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WASHINGTON, D.C.

MOBILE HYDRAULIC CRANE STANDARDS

PCSA STANDARD NO. 2

DEVELOPED AND COMPILED BY

PCSA

A Bureau of Construction Industry Manufacturers Association

Marine Plaza — Suite 1700

111 E. Wisconsin Avenue

Milwaukee, Wisconsin 53202

The Power Crane and Shovel Association, formed in 1943 by United States manufacturers of power cranes and shovels, is one of the oldest and most respected manufacturer groups in the Construction Industry.

In 1962, the decision was made to operate under the sponsorship of the Construction Industry Manufacturers Association. The companies which made up the Power Crane and Shovel Association already were members of CIMA and this move resulted in closer contact with other segments of the Construction Industry. It also resulted in greater economy of operation without diminishing the benefits to its members.

PCSA has become recognized as the spokesman for the Industry in domestic and overseas activities and liaison with the Federal Government. Foremost among its activities has been the promotion of members' products on an overall Industry basis. Related to this has been the establishment and updating of Industry standards in keeping with the advances of technology in newer materials and methods to give the manufacturer, the owner and the operator meaningful guidelines.

The publishing of Technical Bulletins and Manuals is an important function of the Association. Not only have these been well received by those directly connected with the Industry, but colleges and universities in this country and abroad have found them very desirable as technical reference books for classes being conducted in engineering studies. Many have been published in foreign languages.

This Publication which is one of a series, is an example of how the members of the Power Crane and Shovel Association have combined their efforts in a worthwhile project.

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FOREWORD

These standards and recommendations are developed by the Standards Committee of the Power Crane and Shovel Association, a bureau of the Construction Industry Manufacturers Association. They are intended to encompass only mobile hydraulic cranes described in the SCOPE.

The purpose of this manual is to present a coordinated set of standards and recommendations which can serve as a guide to manufacturers of the equipment, users, regulatory authorities, and code writing agencies.

Particular emphasis is placed on the latest recommended practices of the industry, to encourage proper construction, use, and application of mobile power cranes and excavators. Where applicable, reference to other technical standards and recommended practices are included. Acknowledgement for use of these is made to the following:

Society of Automotive Engineers, Inc.
Construction and Industrial Machinery Technical Committee
Two Pennsylvania Plaza
New York, New York 10001

USA Standards Committee B30
The American Society of Mechanical Engineers
United Engineering Center
345 East 47th Street
New York, New York 10017

USASI Standards Committee B93
Fluid Power Systems and Components
P.O. Box 49
Thiensville, Wis. 53092

Construction Industry Manufacturers Association
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Technical Committee,
PCSA

CONTENTS

SECTION 1
PURPOSE

1.01 This Standard is designed to serve the following purposes:

(1) To establish uniform methods and procedures for the guidance of manufacturers, distributors and users in specifying mobile hydraulic cranes and in presenting data concerning them.

(2) To serve as a basis for common understanding, between buyers and sellers, in determining the capabilities and characteristics of machines and in conducting trade negotiations.

(3) To promote fair competition.

(4) To re-affirm generally recognized and accepted rules of good safety practice in design, construction, maintenance, application and operation of the types of equipment covered herein.

(5) To provide means for identification and certification of products which meet the requirements of this Standard.

SECTION 2
SCOPE

2.01 TYPES AND SIZES

This standard applies to mobile hydraulic cranes of the full revolving type, which may or may not be convertible, that use hydraulic power to operate basic functions and, or front end operating equipment. They may be crawler mounted or rubber tire carrier mounted. Front end operating equipment may be for lift crane, clamshell, magnet, dragline and pile driver, as herein described, or any adaptations of the same which retain the basic characteristics.

2.02 UNIFORM SPECIFICATION DATA

The standard provides illustrations, tables, and lists of items which establish the scope and arrangement of important specification requirements and dimensions. The uniform presentation in manufacturer's literature of data on the major operating components makes possible convenient and comprehensive comparisons of the characteristics of the machines. Nomenclature and definitions are included, together with a glossary, to aid in the interpretation of terms used in the trade.

2.03 REQUIREMENTS

The requirements cover features of construction, operation, control, stability, rating and safety. The following requirements which need particular attention in complying with this standard are printed in ***boldface*** type where they occur:

(1) Requirements which apply to design, construction, performance and safety of the equipment.

(2) Requirements which apply to information that the manufacturer shall furnish on request, if it is not included with his current printed specifications and sales literature.

Figure 1. Label adopted by the Power Crane and Shovel Association.

2.04 COMPLIANCE

Methods of certification and labeling as evidence of full compliance with provisions of ***"P.C.S.A. standard no. 2"*** are provided. A label used in the industry is illustrated in Figure 1.

Manufacturers that comply with ***"P.C.S.A. standard No. 2,"*** may so indicate on their products and literature.

Although certification and labeling are intended only for machines which do fully comply, it is recognized that new developments and practices may comply with the spirit although not the letter of this standard. In such cases, compliance certification and labeling are permissible when deviations are clearly stipulated in specifications or contracts and, where applicable, are shown on capacity plates or other signs on the machine.

SECTION 3

BASIC COMPONENTS OF MACHINES

3.01 BASIC OPERATING COMPONENTS
The machines covered in this standard, when equipped for work, consist of four main operating components; (1) revolving superstructure, (2) mobile base mounting, (3) power plant, (4) front end operating equipment, as follows:

3.01.1 Revolving Superstructure — The revolving superstructure includes the rotating frame, and components mounted thereon, common to all functional operations as described in paragraphs 4.01 through 4.08.

3.01.2 Mobile Base Mounting — The mounting is the base for the revolving superstructure. It provides mobility for the machine while in operation, and while moving from job to job. Two types are covered herein; (1) crawler mounting (paragraphs 5.01 through 5.07), and (2) rubber tire carrier mounting (paragraphs 5.08 through 5.20.2). See also paragraphs 5.21 and 5.22 for outriggers.

3.01.3 Power Plant — The power plant (or plants) includes the prime mover which may be an internal combustion engine or electric motor, and the power take-off which may be direct drive, friction clutch, fluid coupling, hydro-dynamic torque converter, hydrostatic or an electric generator type, and may or may not include a gear box, as described in paragraph 6.01 through 6.03.1.

3.01.4 Front End Operating Equipment—Several types of front end attachments may be applied to the basic machine for performing various types of crane functions; such as lifting crane, clamshell, magnet, dragline, pile driver, or any adaptations of the same which retain the basic characteristics. These attachments are described in paragraphs 7.0 through 7.50. Convertible and interchangeable boom equipment and other accessories are generally, but not necessarily available for these operations.

SECTION 4

REVOLVING SUPERSTRUCTURE

4.01 REVOLVING SUPERSTRUCTURE
The revolving superstructure is defined as the rotating frame and components located thereon, except power plant, for operating the machine.

4.02 HOIST MECHANISMS
The hoist mechanism is used for lifting, lowering and holding loads or for other purposes, and may consist of a winch, drum or hydraulic cylinder with necessary rope reeving. ***The hoist mechanism when properly adjusted shall be capable of developing 110% of permissible line pull and be capable of maintaining the load in suspended position in normal operating cycles.***

4.02.1 LOAD LOWERING
Load lowering may be controlled by brakes acting on drums, other means or by "Power Controlled Lowering." ***The lowering mechanism shall be capable of controlling 110% of permissible line pull per par. 4.02.3.***

4.02.2 Available Line Pull—The line pull in pounds (lbs.) developed by hoisting mechanism or off the drum with specified pitch diameter drum or lagging (average pitch diameter of tapered drums), for the first layer of rope, not exceeding that developed by the driving mechanism torque.

4.02.3 Permissible Line Pull — A line pull, less than the available pull, restricted by rope strength, clutch or brake ability, or other limitation in machinery or equipment.

