews prior to construction start. [This should be more comprehensive than pre-construction meetings with a format analogous to an Operational Readiness Inspection (ORI), Test Readiness Review (TRR), etc.] As a pre-requisite for the pre-project safety review, NASA should strongly consider the need for safety and job hazard analyses to be performed and not allow work to start until these are submitted and reviewed.
4. NASA should require that construction contractors conduct daily planning meetings to review work to be performed during the continuous duty time or shift.

Evidence of Recurrence Control Effectiveness:

Pending

Documents Related to Lesson:

JPG 1700.1, "JSC Safety and Health Handbook," Chapter 8.1, Electrical Safety.

Applicable NASA Enterprise(s):

- Aeronautics & Space Transportation Technology
- Biological and Physical Research
- Earth Science
- Human Exploration & Development of Space
- Space Science

Applicable Crosscutting Process(es):

N/A

Additional Key Phrase(s):

- Energy
- Facilities
- Human Factors
- Human Resources & Education
- Independent Verification and Validation
- Industrial Operations
- Personal Protective Equipment
- Policy & Planning
- Procurement, Small Business & Industrial Relations
- Program and Project Management
- Risk Management/Assessment
- Safety & Mission Assurance
- Test & Verification

Approval Info:

- **Approval Date:** 01-oct-2003
- **Approval Name:** Ron Montague
- **Approval Organization:** JSC
- **Approval Phone Number:** 281-483-8576

Lesson Info

- **Lesson Number:** 1369
- **Lesson Date:** 26-mar-2003
- **Submitting Organization:** JSC
- **Submitted by:** Bill Crittenden

Subject/Title/Topic(s):

Functional Failures of Electrical Circuit Breaker Lock Out / Tag Out (LOTO) Devices

Abstract:

Investigation of a lockout device that did not perform its intended function discovered that the circuit breaker could still be operated even with the device in place.

Description of Driving Event:

While working on a lighting system in a JSC building, it was determined that a circuit breaker that had been properly locked and tag out in the de-energized (open) position, had been repositioned to its energized (closed) position, with the lockout device still installed.

INVESTIGATION FINDINGS: It was determined through experimentation that the breaker lever could be thrown to the energized (closed) position with the lock out device installed. Later investigations of TFE and TED breakers also found that another similar breaker thumb-screwed type lockout device had fallen off after it had been properly installed and locked & tagged out on a breaker.

Lesson(s) Learned:

1. Some electrical TFE and TED circuit breaker lock out devices do not reliably secure the breakers in a "Safe" position.
2. Some electrical TFE and TED circuit breaker lock out devices can not support the weight of a tag and lock for a long duration.
3. Facility personnel may try to close a circuit breaker, even when it is locked and tagged out - even when they know it is an action that could result in severe injuries / disciplinary penalties.

Recommendation(s):

Stress to your personnel who secure and lock and tag out circuit breakers;

1. They must insure that the circuit breaker lock out devices reliably secure the breaker in a "Safe" configuration, and can support the weight of the lock and tag for the duration of the Lock Out Tag Out operation.
2. They must carefully try out the locked and tagged out breaker to ensure that it is really secured in a "Safe" position. This requires that the breaker lever to be physically pushed on in an effort to close the breaker after the device is properly

installed, while no one is exposed to the hazards of the circuit. Some of the breaker lock out devices allowed enough play in the breaker lever, to close or energize the circuit with the lock out device in place.

3. The importance of qualified personnel actually testing the electrical circuit with validated test equipment, to ensure that the circuit has been, and still is in a "Safe" deenergize state before working on it. This must be done initially and upon returning from any absence or break in time when the "Safe" condition of the circuit could have been re-configured. In short - lock out, tag out, try out, and test out the electrical circuits being locked and tagged.