4.02.4 Available Line Speed — The line speed in feet per minute (fpm) developed by hoisting mechanism or at the drum, with specified pitch diameter drum or lagging (average pitch diameter for tapered drum), for the first layer of rope, developed by power plant output speed as defined in Par. 6.03.1

4.02.5 ***Minimum ratio of lifting crane load hoist drum and sheave pitch diameter to nominal rope diameter shall not be less than 18 to 1 specified in SAE Standard J881 (see Appendix E).***

4.03 BOOM HOIST AND SUPPORTING MECHANISM

Defined as the mechanism to control the elevation of the boom and to support the boom. Boom hoist may be a rope drum and its drive or a hydraulic cylinder(s). The supporting mechanism may be a gantry (as defined in section 4.06) or the same hydraulic cylinder(s) used to elevate the boom. In a rope supporting and elevating arrangement, boom lowering may be controlled by a brake only or by engagement to the power train. ***Engagement to the power train is mandatory for lifting crane service.***

4.03.1 Independent Boom Hoist — When a boom hoist drive is independent of all other functions, it usually is designated as the independent type.

4.03.2 ***The boom hoist shall be capable of elevating boom and 110% of rated load. The boom hoist shall be capable of supporting the boom and 110% of rated load without attention from the operator and allow lowering to rated radius only when under operator's control.***

4.03.3 ***A braking mechanism is required regardless of the type of drive.***

A. On rope boom support machines ***a ratchet and pawl or other positive locking device shall be provided to prevent inadvertent lowering of the boom.***

B. For hydraulic cylinder boom support machines, ***a holding device*** (such as load checks) ***is required to prevent inadvertent lowering of the boom.***

4.03.4 ***Minimum ratio of boom hoist drum and sheave pitch diameters to nominal rope diameters shall not be less than 15 to 1 specified in SAE Standard J881 (See Appendix E).***

4.03.5 Boom Hoisting Time — Crane boom hoisting and lowering times between minimum and maximum boom angles may be specified without a suspended load. ***The booming time shall be measured within the included angle of no less than 20° from horizontal to no greater than 70° from horizontal, to provide room for overtravel in a proof test.***

4.03.6 ***On a telescoping boom the retract function shall be capable of controlling 110% of rated load.*** A holding device (such as a load check) may be provided.

4.03.7 Boom telescoping time (telescopic booms). The time to fully extend and fully retract the telescopic boom may be specified without a suspended load. ***The boom telescoping extension and retraction time shall be measured at a boom angle of 60° from horizontal.***

4.04 SWING

Swing is defined as the function of revolving the superstructure of the machine.

4.04.1 Swing Speed — Swing speed is defined as the speed, in revolutions per minute, at which the revolving superstructure rotates. ***The manufacturer shall specify rated swing speed as defined in 6.03.1.***

4.04.2 Swing Lock and Swing Brake — A swing lock is a mechanical device (such as a latch, self-locking worm, etc.) to lock the revolving superstructure to the mounting in an established or desired position. A swing brake is a friction device to hold the revolving superstructure in any desired position relative to the mountings. ***Unless swing drive mechanism is of a self-locking type, a swing lock or swing brake capable of preventing rotation under normal working conditions shall be provided. The manufacturer shall specify the type furnished—swing lock, swing brake, self-locking or combination thereof.***

4.05 CONTROLS

Controls may be located on the revolving superstructure or the mobile base mounting. ***All controls essential to operation shall be located within easy reach of the operator while seated at his station. The arrangement of controls shall be such as to provide proper co-ordination of hand and foot movements required by the various types of front end operating equipment.*** See Appendix D for suggested control arrangement.

4.05.1 Hand Levers and or Foot Pedals — ***Controls for load hoist, boom hoist, swing and boom telescope shall be provided with means for holding in neutral position without use of positive locks.***

4.05.2 Control Forces and Movements — ***When controls and corresponding controlled elements are properly maintained and adjusted and the machine is operated within the manufacturer's rating with recommended mechanisms, the following shall be provided under normal operation:***

A. Lifting crane service — forces not greater than 35 lbs. on hand levers. Forces not greater than 50 lbs. on foot pedals.

B. Travel distance on hand levers not greater than 14" from neutral position on two-way levers and not greater than 24" on one-way levers. Travel distance on foot pedals not greater than 10".

4.06 GANTRY

A gantry is used on machines of the rope boom supporting type and is a structure mounted on the revolving superstructure of the machine to which the boom supporting ropes are attached. Gantries may be available in different heights and types for various conditions. ***Manufacturer shall specify condition of use, and specify whether fixed or lowerable.***

4.07 BOOM EQUIPMENT

The boom may have a basic boom structure of two sections (upper and lower) between which additional sections may be added to increase its length or may consist of a base boom from which one or more boom extensions are telescoped for additional length. The boom is pivotally mounted on the revolving superstructure and is adjustable as to angle by means described in Section 4.03. The boom is equipped with boom point sheaves and other parts as required.

4.07.1 Boom Length — (See X in Appendix A Fig. 6) Boom length is the straight line thru the centerline of boom pivot pin to the centerline of the boom point load hoist sheave pin, measured along the longitudinal axis of the boom.

4.07.2 Boom Angle (See Z in Appendix A Fig. 6) Boom angle is the angle above horizontal of the longitudinal axis of the boom.

4.07.3 Boom Hoist Ropes (for the rope boom supporting type) —

(1) Continuous Suspension — Boom hoist running rope reeving leads without interruption from the gantry to the boom head. If the boom is lengthened or shortened by a considerable amount it may be necessary to reeve a longer or shorter rope.

(2) Pendant Suspension — A floating boom harness, bridle, or spreader equipped with sheaves is connected to the boom upper section by stationary ropes usually called pendants. The boom hoist running rope leads from the gantry to the floating boom harness. To change the boom length, it is necessary only to change the pendants.

(3) Mast Suspension—Similar to Pendant Suspension except that the floating boom harness is supported by a strut hinged near the boom pivot.

4.08 REVOLVING SUPERSTRUCTURE DIMENSIONS

See Figs. 4 and 5 in Appendix A.

SECTION 5

MOBILE BASE MOUNTINGS

CRAWLER MOUNTINGS

5.01 CRAWLER MOUNTING

A crawler mounting is defined as two continuous, parallel crawler belts, consisting of a series of tread shoes or links encompassing rollers and drive tumblers, supporting a base frame which houses the propelling mechanism, driven and controlled from revolving superstructure.

5.02 BEARING LENGTH AND AREA

The effective bearing length of each crawler on the ground is computed as not more than the normal distance from center to center of the crawler end sprockets or tumbler wheels at midpoint of adjustment range C, plus 35 percent of the overall crawler height H at center of end sprocket or tumbler wheels. The total bearing area is computed by multiplying the effective crawler bearing length (as above defined) of both crawlers by the width of tread shoes. See Figure 2, and also Appendix B.

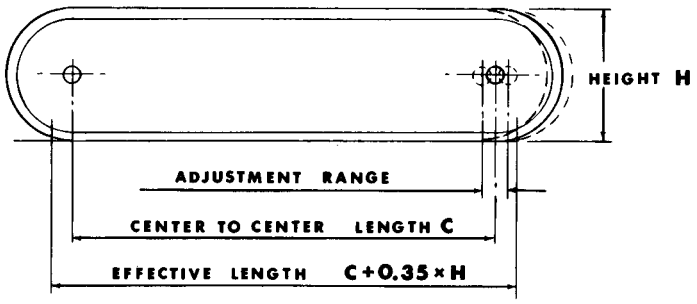


Figure 2.

5.03 GROUND PRESSURE

Ground pressure is the average pressure in pounds per square inch derived by dividing the total working weight of the machine with complete front end equipment, but without load, by the crawler bearing area.

5.04 PROPEL DRIVE

Travel power is furnished by the power plant on the revolving superstructure, through the axis of rotation, and is distributed to the two crawler belts through means permitting steering. Propel drive may be either single or multiple speed. When the propel drive from the power plant is separate from all other functions, it is usually designated as independent propel.