Evidence of Recurrence Control Effectiveness:

Pending

Documents Related to Lesson:

JPG 1700.1, "JSC Health and Safety Handbook", Chapter 8.1, Electrical Safety, & chapter 8.2, Lockout/Tagout Practices

Applicable NASA Enterprise(s):

N/A

Applicable Crosscutting Process(es):

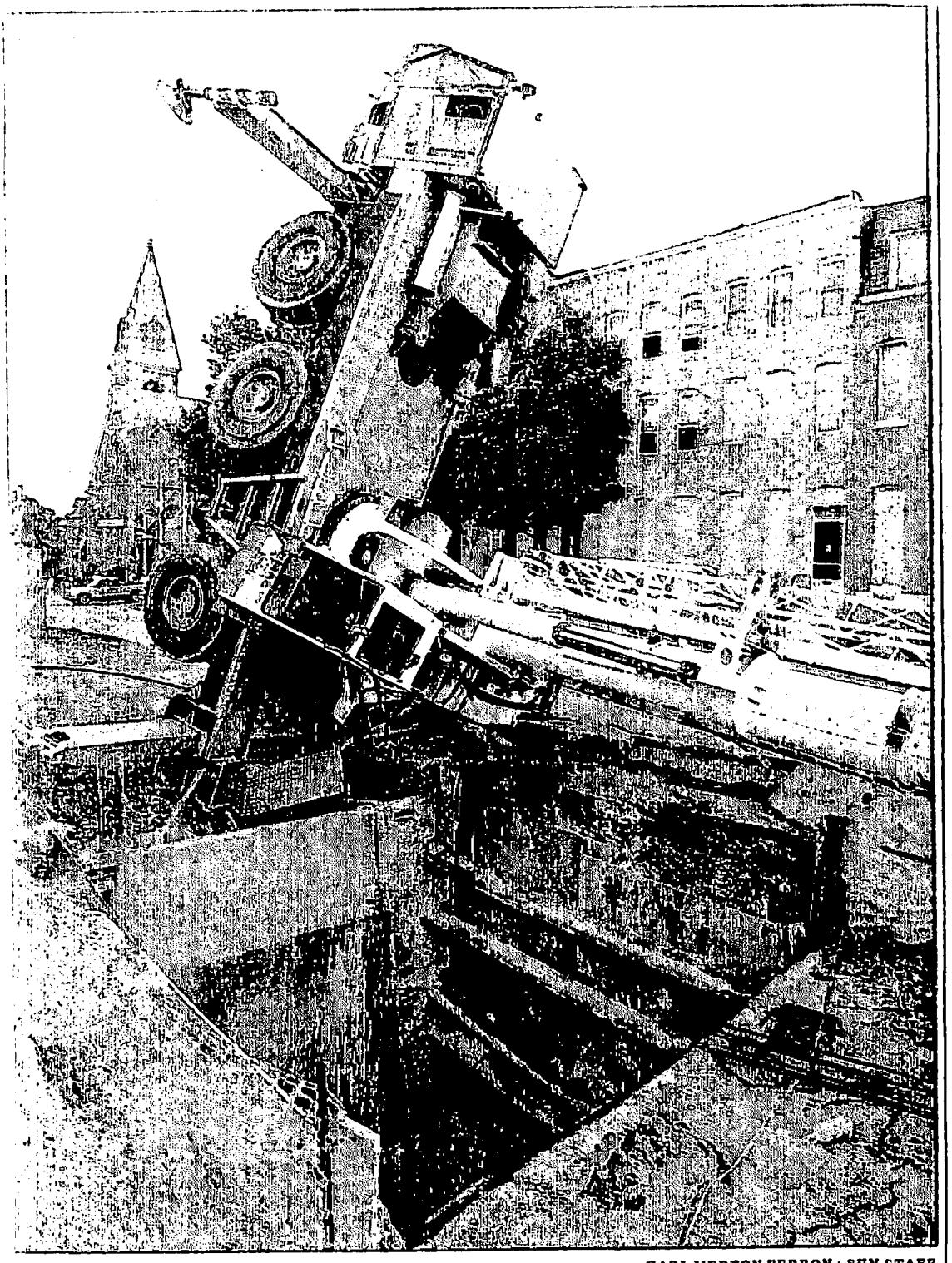
- Manage Strategically
- Provide Aerospace Products & Capabilities: Approval
- Provide Aerospace Products & Capabilities: Implementation