5.04.1 Gradeability — ***Machines without load shall be capable of climbing a 30 percent grade (30 feet rise in 100 feet horizontal) on smooth, firm, dry surface, free of loose material, providing the required traction.***

5.04.2 Speed — ***Manufacturer shall specify travel speed (or speeds if more than one is available) developed by power plant output speed as defined in paragraph 6.03.1.***

5.04.3 Steering—***Machine shall be capable of being steered either right or left in either direction of travel. Control shall be from the operator's position on revolving superstructure.***

5.05 TRACTION LOCK OR BRAKE

A traction lock or brake shall be provided capable of holding the machine stationary under normal working conditions, and on any grade the machine is capable of negotiating. Manufacturer shall specify the type of holding means provided.

5.06 CRAWLER MACHINE DIMENSIONS

Manufacturer shall specify dimensions shown in Appendix A, Figure 4 & 5.

5.07 GROUND CLEARANCE

See Figures 4 & 5 in Appendix A and Paragraph 10 in Appendix B.

RUBBER TIRE CARRIER MOUNTINGS

5.08 TRUCK TYPE MOUNTING

A rubber-tire carrier supported by two or more axles and having the general characteristics of a heavy-duty truck, upon which is mounted a revolving superstructure with appropriate front end equipment, and which is controlled for over-the-road travel from a cab mounted on the carrier. It generally has separate engines for carrier and superstructure.

5.09 SELF PROPELLED MOUNTING

A rubber-tire carrier supported by two or more axles, upon which is mounted a revolving superstructure with appropriate front end equipment, and which is controlled for travel from the operator's station. It generally has one engine for carrier and superstructure.

5.10 WHEEL AND AXLE ARRANGEMENT

Rubber tire carrier mountings are classified by a double number, the first indicating the number of wheels, and the second, the number of wheels which are driven. For example:

4 x 4 signifies the mounting has four wheels, all of which are powered for travel.

6 x 4 signifies the mounting has six wheels, four of which are powered for travel.

5.11 POWER EQUIPMENT

Carriers covered by this standard are usually powered by internal combustion engines of various types.

5.11.1 ***When carrier has separate engine, power plant shall be specified according to section 6.***

5.11.2 When there is no engine in the carrier, travel power is furnished from the revolving superstructure, through the axis of rotation, to one or more of the axles. When such drive from the superstructure is separate from all other functions, it usually is designated as independent propel.

5.12 GRADEABILITY
Gradeability is defined as the grade in percent (feet rise in 100 feet horizontal) which the machine can negotiate on a smooth, firm, dry surface, free of loose material, providing the required traction. When gradeability is specified, it should be determined in accordance with SAE Recommended Practice J688 "Truck Ability Prediction Procedure." See Appendix C.

5.13 TRAVEL SPEED
Manufacturer shall specify the number of gear speeds in forward and reverse, and vehicle speeds in lowest and highest gears determined in accordance with SAE recommended practice J688 "truck ability prediction procedure" for "good class 1 road" at sea level. See Appendix C.

5.14 BRAKES
Service brakes shall be provided to properly bring the machine to a stop from normal travel speeds. Means shall be provided to adequately hold the machine stationary during working cycles. Means shall also be provided to hold the machine on any grade which it can negotiate.

5.15 TURNING ABILITY
Manufacturer shall specify the vehicle clearance circle. See Figure 1 in Appendix A.

5.16 SPECIAL REGULATIONS
When a rubber tire mounted machine is to operate on public streets or highways, compliance with local regulations governing such use is the purchaser's responsibility.

5.17 DIMENSIONS
See Figures 2 & 3 in Appendix A.

5.18 GROUND CLEARANCE
See SAE J894 in Appendix B.

5.19 REMOTE CONTROL
When supplied on a truck type carrier, remote control provides control of the carrier functions from the revolving superstructure. ***Carrier functions controlled from the revolving superstructure shall be specified.***

5.20 RAIL-WHEEL ATTACHMENT
Rubber tire mounted machines sometimes are provided with auxiliary, retractable, flanged wheels for use on tracks for right-of-way construction and maintenance where space does not permit off-track operation. Basically they are rubber tire mounted machines as covered by Section 5.08.

5.20.1 Propel Drive — Generally the rail wheels are positioned so that enough weight remains on the tires, bearing against either rails or ties, to provide traction for both travel and braking.

5.20.2 Special Regulations — Compliance with local regulations governing the use of such machines both on public highways and public carrier tracks is the purchaser's responsibility.

OUTRIGGERS

5.21 OUTRIGGERS
Outriggers are members attached to the carrier frame to increase stability. Extendible type can further increase stability by increasing the size of the supporting base.

5.22 MANUFACTURER SHALL SPECIFY:

A. Number and location of outriggers.

B. Whether outriggers are fixed or extendible; if extendible, whether telescoping or hinged, and whether manually or by power.

C. Whether jacks and supporting floats are furnished; if furnished, whether jacks are manual or powered.

D. Whether outrigger boxes are permanently attached or removable.

SECTION 6

POWER PLANT

6.01 POWER PLANT

The power plant is defined as the prime-mover, and power take-off.

6.02 PRIME-MOVER

Generally internal combustion engine or electric motor.

6.02.1 Internal Combustion Engine Data. ***Manufacturer shall specify:***

(1) Engine make and model number.

(2) Spark ignition or diesel.

(3) Number of cylinders, bore and stroke, displacement, two or four cycle.

(4) Naturally aspirated, blown, supercharged, or turbo-charged. Special characteristics, such as after-cooling, if employed.

(5) Liquid or air cooled.

(6) Type of starting equipment.

(7) Engine speed (RPM) related to paragraph 6.03.1.

6.02.2 Internal Combustion Engine Installation

(1) The exhaust should be directed away from the machine operator.

(2) Hot exhaust manifolds and pipes that may be contacted by personnel in performance of their regular duties should be guarded.

6.02.3 Internal Combustion Engine Power at High Altitude. — Since internal combustion engines tend to lose power as altitude increases, the purchaser should specify the altitude at which the machine is to be used if this exceeds 3,000 feet above sea level.

6.02.4 Electric Motor Data — ***Manufacturer shall specify:***

(1) Alternating or direct current, voltage, and frequency.

(2) Type of motor.

(3) Motor rating (continuous, or intermittent time).

(4) Type of starter.

6.02.5 ***Electric drive machines shall be adequately grounded between revolving superstructure and mounting base, either by inherent means or other grounding device.***

6.02.6 ***The machine manufacturer is not responsible for compliance with local electrical codes, unless such compliance is specified in the contract and copies of the codes are furnished by purchaser.***

6.03 POWER TAKE-OFF

Power take-off from prime-mover may be direct drive, friction clutch, fluid coupling, hydro-dynamic torque converter, hydrostatic or an electric generator type.

6.03.1 Mechanical and Hydrodynamic Drives.—***Net delivered horsepower at the power take-off output shaft shall be specified. Machine performance specifications shall be based on torque and speed for this power. For hydraulic functions performance specifications shall be based on pumps net rated gallonage at rated relief pressure.***

SECTION 7

FRONT END OPERATING EQUIPMENT

7.0 COMMON STABILITY INFORMATION FOR LIFT CRANE, CLAMSHELL, DRAGLINE, MAGNET AND PILE DRIVING EQUIPMENT.

7.01 TIPPING CONDITION

A machine is considered to be at the point of tipping when a balance is reached between the overturning moment of the load and the stabilizing moment of the machine when on a firm, level supporting surface.

Note: For suggested test procedure see SAE Recommended Practice J765 "Crane Load Stability Test Code," Appendix F.

7.01.1 ***When outriggers are used, wheels or crawler tracks within the boundary of the outriggers shall be relieved of all weight by the outrigger jacks or blocking.***

7.01.2 ***Radius of load*** (See Y in Appendix A Fig. 6) ***shall be measured as the horizontal distance from a projection of the axis of rotation to the supporting surface, before loading, to the center of vertical hoist line or tackle with load applied.***

7.01.3 Tipping Load is the Load Producing a Tipping Condition at a Specified Radius. ***Weights of hook, hook blocks, slings, etc. except the hoist rope itself, shall be considered part of the load.***

7.02 BACKWARD STABILITY (counterweight limitations)

To maintain a reasonable margin of backward stability with the subject equipments, standard counterweighting shall be limited by the weight distribution specified below, established when the machine is on a firm, level supporting surface; equipped with the shortest recommended boom set at minimum recommended radius; with hook, hook block, bucket, or other load handling equipment resting on the ground; and with outriggers, if provided, retracted and free of the ground.