Additional Key Phrase(s):

- Configuration Management
- Energy
- Facilities
- Ground Equipment
- Ground Operations
- Hardware
- Human Factors
- Human Resources & Education
- Industrial Operations
- Personal Protective Equipment
- Policy & Planning
- Risk Management/Assessment
- Safety & Mission Assurance
- Security
- Test & Verification

Approval Info:

- **Approval Date:** 01-oct-2003
- **Approval Name:** Ron Montague
- **Approval Organization:** JSC
- **Approval Phone Number:** 281-483-8576



KARL MERTON FERRON : SUN STAFF

Crane upends on Broadway

The operator of this 60-ton crane escaped injury when the rig toppled during construction work on North Broadway in the city. The accident occurred about 4 p.m. yesterday when ground under the crane gave way as it was lifting a 42,000-pound block of concrete during the installation of sewer lines, and the $850,000 machine fell into a hole.

FROM THE BALTIMORE SUN · TUES. AUG. 5, 2003

A HUMAN TRAGEDY

FOCUS... CRANE TWO-BLOCKING HAZARD

A detailed analysis and viewpoint on the hazard of two-blocking on cranes for those who own, rent oversee their use, or plan to purchase a crane.

A Case in Point:

Two-blocking occurrence wrecked worker's life!

In August 1990, Luis was being raised in a makeshift aerial platform, a 55 gallon drum suspended by two cable straps without any overhead protection to resume painting of a pipeline compressor building. A hydraulic, self-propelled, 18-ton capacity, rough terrain crane was use for the lift. To paint the eaves of the building, Luis asked to be raised slightly and moved in an easterly direction, causing the boom to be extended. As this was being done, he heard a scraping sound, and then the drum he was riding fell to the ground below. Luis was immediately struck on the head and shoulders by the falling hook and block and lost consciousness.

Fifteen days later, Luis awoke from his coma in a hospital bed where he stayed until April 1991. During his hospitalization, he underwent surgery to fuse his neck and back and spent 90 days immobilized in a traction brace with a halo to support his neck, chest and back. During this time he was placed on a respirator and fed intravenously. When finally released from the hospital, Luis was a permanent quadriplegic confined to a wheelchair and required to wear special splints on his hands and feet along with medical stockings to prevent blood clots. Having lost his motor function in his limbs, he was given a "universal cuff" device so he could feed himself. Normal bodily functions are possible only with a permanently installed catheter. He must rely on his wife for constant 24-hour care, as well as daily three-hour visits from a nurse.

The employer was cited for the following OSHA violations:

1. Use of a crane without an anti-two-blocking device when hoisting personnel; 29CFR 1926.550(g)(3)(ii)(c).
2. Use of a 55-gallon drum bucket suspended from the load block by two wire rope slings, rather than a personnel platform and suspension system designed by a qualified engineer or qualified person competent in structural design; 29 CFR 1926 .550 (g)(4)(i)(A).
3. Use of personnel platform which was not conspicuously and permanently marked to show the weight and rated capacity or a maximum intended load; 29 CFR 1926.550(g)(4)(ii)(I)
4. Use of a crane without a boom angle indicator; 29 CFR 1926.550(g)(3)(ii)(A).
5. Use of a crane without a boom length indicator; 29 CFR 1926.550 (g)(3)(ii)(B).
6. Use of a load hook with a broken safety latch; 29 CFR 1926.550(g)(4)(iv)(B).
7. No pre-lift plan or meeting for the crane operator, signal person and personnel to be lifted, to review procedures to be followed; 29 CFR 1926.550(g)(8).

Continued on page 3

TWO -BLOCKING

DEFINITION

The Dictionary of Terms Used in the Safety Profession, Third Edition, American Society of Safety Engineers (ASSE) 1988, defines two-blocking as: "In crane operation, the condition in which the lower load block (or hook assembly) contacts the upper load block (or boom point sheave assembly), seriously interfering with safe operation of the crane. When two-blocking occurs life threatening forces can be applied to the hoist or hook arrangement, either breaking the hoist cable or disengaging the load straps from the hook, causing the load hook to fall or lose the load, and imperiling the lives of those working or standing directly below."

Continued from Page 2

8. No trial lift made from the ground level using the unoccupied personnel platform with the anticipated weight to be lifted immediately before placing personnel on the platform; 29 CFR 1926.550(g)(5)(i).

In New York, Texas and some other states, employers who are normally protected from liability by workers compensation can be named as third-party defendants in lawsuits if it is apparent that the employer was negligent. In Luis' case he was able to sue both his employer and the supplier of the crane for the following reasons: (1) the crane could suddenly, unpredictably, and without warning "two-block" (2) it did not have a safety device to extend the hoist cable automatically while extending the boom;(3) and it did not have either an audible or visual signal to warn the operator of impending two-blocking. He was also able to show that the personnel platform did not provide any protection from falling objects.

The consequences of two-blocking were devastating to all parties involved:

- Luis' loss of a normal life
- the OSHA fines
- the compensation expense
- the employer's embarrassment over local news and TV coverage
- the crane owner's and the manufacturer's monetary loss for not providing an anti-two-block device.

The cost of preventing this hazard would have been minuscule when compared to the physical and monetary catastrophe that resulted.

WHAT ARE THE CHANCES OF INJURY OR DEATH?

Death or crippling injury often result when a line two-blocks. If the load line breaks, and it happens to be supporting a worker on a personnel platform, several workers on a floating scaffold, or a load above people, a tragedy can result. Over the years, there have probably been thousands of two-blocking occurrences resulting in a broken hoist cable, with most of them going unrecorded because no one, luckily, was injured when the hook or load dropped.

WHY TWO-BLOCKING KEEPS OCCURRING

Both latticework and hydraulic boom cranes are prone to two-blocking.

On latticework booms, the following stresses in combination can break the hoist cable:

- the weight of the load
- the weight of the headache ball and rigging
- the tension caused by the hoist drum
- the weight of the boom when pendant guys go slack
- whip caused by a long latticework boom

On hydraulic boom cranes, the power of the hydraulic rams that extend the boom are often sufficient to break the hoist cable if the line two-blocks. Both crane types will two-block when the hook is near the tip and the boom is lowered. An operator can forget to release or pay out the load line when extending the boom and the hoist cable can be broken.

A crane equipped with a job or a flyline on the boom is even **more** prone to two-blocking, since the operator must watch two separate hooks in addition to the signaler and the load. An operator can easily be unaware of a two-blocking situation that may be occurring on the line not being used. Human factors' logic tells us that when an operator must use two controls, one for hoist cable and one for the hydraulic boom extension, the chance of error is increased. With a second hook to watch, the operator is clearly over-tasked.

HOW TWO-BLOCKING CAN BE PREVENTED

By using a crane equipped with a functioning anti-two-blocking device, two blocking can be prevented! Anti-two-blocking devices have been available for years, but their acceptance and use, as a preventative measure has been painfully slow. There are several ways to avoid two-blocking:

Continued on Page 4

MINING DIVISION
LONG RANGE PLAN SUMMARY

The Mining Division becomes the newest division to the Society. The goals and visions of this newest division are consistent with the goals and objectives of the 1995 Board of Directors and Assembly approved Vision Statement of the Society: **To provide national leadership of the safety profession.** The Mining Division will do just that and more by promoting the safety profession nationally. The Mining Division will enhance the professional development of its members through an exchange of national safety technology, research, and management processes. This network will enhance the Mining Division by creating a network for similar-minded safety professionals. This will provide the Society with a national resource on matters of importance to the mining profession.