(1) Crawler cranes

The horizontal distance between the center of gravity of the crane and the axis of rotation shall not exceed 70 percent of the radial distance from the axis of rotation to the backward tipping fulcrum in the least stable direction.

Practice J765 "Crane Load Stability Test Code," Appendix F.

(2) Truck and wheel mounted cranes

A. With the longitudinal axis of the rotating superstructure of the crane at 90 degrees to the longitudinal axis of the carrier, the total load on all wheels on the side of the carrier under the boom shall not be less than 15 percent of the total weight of the crane.

B. With the longitudinal axis of the rotating superstructure of the crane in line with the longitudinal axis of the carrier, in either direction, the total load on all wheels under the lighter loaded end of the carrier shall be not less than 15 percent of the total weight of the crane.

7.03 LOAD DEFINITIONS:

(1) Rated Load — Rated loads at specified radii with the subject equipment are the lesser of a specified percentage of tipping loads or the machine's hydraulic or structural competence as established by the manufacturer, and are the maximum loads at those radii covered by the manufacturer's warranty.

(2) Net Load — Net loads are the weights of material that can be handled, determined by deducting the weight of auxiliary load handling equipment such as hooks, hookblocks, slings, buckets, magnets, pile driver leads, etc. from the rated loads.

(3) Practical working loads — practical working loads for the particular job shall be established by the user with due allowance for operating conditions. These conditions include the supporting ground and other factors affecting stability, wind, hazardous surroundings, experience of personnel, etc.

7.10 LIFTING CRANE

7.11 LIFTING CRANE EQUIPMENT

(See Appendix A, Fig. 6) Machines with lifting crane attachments are used to raise, lower, and place miscellaneous loads.

7.11.1 Boom — See paragraph 4.07

7.11.2 Boom Angle Indicator If Specified — ***An indicator showing the angle of the boom above horizontal shall be located on the crane to be clearly visible to the operator from his position at the controls.***

7.11.3 Boom Length Indicator If Specified. ***Telescopic booms that have an indicator shall show the boom length (as defined in section 4.07.1) from minimum to maximum and be visible to the operator from his position at the controls.***

7.11.4 Boom Stops — ***Stops shall be provided to resist the boom falling backwards on a grade, in a high wind, or in case the hitch fails.***

(1) A fixed or telescoping bumper
(2) A shock absorbing bumper
(3) Hydraulic boom elevation cylinder(s)

7.11.5 Boom Hoist Disconnect — ***A boom hoist disconnect shut-off or hydraulic relief shall be provided to automatically stop the boom hoist when the boom reaches a predetermined high angle.***

7.11.6 Load Hooks — ***Load hooks and hook blocks shall be counterweighted to overhaul the line from the highest hook position. All hooks and hook blocks shall be permanently labeled with their rated capacity.*** Load hooks may be equipped with safety latches. Load hooks on multiple part blocks may be equipped with a swivel.

7.11.7 Jib or Boom Tip Extension — (See "19" in Appendix A, Fig. 6) An extension attached to the boom head to provide added boom length for handling specified loads. The jib may be in line with the boom or offset.

7.12.1 Rated Loads—(See par. 7.03 [1]) ***Lifting crane rated loads at specified radii shall not exceed the following percentages of tipping load (par. 7.01.3) at specified radius:***

(1) Crawler mounted machines 75%
(2) Rubber tire mounted machines 85%
(3) Machines on outriggers 85%

Rated loads shall be based on the direction of minimum stability from the mounting, unless otherwise specified. No load shall be lifted over the front area of a truck mounted crane, except as approved by the crane manufacturer.

7.12.2 Classification, applicable to cranes with boom length of 50 feet or greater—***lifting cranes shall be classified by a symbol consisting of two numbers based on crane rated loads (Par. 7.12.1) in the direction of least stability, with outriggers set if the crane is so equipped.***

(1) The first number of the group shall be the crane rating radius, in feet, for the maximum rated load, with base boom length.
(2) The second number of the group shall be the rated load (expressed in pounds divided by 100, and rounded off to the nearest whole number) at 40-ft. radius, with 50-ft. boom length.

Example. — To illustrate the above method of classification, assume a truck crane rated 40 tons at 12-ft. radius with base boom length, and 19,600 pounds at 40-ft. radius with 50-ft. boom length. The classification of this crane would be:

"40-ton truck crane (Class 12-196)"

The number 12 represents the radius, in feet, for the 40-ton rated load, and the number 196 represents the rated load in pounds, at 40-ft. radius, divided by 100. This method is illustrated in Figure 3.

7.13.1 Allowable Rope Loading — ***The strength factors for wire ropes shall not be less than those specified in SAE Standard J959, Appendix G.***

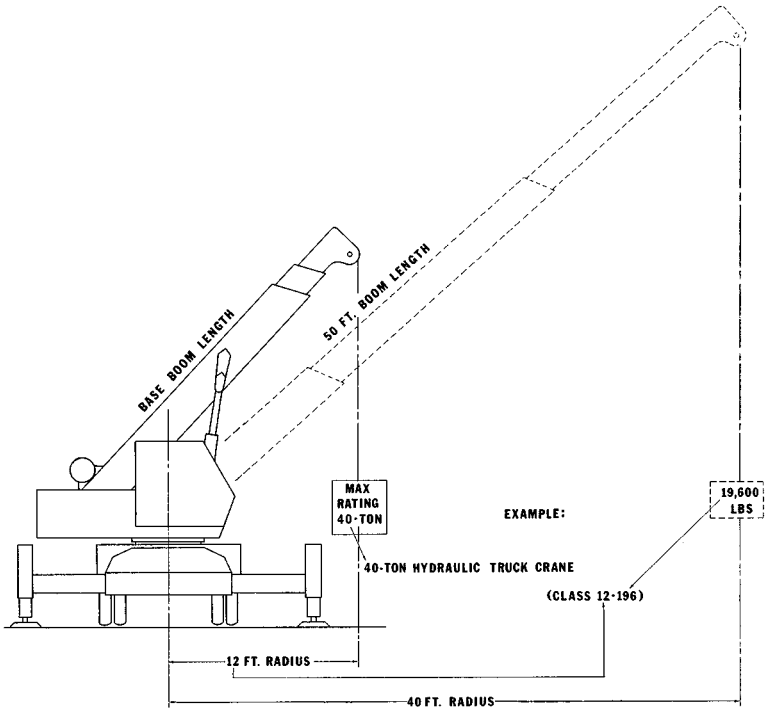


Figure 3. Method of Determining Crane Rating Classification.

	Running	Standing
Supporting Rated Load	3.5	3.0
Supporting Boom and Attachments at Gantry Height to Minimize Travel Clearance	3.5	3.0
Supporting Boom at Ground Level for Erection	3.0	2.5

The rope strength factor shall be considered to be the total "nominal" breaking strength of all ropes in the system divided by the load imposed on the rope system when supporting the static weights of structure and crane rated load (par. 7.12.1).

7.13.2 Sheave Diameters — ***Ratios of sheave pitch diameter to nominal rope diameter shall not be less than those specified in SAE Standard J881, Appendix E.***

Minimum ratio	Sheave Pitch Diam. To Rope Diam.
Load hoisting sheaves on boom	18.0 to 1
Load hoisting sheaves in lower block	16.0 to 1
Boom hoisting sheaves	15.0 to 1

7.13.3 Drum Diameters — For drum to rope diameter ratios, see par. 4.02.5 and 4.03.4.

7.14 ***Crane rating chart — a load rating chart and/or label(s) shall be located on the crane to be available to the operator from his position at the control stand, it shall include:***

Crane classification if it applies (see par. 7.12.2)

Rated crane loads for recommended boom lengths at recommended radii.

Basis of crane rating: firm, level, and uniform supporting surface (par. 7.01); rating percentage (par. 7.12.1); net load and practical working load definitions (par. 7.03 [2] ***and 7.03*** [3]***). Rated loads based on factors other than stability shall be so indicated.***

(For cylinder boom support and telescoping boom machines) ***State maximum loads permitted during actual boom telescoping operation.***

Maximum loads in relation to recommended rope size and strength and number of parts in hoist tackle (see par. 7.13.1).

Deductions to be made from rated loads on the boom when attachments such as jibs are mounted.

Data on jibs: Available lengths, permissible offsets, and rated loads.

7.15 ***Lifting crane data — the manufacturer shall furnish the following data:***

A. Data on load rating chart (see par. 7.14)

B. Telescopic boom information:

(1) List the maximum telescopic travel length of each boom telescopic section.

(2) Specify whether sections are telescoped with power or manual.

(3) Procedure for extending and retracting telescopic boom section.

C. Height of boom point load hoist sheave pin

D. For each hoist drum or hoist mechanism:

(1) Drum Pitch Diameter
(2) Available Line Pull (see par. 4.02.2)
(3) Permissible Line Pull (see par. 4.02.3)
(4) Available Line Speed for both hoisting and lowering (see par. 4.02.4)
5. Rope Spooling Capacity

E. Hoist holding mechanism:

State whether hoist holding mechanism is automatically controlled, manually controlled, if free fall available or any combination thereof.

F. Hydraulic relief valve

Relief valve settings shall be specified and any change in relief valve setting without the consent of the manufacturer shall be the user's responsibility. (See Par. 8.2)

G. Tire pressures

7.20 CLAMSHELL CRANE

7.21 CLAMSHELL EQUIPMENT

(See "21" in Fig. 6, Appendix A) Machines with clamshell attachments are used to load material from stock piles, gondola cars, barges, and the like, or from virgin soil generally out of small area holes, deep trenches, or from below water. Orange peel buckets, grapples, and similar rope suspended attachments are included in this classification.

7.21.1 Clamshell Bucket — A clamshell bucket can be operated either by ropes or hydraulic cylinders.

A rope operated bucket usually consists of two or more similar scoops hinged together and a head assembly connected to the outer corners of the scoops by struts. When the head and hinge are pulled toward each other, the scoops are forced together to dig and hold material. Control is by a holding line reeved over a boom point sheave and attached to the head assembly to support the bucket in open position and usually by a closing line also reeved over a boom point sheave, ending in a force amplifying tackle or other means between the head assembly and scoop hinge to close the bucket.

A hydraulic clamshell bucket usually consists of two or more scoops hinged to a head assembly housing the hydraulic cylinder or cylinders and the force amplifying linkage to open and close the scoops and to supply the digging force for the scoops. The bucket assembly is suspended from the boom by a rope. Because digging ability is largely dependent upon bucket weight, buckets are supplied in various weight classes which range from light for easily dug stock piled materials to heavy for excavating a hard pan material and the like.

7.21.2 Boom — See paragraph 4.07

7.21.3 Boom Angle Indicator — If specified, see 7.11.2

7.21.4 Tagline — A line attached to the bucket and a spring loaded, counterweighted, or powered unit providing tension to retard rotation and pendulum swaying of the otherwise freely suspended bucket.

7.22 CLAMSHELL RATING

Shall be the lesser value as determined by paragraphs 7.22.1, 7.22.2, or 7.22.3.

7.22.1 Rated Loads — (See par. 7.03 [1]) ***The combined weight of clamshell bucket and contents shall not exceed 75% of tipping load (par. 7.01.3) at specified radius for all mountings.*** For normal operation it is recommended that the combined weight of bucket and contents for any given radius of operation should not exceed 90% of Crane Rated Load for Crawler Mounting par. 7.12.1(1), and 80% of Crane Rated Load for Rubber Tire Mounting par. 7.12.1(2). Also see par. 7.03(2) and 7.03(3).

7.22.2 Maximum Clamshell Load — ***The combined weight of bucket and contents shall not exceed the limits imposed by allowable rope loading*** (par. 7.23.1).

A. Rope operated, for normal operation the combined weight of bucket and contents should not exceed 70% of the available closing line pull (Par. 4.02.2)

B. Hydraulic operated, for normal operation the combined weight of bucket and contents should not exceed 70% of available hoist line pull (Par. 4.02.2).

7.22.3 The manufacturer should state any other limitations on bucket size that apply to particular machines, and when requested, to particular operations.

7.23.1 Allowable Rope Loading — ***The rope strength factor shall be considered to be the total "nominal" breaking strength of all active ropes in the system divided by the load imposed on the rope system when supporting the static weights of structure and clamshell bucket loaded to rated capacity.*** See Par. 7.13.1 for allowable rope loading.

Note: Term "Active Ropes" is used because generally the holding line cannot be included as support for a loaded bucket, but in some cases it is used.

7.23.2 Sheave Diameters — ***Ratios of sheave pitch diameter to nominal rope diameter shall not be less than those specified in SAE Standard J881, Appendix E.***

Minimum ratio	Sheave Pitch Diam. To Rope Diam.
Load hoisting sheaves on boom	18.0 to 1
Closing tackle sheaves in bucket	16.0 to 1
Boom hoisting sheaves	15.0 to 1

7.24 CLAMSHELL RATING CHART

A load rating chart shall be located on the crane, available to the operator from his position at the control stand. It shall include:

Rated clamshell loads for recommended boom lengths at recommended radii.

Basis of clamshell rating; firm, level, and uniform supporting surface (par. 7.01); rating percentage (par. 7.22); net load and practical working load definitions (par. 7.03[2] and 7.03[3]).

Maximum weight of clamshell bucket and contents (par. 7.22)

Notes on the ***crane rating chart*** (par. 7.14) satisfy this requirement.

7.25 CLAMSHELL DATA

The manufacturer shall furnish the following data:

A. Data on clamshell rating chart (see par. 7.24)

B. For holding and closing drums:
(1) Drum Pitch Diameter
(2) Available Line Pull (see par. 4.02.2)
(3) Permissible Line Pull (see par. 4.02.3)
(4) Available Line Speed (see par. 4.02.4)
(5) Closing Time in Seconds

C. For holding mechanisms for hydraulic operated clamshell:
(1) Drum Pitch Diameter
(2) Available Line Pull (see par. 4.02.2)
(3) Permissible Line Pull (see par. 4.02.3)
(4) Available Line Speed (see par. 4.02.4)

D. For opening and closing mechanism for hydraulic operated clamshell:
(1) Opening Time in Seconds
(2) Closing Time in Seconds
(3) Maximum Available Radial Tooth Force

E. Hydraulic relief data
Relief valve settings shall be specified and any change in relief valve setting without the consent of the manufacturer shall be the user's responsibility. (See par. 8.2)

7.26 CLAMSHELL BUCKET CAPACITY RATING

The following formula has been established by the Bucket Manufacturers Bureau of the Construction Industry Manufacturers Association.

All dimensions are taken on the inside of a bucket and are expressed in inches.

As all buckets will heap differently in the various materials they are called upon to handle, The Bucket Manufacturers Bureau does not recognize "heaped load" ratings by manufacturers. The bucket user is encouraged to seek actual or estimated performance data for the particular material he is interested in handling.

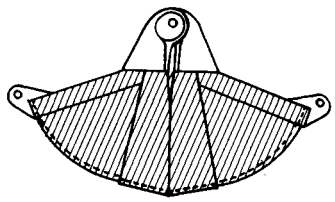


Fig. 4. Plate Line Capacity The plate line capacity shall be the area of the **shaded** portion shown in Fig. 4 multiplied by the average inside width of the bucket scoops. This shall be stated to the nearest one-tenth cubic foot. Formerly, some manufacturers referred to this as struck measure capacity.

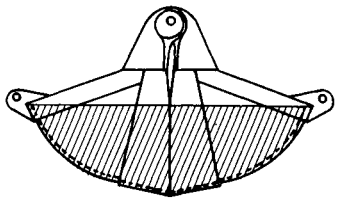


Fig. 5. Water Level Capacity The water level capacity shall be the volume of water a bucket would hold. This shall be calculated by multiplying the area of the shaded portion in Fig. 5 by the average inside width of the bucket scoops. This shall be stated to the nearest one-tenth cubic foot.