The proposed division's strengths include growth potential through restructure process. Professional development involvement and quality sessions, and to become the global safety and health resource to mining safety professional worldwide. This development of the Mining Division will be accomplished through various initiatives including the following:

- Planning and Development
- Organization and Development
- Financial Stability
- Professional Development
- Internal Communication
- External Communication
- Technical Resources
- Membership Growth/Division Development
- Professional Recognition

Initially the Mining Division will be led by Mr. Robert N. Cooke who will serve as its first Administrator. Mr. Cooke may reached at the following addresses:

Robert N. Cooke, CSP, MBA
Robert Cooke Enterprises, Inc.
President
P.O. Box 1090
Brookfield, WI 53005
(414)790-9973
(414)790-9974 - fax
RNCooke@aol.com

ADMINISTRATOR'S COMMENTS

Continued from Page 1

Environment will be held in Seattle, WA., June 14-17, 1998. The American Society of Safety Engineers and The Canadian Society of Safety Engineering (CSSE) will sponsor the first ever joint Professional Development Conference and Exposition. The conference will be an internationally centered program featuring over 60 educational sessions. I hope to see many Construction Division members at the PDC and other related division functions.

A HUMAN TRAGEDY

Continued from Page 3

1. ***An electrical sensing device.*** A weighted ring around the hoist cable can be suspended on a chain from a limit switch attached to the boom tip. When the hoist block or headache ball touches the ring, the limit switch closes and an alarm warns the operator. It can be wired to intercede and stop the hoisting. The circuitry of an anti-two-blocking device is no more complex than an electric doorbell.

2. ***The sequencing of the hydraulic valve system on hydraulic cranes.*** The hydraulic valving can be sequenced to pay out the hoist cable automatically while the boom is being extended.

3. **Sufficient boom length.** When making a lift, sufficient boom length is necessary to accommodate both the boom angle and adequate space for rigging, such as slings, spreader bars, and straps. To avoid bringing the hook and headache ball into contact with the boom tip, a boom length of 150 percent of the height of the intended lift is required for a boom angle of 45 degrees or more.

ANTI-TWO-BLOCKING DEVICES SHOULD BE INSTALLED ON ALL CRANES.

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David V. MacCollum, P.E.,CSP, Editor in Chief

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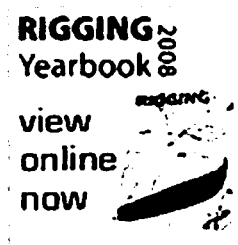

News

Crane rider falls to death

22 February 2006

A man who climbed a bridge crane with the intention to ride it fell to his death in January.

In the early morning of New Year's Day, 1 January, Eric Passon and another man entered the Giddings & Lewis Machine Tools plant in Fond du Lac, Wisconsin, USA and climbed the ladder of an overhead crane, according to police reports.

Passon fell from the 50 ft (15m)-high bridge at about 3 am.

Neither man was an employee of the company.

Authorities believe that alcohol was a factor in the incident, according to a report in local newspaper the Fond du Lac Reporter.

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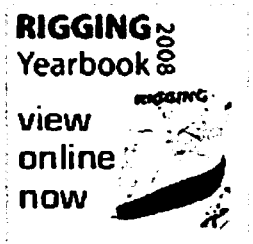

News

More information following crane death

17 October 2007

More information has been revealed by WorkSafe following the death of a man in the yard of D&G Hoist & Crane Hire, Malaga, Perth, Australia.

An initial report in the Perth *Sunday Times* said a 22-year-old Leeming-based man received fatal injuries after becoming trapped under heavy construction equipment at the Mulgul Road worksite.

WorkSafe has since told *Hoist*: "The crane and hoist hire company at which the incident took place received crane parts and assembled the finished cranes at the site, and the deceased man was engaged in this process."

Caroline De Vaney, WorkSafe media liaison officer, added: "A section of tower crane was being raised and it dislodged and struck the man on the head as it fell."

WorkSafe inspectors travelled to the site as soon as notification was recieved and began their investigation, which will involve interviewing witnesses, looking at the machinery involved and assessing the work practices at the site.

The suggested time frame for completion of a fatality investigation is 12 weeks, some take less, some more. When the investigation is complete, a report will be compiled which will go through a legal process which determines whether any prosecution will take place.

D&G Hoist & Crane Hire is yet to respond to *Hoist*'s

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Authorities to investigate overhead crane death

12 November 2008

Authorities are investigating how a Calumet City man was crushed to death at work at a Chicago Heights steel company, according to *southtownstar.com*.

Heladio Ramirez, 32, had been operating a radio-controlled overhead crane that bundled and loaded steel when a cable snapped, the report said.