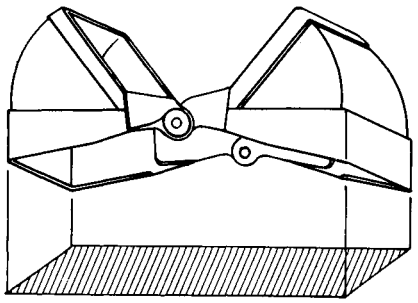


Fig. 6. Deck Area The deck area shall be the area of the shaded portion shown in Fig. 6. This area shall be the product of the outside width of the lips times the open length of the lips.

7.30 MAGNET CRANE

7.31 MAGNET EQUIPMENT

(See "24" in Fig. 6, Appendix A) Machines with magnet attachments are used to handle ferrous products in either the form of raw materials as pig iron and scrap, or as semi-finished billets, plates, and castings.

7.31.1 An electro-magnet, generally direct current, is suspended from the crane hook; is powered from a generator on the revolving superstructure; and is regulated at the operator's station.

7.31.2 Boom — see paragraph 4.07.

7.31.3 Boom Angle Indicator — If specified, see 7.11.2.

7.31.4 Magnet Generator — May be driven by the prime mover on the revolving superstructure or by a separate engine.

7.31.5 Cable Reel — A drum on which the electric cable supplying the magnet is wound to take up slack cable.

7.32 MAGNET LOAD RATING
Shall be the lesser value as determined by paragraphs 7.32.1, 7.32.2, or 7.32.3.

7.32.1 Rated Loads—(See par. 7.03[1]) ***The combined weight of magnet and load shall not exceed 75% of tipping load (par. 7.01.3) at specified radius for all mountings.*** For normal operation handling scrap or pig iron it is recommended that the combined weight of magnet and load for any given radius of operation should not exceed 90% of Crane Rated Load for Crawler Mounting par. 7.12(1) and 80% of Crane Rated Load for Rubber Tire Mounting par. 7.12.1(2). Also see par. 7.03(2) and 7.03(3).

7.32.2 Maximum Magnet Load — ***The combined weight of magnet and load shall not exceed the limit imposed by allowable rope loading (par. 7.23.1).*** For normal operation the combined weight of magnet and load should not exceed 70% of the available line pull (par. 4.02.2).

7.32.3 The manufacturer should state any other limitation which may apply to a particular machine or operation.

7.33.1 Allowable Rope Loading — (Same as 7.13.1)

7.33.2 Sheave Diameters — (Same as 7.13.2)

7.34 MAGNET CRANE RATING CHART
Use Clamshell chart (par. 7.24)

7.35 MAGNET CRANE DATA
The manufacturer shall furnish the following data:
A. Data on magnet rating chart (see par. 7.34)
B. For hoist drum:
(1) Drum Pitch Diameter
(2) Available Line Pull (see par. 4.02.2)
(3) Permissible Line Pull (see par. 4.02.3)
(4) Available Line Speed (see par. 4.02.4)
C. For magnet generator:
(1) Driven by main engine or separate engine
(2) AC or DC
(3) Voltage
(4) KW Rating
D. Hydraulic relief data
Relief valve settings shall be specified and any change in relief valve setting without the consent of the manufacturer shall be the user's responsibility. (See par. 8.2).

7.40 DRAGLINE

7.41 DRAGLINE EQUIPMENT
(See "22" in Fig. 6, Appendix A) Machines with dragline attachments are generally used to excavate material from below the grade on which the machine is placed.

7.41.1 A dragline bucket is loaded by the drag rope pulling it toward the machine, it is lifted and carried by the hoist rope reeved over the boom point sheave, and is balanced by the dump rope interconnecting the drag and hoist ropes. Buckets are supplied in various weight classes ranging from light for loose formations to heavy for compact or cemented formations.

7.41.2 Boom — See paragraph 4.07

7.41.3 Fairlead — A combination of sheaves and or rollers mounted at the front of the machine to guide the drag rope to the drag drum.

7.42 DRAGLINE LOAD RATING
Shall be the lesser value as determined by paragraphs 7.42.1, 7.42.2, or 7.42.3.

7.42.1 Rated Loads — (See par. 7.03[1]) ***the combined weight of dragline bucket and contents shall not exceed 75% of tipping load (par. 7.01.3) at specified radius, for all mountings*** (100% of Crane Rated Load for Crawler Mounting par. 7.12.1(1), and 90% of Crane Rated Load for Rubber Tire Mounting par. 7.12.1(2). Also see par. 7.03(2) and 7.03(3).

7.42.2 Maximum Dragline Load — For normal operation the combined weight of bucket and contents should not exceed 60% of the available hoist line pull (par. 4.02.2).

7.42.3 The manufacturer should state any other limitations on bucket size that apply to particular machines and, when requested, to particular operations.

7.43 DRAGLINE RATING CHART
A load rating chart shall be located on the machine, available to the operator from his position at the control stand. It shall include:
Rated dragline loads for recommended boom lengths at recommended radii.
Basis of dragline rating; firm, level, and uniform supporting surface (par. 7.01): rating percentage (par. 7.42) net load and practical working load definitions (par. 7.03[2] and 7.03[3]).
Maximum weight of dragline bucket and contents (par. 7.42). Notes on the ***crane rating chart*** (Par. 7.14) satisfy this requirement.

7.44 DRAGLINE DATA
The manufacturer shall furnish the following data:
A. Data on dragline rating chart (see par. 7.43)
B. For hoist and drag drums:
(1) Drum Pitch Diameter
(2) Available Line Pull (see par. 4.02.2)
(2) Available Line Speed (see par. 4.02.4)
C. Hydraulic relief data
Relief valve settings shall be specified and any change in relief setting without the consent of the manufacturer shall be the user's responsibility. (See par. 8.2)

7.45 DRAGLINE BUCKET CAPACITY RATING

The following formula has been established by the Bucket Manufacturers Bureau of the Construction Industry Manufacturers Association.

All dimensions are taken on the inside of a bucket and are expressed in inches.

Wa = Average inside width.

$$Wa = \frac{Wb + Wc + Wd + We}{4}$$

Ha = Average inside height.

L = Edge of cutting lip to inside of back.

Sc = Struck Capacity.

Rc = Rated Capacity.

$$\text{Struck Capacity in Cubic feet} = \frac{Wa \times Ha \times L \times F}{1728}$$

F—represents a corrective factor expressing the loss of the capacity created by the adaption of the various curvatures by each manufacturer.

$$\text{Rated Capacity in Cubic yards} = \frac{Sc \times 0.90}{27} = \frac{Sc}{30}$$

0.90 expresses a 10% loss of the struck capacity due to the angle of repose of the material.

Struck or rated capacities shall be within 2% ± of a specific size.

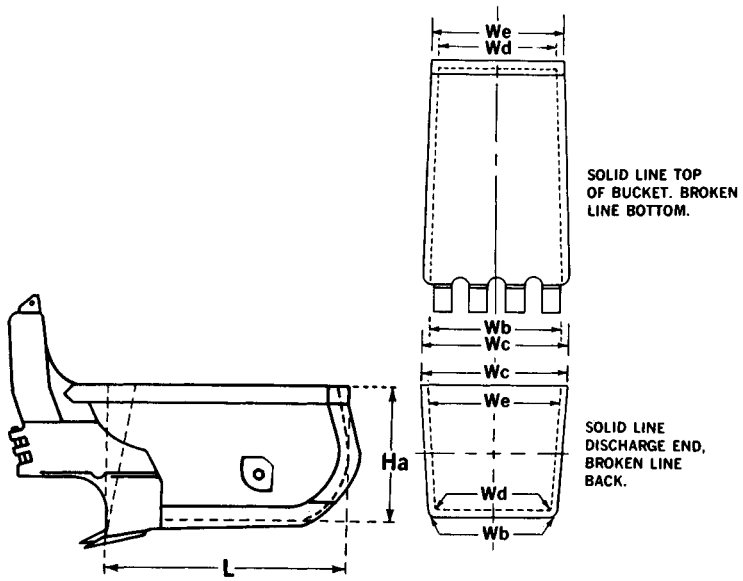


Figure 7.