It is believed a block and spreader - heavy equipment used to move bundles of steel - fell, hitting Ramirez about 25 feet below. The items hit Ramirez in the leg, bounced on the cement floor and struck him in the face, shattering his hard hat, police said.

The Occupational Safety and Health Administration (OSHA) has been notified of the incident.

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SAFETY

Breaking the taboo

06 November 2008

Are US steel mills doing enough to keep their workers, including overhead crane operators and employees who work near overhead cranes, safe? Myra Pinkham reports.

Questions have been raised over the safety of crane operations at US?steel mills, after what seems to be an increased number of fatal and non-fatal accidents in the US steel industry, some of which have involved overhead cranes.

Just in the first half of this year, according to The Wall Street Journal, a total of 15 US workers died in steel mill accidents. Not all of these involved cranes, but some did. This seems to be quite high given that in all of 2006 (the last year for which US government statistics are available), 14 workers were killed in iron and steel mills, up from eight in 2005, nine in 2004 and eight in 2003.

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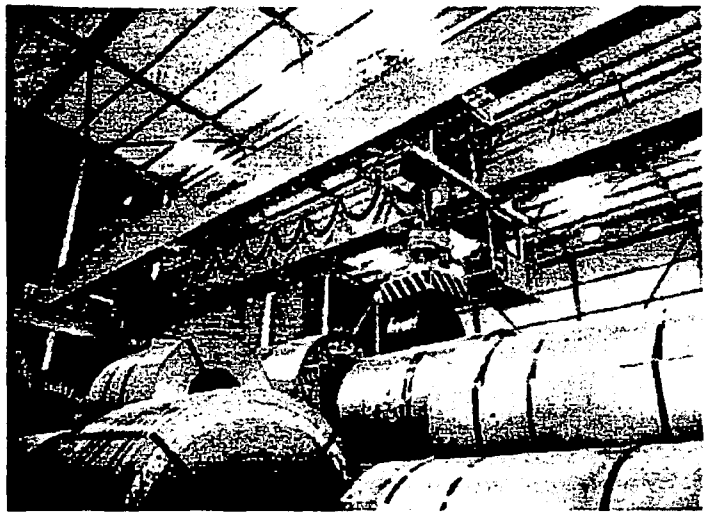
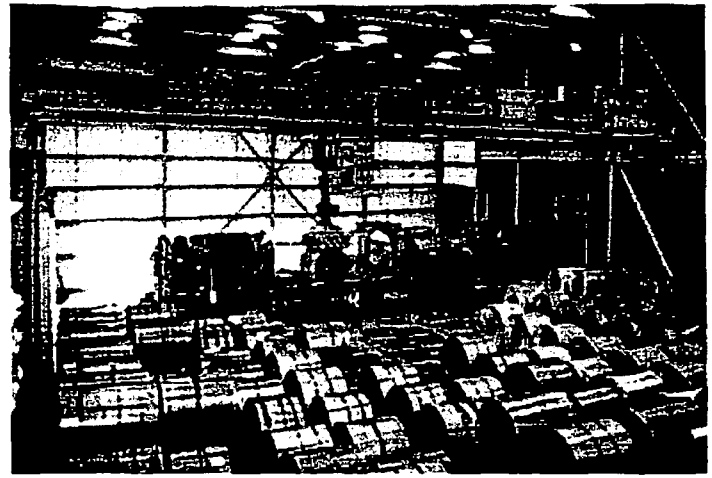


While this seems to be a large number of incidents involving overhead cranes at steel mills, Earl W Hicks, a spokesperson for the US Occupational Safety & Health Administration (OSHA) says it does not appear that there has been a major spike in the frequency of these accidents.

"It is impossible to say if the amount of crane related steel accidents has increased or decreased," says Michael Wright, head of health, safety and environment for the United Steelworkers of America (USW) labour union. "There aren't good enough statistics other than for fatalities. Also the numbers are too small to draw a statistical conclusion. But any accident and especially every fatality is a tragedy. We don't care if they increased or decreased. It doesn't matter to family members who lost a loved one if there are others as well. We aren't satisfied until no one has died or was seriously injured on the job," Wright adds.

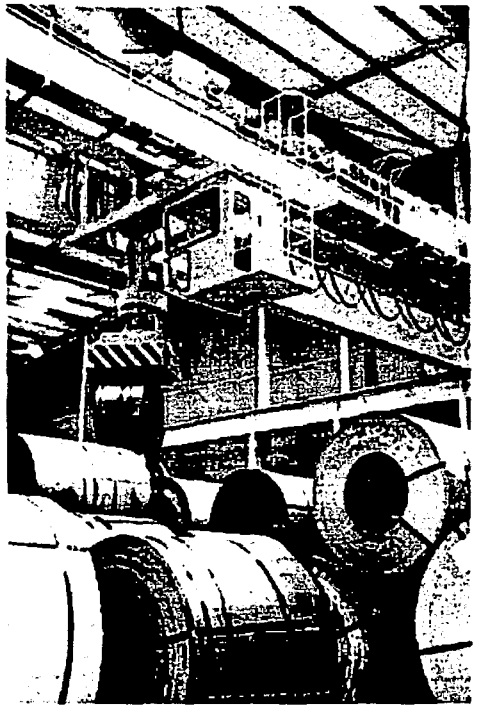
That is also what steelmakers are trying to achieve, says Katie Patterson, a spokesperson for Chicago-based ArcelorMittal USA. She says "ArcelorMittal's greatest responsibility and priority is ensuring the health and safety of our employees on a daily basis. While we are the largest and fastest growing steel company in the world, if we are to realise our true potential we must also be recognised as one of the safest steel companies in the world."



She says the company's commitment to health and safety was recently strengthened through its agreements with the USW, the International Metal Workers Federation and the European Metalworkers Federation to establish joint health and safety committees in all of its facilities worldwide.

ArcelorMittal USA, Patterson continues, "are undertaking new initiatives to provide our employees with the necessary tools and training to improve work planning and on-the-job hazard assessment and control of hazards to provide every employee with a full understanding of how to best prevent serious injury and accidents while on the job," she says.

Wright says "Steel mill workers do get very extensive training on operating, rigging and preparing cranes. The USW and the steel mills try to make sure they are as comprehensive as possible."



"There are certainly optional training programs available to the end-user community from us, other crane manufacturers and elsewhere," says Gene Buer, executive director of hoist products for Columbus McKinnon Corp., Amherst, New York. "We are seeing substantial demand for training programs for crane and hoist safety and operating procedures. It is available and more and more end users are taking advantage of the training being offered," he adds.

"OSHA is always seeking to engage employers and employees in cooperative efforts, such as partnerships and alliances to promote their special safety needs and to provide training," says Hicks.

Meanwhile, the USW has been pushing for mills to be audited periodically for all of the factors involved with crane operation, says Wright. "They need to be periodically monitored to see what can go wrong. There are a number of potential problems that could be identified in advance. A lot of things that could be hazardous conditions can be identified in a periodic audit," he maintains.

Wright says: "Primarily it would help to alleviate certain unsafe conditions as well as certain unsafe acts of operators. Sometimes something is wrong with the crane or people work too close to the cranes. These are sometimes things that a comprehensive safety audit would have identified."

He is a big supporter of crane training, including training "that does not just tell workers what the rules are, but why those rules are in place. Workers need to have a deep understanding of the rules and procedures in place, as well as the fact that they have the right to remove themselves from a dangerous situation," even when being pushed by management to be in that situation.

Looking into the future, the overhead crane industry should follow in the footsteps of the tower and mobile crane industry and push for certification of crane operators, riggers and signal persons, says Graham Brent, executive director of the Fairfax, Virginia-based National Commission for the Certification of Crane Operators (NCCCO). Already, Brent says there are certain states that require that

construction crane operators be certified.

"While certification of crane operators is not a cure all, it could go a long way in mitigating risk," he says, adding: "There has been evidence in the mobile crane industry that there has been a dramatic decrease in accidents and near misses over a sustained period of time largely due to crane operator training and certification." One example, he says, is California where there has been an 80% drop in crane fatalities and a 50% drop in injuries due to a mandatory program for certification of mobile crane operators there.