7.50 PILE DRIVER

7.51 PILE DRIVER EQUIPMENT

(See "23" Fig. 6, Appendix A) Machines with pile driver attachments are used to drive or extract piling.

7.51.1 Pile Driving Units — These units include the following:

(1) Drop Hammer — A simple weight sliding in leads, which is raised by the hoist machinery and allowed to drop on the upper end of the pile. It can be used to drive both vertical (plumb) and off-vertical (batter) piling.

(2) Power Hammer — A unit, usually guided by leads, that rests on the upper end of the pile and which contains within itself a member (ram) which is caused to reciprocate either by means of an externally supplied air, steam, hydraulic fluid under pressure, or by internal combustion within the unit. It can be used to drive both plumb and batter piling.

(3) Vibrator — A unit which normally is firmly clamped or fixed to the upper end of the pile and which contains elements that produce vibratory forces, usually longitudinal, in the pile. The weight of the unit, in some cases supplemented by counterweight or other downward forces, when added to the vibratory forces, drive the pile. It can be used to drive both plumb and batter piling.

(4) Extractors — These units include the following:

A. Pulling frame — A mechanism which amplifies hoisting forces to permit direct extraction of piling.

B. Power extractor — A unit, hanging from the hoist line or block and attached to the upper end of the pile and containing within itself a member (ram) which is caused to reciprocate either by means of an externally supplied air, steam, hydraulic fluid under pressure, or by internal combustion within the unit. Upward pull from the hoisting machinery supplements the extraction forces.

C. Vibrator — Same as described in (3) above except that upward forces in excess of the weight of the unit are added by means of the hoist machinery in order to extract the pile.

NOTE: When power or vibratory extractors are employed, high hoisting forces are usually required and a shock absorber or vibration isolator interposed between the hoist line and the extractor is recommended to reduce the shock and vibration transmitted to the boom and machine.

7.51.2 Boom — See paragraph 4.07.

7.51.3 Pile Leads — These units include the following:

(1) Box or Parallel — A structure consisting of two parallel, properly shaped members suitably interconnected which form a guide within or on which the pile driving unit and pile cap may operate.

(2) Spud — A structure consisting of a single suitably shaped member on which the pile driving unit and pile cap, when equipped with suitable guides may operate.

7.51.3.1 Pile Lead Attachment — The pile leads may be attached to the basic machine crane boom in several ways including:

(1) Free Swinging — Where the leads are suspended by one of the hoist cables.

(2) Underhung or Fixed — Where the upper ends of the leads are hinged directly at or near the boom point. Struts may be provided to tie the lower end into the machine.

(3) Extended or Cantilevered — Where leads are attached similarly to the underhung method except that in addition to the lead hanging below the boom point, it extends upward for some distance above the boom point as well. This construction permits the driving of piling in lengths in excess of the boom length.

7.51.4 Pile Cap — An adapter between the pile driving unit and the upper end of the pile used to center the pile under the pile driving unit and to reduce damage to the upper end of the pile.

7.51.5 Cushion Block — A means of reducing impact damage to hammer and pile. This unit usually consists of plastic or wood cushioning material suitably retained and positioned between pile driving hammer and pile cap. Use of wire rope, steel plates, or other such inelastic material as cushioning means is not normally advisable.

7.51.6 Extra Drums — Machines equipped with pile driving attachments may be equipped with more than two hoisting drums to meet the various needs of this operation.

7.52 LOAD CAPACITY

When driving plumb piling, the combined weights of leads, pile driving unit, pile, and any attached appurtenances should not exceed the rated lifting capacity of the machine with the boom length used at the operating radius. If piling is to be driven at a fore and aft batter (off-vertical but lying in a vertical plane passing through the longitudinal centerline of machine and boom) necessary allowances for the changes in radii of centers of gravity of leads, pile driving unit, and pile must be made to avoid exceeding the rated lifting capacity. Great care must be exercised for side-batter (pile inclined out of a vertical plane passing through the longitudinal centerline of machine and boom) as such operation imposes severe demands upon both strength and stability of machines so employed.

SECTION 8
SAFETY REQUIREMENTS

8.0 GENERAL

The use of mobile hydraulic cranes may involve certain hazards because they are subjected to an extremely wide variety of job applications and environmental conditions. For this reason it is impractical to produce a standard of safety requirements and recommendations which will cover all possible conditions encountered in the use of such equipment, and in itself provide complete assurance of safety. However this Standard does include extensive coverage on matters pertaining to safety, and if these rules are observed and supplemented by good job management and judgment, in dealing with conditions not specifically covered, satisfactory overall safety can be achieved. For additional information on safety practices refer to "USA Standard Safety Code for Crawler, Locomotive and Truck Cranes, USAS B30.5."

8.01 CARE & OPERATION MANUALS

Before operating or performing maintenance work, personnel should thoroughly study and understand all instructions found in manuals provided by the manufacturer, for the machine involved.

8.02 CLASSIFICATION OF SAFETY REQUIREMENTS

The degree of safety which can be expected in the use of mobile hydraulic cranes is dependent upon the degree of adherence to good safety practice in each of the following separate areas of activity and responsibility.

8.1 Machine Construction and Characteristics.

8.2 Machine Inspection and Maintenance.

8.3 Machine Application and Operation.

8.1 MACHINE CONSTRUCTION & CHARACTERISTICS

This area of safety pertains to the physical capability and construction features of machines in relation to safe performance of specific work intended under conditions stipulated by the machine manufacturer. Since the general purpose and requirements of the previous sections deal principally with capability and construction features of mobile hydraulic cranes, safety requirements in this area are given particular emphasis. Many of these safety requirements are found in various other sections of the Standard for the reason that they are closely related to other subject matter in these sections. In such instances they also are made a part of this Sub-Section by paragraph references herein. ***Compliance with the safety requirements in 8.1 is the responsibility of the machine manufacturer.***

8.1.1 Rated Capacities

8.1.1.1 Lifting Crane (See par. 7.12.1)

8.1.1.2 Clamshell Crane (See par. 7.22)

8.1.1.3 Magnet Crane (See par. 7.32)

8.1.1.4 Dragline (See par. 7.42)

8.1.1.5 Pile Driver (See par. 7.52)

8.1.2 Rating Charts

8.1.2.1 Lifting Crane (See par. 7.14)

8.1.2.2 Clamshell Crane (See par. 7.24)

8.1.2.3 Magnet Crane (See par. 7.34)

8.1.2.4 Dragline (See par. 7.43)

8.1.3 Backward Stability (See par. 7.02)

8.1.4 Relief Valves — Hydraulic relief valves utilized to limit maximum pressure developed within the hydraulic system shall have pressure settings of sufficient magnitude to provide the capabilities of operation under 110% of rated loading conditions. ***Gauge ports shall be provided in each hydraulic circuit for checking manufacturer's specified pressure settings.***

8.1.5 Hoist Mechanism (See par. 4.02)

8.1.5.1 Rope Capacity — ***The drums shall have sufficient rope capacity with recommended rope size and reeving to perform front end attachment functions within the range of boom lengths, operating radii and load travel distances stipulated by the manufacturer.***

8.1.5.2 Rope Reserve — ***No less than two full wraps of rope shall remain on the drums with loads or front end attachment in extreme positions stipulated by the manufacturer.***

8.1.5.3 Adjustments — ***Brakes & clutches shall be provided with adjustments where necessary to compensate for wear and to assure proper performance of these components.***

8.1.6 Boom Hoist & Supporting Mechanism (See par. 4.03)

8.1.6.1 Rope Capacity — ***The boom hoist drum or drums shall have sufficient rope capacity to operate the boom to highest angle permitted with recommended rope size and reeving.***