There are voluntary certification programs for overhead crane operators, Brent says, but there has been a slow acceptance curve. He says his group does not yet offer certification programme?s for overhead crane riggers and signal persons, although it does for those involved with tower and mobile cranes. "It depends on the response of that industry whether we expand it to overhead cranes."

Hicks says the OSHA could make no predictions about the number of accidents related to overhead cranes in the future, but "the agency remains hopeful that, with increased attention paid to these hazards and the sources of help available, including training, outreach and cooperative efforts, fewer accidents will occur."

Steel mill accidents involving overhead cranes

- July 2007: a worker at Nucor Steel Corp.'s Marion, Ohio, facility was killed after being yanked into a crane. He had been suspended in a harness 30-40ft above the ground while working on the mill's air conditioning system. The harness reportedly became tangled in the crane's shaft causing the man to be pulled into the crane.

- February 2008: an AK Steel Corp. Coshocton, Ohio, worker, David Wemtz, was killed while performing maintenance work. He was crushed by a steel coil that was being lowered by an overhead crane.

- March 2008: a worker at the Montpelier, Iowa, plate mill of Ipsco Inc. (now known as SSAB North American Division) was killed when he fell approximately 100ft from a crane.

- March 2008: a Keystone Steel & Wire Co. worker, Edward

Schimmelpfennig, died when the crane he was operating tipped over. He had been either loading or unloading steel from a flat bed truck crane flipped.

- March 2008: a crane operator, Jason Lee Blackmon, fell 40ft to his death at Gerdau Ameristeel Corp.'s Jackson, Tennessee, facility. Reportedly he had been on a platform about to board the crane during a shift change when the the crane failed to come to a complete stop, as it is required to do when a worker boards the crane.

- May 2008: Russell Payne, a millwright at ArcelorMittal USA's Burns Harbor, Indiana, facility died when he was caught between two steel beams and crushed. The crane caught one beam and dragged it to another. Reportedly the crane operator had thought that Payne had moved out of the area, and attempted to put the crane back in place via remote control.

- June 2008: a crane collapsed during a storm at OAO Severstal's Sparrows Point, Maryland, steel mill. Two men working on the crane were stuck 50-70ft above the ground when it collapsed, but they escaped uninjured.

A viewpoint from Europe

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Firm guilty after overhead crane death

23 April 2008

A Liverpool, UK-based company has been fined £100,000 and ordered to pay £16,941 in costs after a man was killed and another seriously injured when they were struck by a load that fell from an overhead crane.

The UK's Health and Safety Executive (HSE) has warned of the dangers of allowing cranes to operate over the heads of employees.

MRX Engineering Support Services Ltd., trading as Stackright Building Systems of Charleywood Road, Kirby, was fined at Liverpool Crown Court of breaching S 2(1) of the Health and Safety at Work etc Act 1974 in that it failed to ensure the safety of its employees. The company pleaded guilty at an earlier hearing at Knowsley Magistrates Court.

Welder Keith Wharton, aged 41, from Kirby was killed instantly and his colleague Christopher Cansfield, 31, from Bootle sustained severe injuries including a broken neck and leg in the incident on March 8 2007.

HSE inspector Iain Evans, who investigated the incident, said: "Keith Wharton should not have died. His was an avoidable, pointless and unnecessary death in an environment where there were numerous safety issues. If the company which employed him had dutifully exercised its responsibility to ensure their safety, his family would not be here at court today grieving their loss."

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He added: "There is a very clear responsibility on employers and managers to safeguard their workers. There is plenty of advice and guidance within industry and from the HSE on how to comply with the law. The failure to do so in this instance cost one man his life, and seriously injured his colleague."

The court heard that the Mr Wharton was killed and Mr Cansfield seriously injured when a steel lifting frame weighing more than half a ton fell from an overhead crane. There was no safety catch on the hook of the crane, which could have prevented the load from falling. The company should not have allowed loads to be moved over people's heads and the crane operators had not been adequately trained in its safe use.

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