8.1.6.2 Rope Reserve For Rope Supported Booms — ***No less than two full wraps of rope shall remain on the drum or drums with the boom point of crane, clamshell, magnet, dragline and pile driver attachments lowered to the level of the machine supporting surface.***

8.1.6.3 Adjustments — ***Clutches and brakes shall be provided with adjustments where necessary to compensate for wear and to assure proper performance of these components.***

8.1.6.4 Boom Stops (See par. 7.11.4)

8.1.6.5 Boom Hoist Disconnect (See par. 7.11.5)

8.1.7 Swing (See par. 4.04)

8.1.7.1 Swing Control — ***The swing mechanism in good order and properly adjusted shall be capable of smooth starts and stops with various degrees of acceleration and deceleration required in normal and proper operation.***

8.1.8 Travel Functions (See pars. 5.04 — 5.05 & 5.14)

8.1.9 Controls (See pars. 4.05 Appendix D)

8.1.10 Wire Ropes & Reeving Accessories (See paragraphs: 7.13.1 & 7.13.2)

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

8.1.11 Cab Construction — ***Insofar as practical, without interference with operation, cabs shall provide necessary protection of the machinery and operator's station from the weather.***

8.1.11.1 Cab Windows—***Windows and/or openings shall be provided and arranged for visibility of work area and to each side of the operator. All cab windows shall be of safety glass.***

8.1.11.2 Doors — ***All cab doors whether of sliding or swinging type shall be adequately restrained from accidental opening or closing while traveling or operating the machine. The door adjacent to the operator, if of the swinging type shall open outward and if of the sliding type shall slide rearward to open.***

8.1.11.3 Walk-ways — ***Principal walking surfaces shall be of a skid resistant type.***

8.1.11.4 Access — ***Suitable hand holds and/or steps shall be provided to facilitate entrance to and exit from operator's cab(s), when necessary for rigging or service requirements, ladders or steps shall be provided to facilitate access to the cab roof.***

8.1.12 General Safety Requirements

8.1.12.1 Load Hooks (See par. 7.11.6)

8.1.12.2 Engine Exhaust — ***Exhaust gases from internal combustion engines shall be piped to the outside of the machinery cab and directed away from the machine operator. All exhaust pipes shall be insulated or guarded in areas where they may be contacted by personnel in the performance of their normal duties.***

8.1.12.3 Outriggers — ***Means shall be provided to hold outriggers in both the retracted and extended positions. Floats, if provided, shall be attached to outriggers when in use.***

8.1.12.4 Safety Guards — ***Insofar as practicable all moving machinery parts exposed to contact by personnel while following normal and proper operating and maintenance procedure shall be provided with suitable guards.***

8.1.12.5 Sheave Guards — ***Sheaves carrying ropes which can momentarily be unloaded shall be provided with close fitting guards to guide the rope back into the groove when the load is again applied.***

8.1.12.6 Clutch & Brake Protection — Friction type brakes and clutches should be protected from weather insofar as practicable.

8.1.12.7 Lubrication — Lubricating fittings should be located in as easily accessible positions as possible.

8.1.12.8 Boom Angle indicator (See par. 7.11.2)

8.1.12.9 If a magnet is furnished by the manufacturer, energizing current should be of sufficient capacity and uniformity to minimize dropping portions of the load while swinging.

8.2 MACHINE INSPECTION AND MAINTENANCE

This area of safety pertains to inspection, servicing and maintenance which are extremely important in the safe use of mobile hydraulic cranes. Many critical components on the machines are subject to wear and other deterioration or damage which limit their useful life; thus, they are expendible. When new, all such parts have a built-in reserve strength against unknown conditions and reasonable loss of strength due to gradual deterioration. However if replacement is neglected, these parts can eventually reach a condition where they become a safety hazard. Failure to maintain correct adjustments of the various mechanisms to assure proper performance of the machine also can be a safety hazard. Hydraulic relief valve settings should never exceed specified pressure without the consent of the manufacturer. Readjustment, if necessary, should be performed by competent, qualified personnel. ***Since the machine manufacturer has no direct control over the field inspection and maintenance, safety in this area is the responsibility of the user.***

8.2.1 Inspection — All machines in active service should be inspected at regular intervals for proper adjustment of operating mechanisms, excessive wear or deterioration of components, cleanliness of the hydraulic system, accidental damage and any other defects which might be questionable as to safety. Any deficiencies noted should be carefully investigated and determination made as to whether they constitute a safety hazard. Inspection is vital to safe operation. It should be performed by competent personnel and on a regular and systematic basis.

8.2.1.1 Inspection Frequency — Frequency requirements of inspection depend upon numerous factors such as machine activity, severity of service, vulnerability of parts to wear and damage and the extent to which parts may be deemed critical in relation to safety. Inspection frequency can be divided into two general categories as follows:

(1) Daily to monthly intervals including observation during operation for any defects which might appear between regular inspections. Items such as all functional operating mechanisms, oil levels, hydraulic hoses and components, filters and strainers, rope, rope reeving, sheaves, drums, brakes, locking and safety devices, hooks, boom, jib, etc. should be included in this category.

(2) One to twelve month intervals. A complete machine inspection including items as in 1 above and in addition the machine basic structure, gearing, shafting, bearings, power plant and radiator, oil cooler, chain drives, electrical equipment, etc.

8.2.1.2 Wire Rope Inspection — All wire ropes in active service should be visually inspected once every working day. A thorough inspection of such ropes should be made at least once a month and dated records kept as to rope condition. Any deterioration, resulting in appreciable loss of original strength should be carefully examined and determination made as to whether further use of the rope would constitute a safety hazard. Conditions such as the following should be sufficient reason for questioning rope safety and for consideration of replacement.

(1) Corrosion.

(2) More than one broken wire in any one strand. Breaks occurring on crowns of outside wires indicate normal deterioration. Breaks in valleys between strand indicate an abnormal condition, possibly fatigue or breakage of other wires not readily visible.

(3) More than one broken wire near attached fittings.

(4) Heavy wear and/or broken wires in rope sections under sheaves where rope travel is limited or at points of contact with saddles.

(5) Evidence of appreciable reduction in original rope diameter after allowance for normal stretch and diameter reduction of newly installed rope.

(6) Extensive abrasion, scrubbing and peening of outside wires, pitting, kink damage or other mechanical abuse causing distortion of rope structure.

(7) Sheaves, guards, guides, drums, flanges, and other surfaces contacted by the rope during operation should be inspected for conditions which are harmful to the rope.

(8) See S.A.E. Standard J959, Appendix G, Lifting-Crane Wire-Rope Strength Factors for additional recommendations.

8.2.1.3 Hydraulic Hose, Fittings, and Tubing Inspection — All hydraulic hoses, and particularly those which flex in normal operation of crane functions should be visually inspected once every working day. A thorough inspection of all hoses, fittings, and rigid tube lines should be made at least once a month. Any deterioration should be carefully examined and determination made as to whether further use of the component would constitute a safety hazard. Conditions such as the following should be sufficient reason for consideration of replacement.

(1) Any evidence of hydraulic oil leakage at the surface of the flexible hose or its junction with the metal end couplings.

(2) Any blistering or abnormal deformation to the outer covering of the hydraulic hose.

(3) Hydraulic oil leakage at any threaded or clamped joint that cannot be eliminated by normal tightening or recommended procedures.

(4) Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or hydraulic fitting. Means shall be taken immediately to eliminate the interference of the elements in contact or otherwise protect the components.

8.2.2 Maintenance — Preventive maintenance programs based on the manufacturer's recommendations should be established. However, due to the wide variation in job applications, severity of service, machine activity and environment it is impossible for the manufacturer to develop a single, complete standard procedure which will fit all applications. Therefore such programs should be developed by trained and experienced personnel, responsible for maintenance of the machine, by adjustment and extension of the manufacturer's general recommendations, to suit the particular needs.

8.2.2.1 Adjustments, Replacements & Repairs — Any conditions, disclosed by the inspection requirements of complete paragraph and sub-paragraphs of 8.2.1, which are considered to constitute safety hazards should be corrected before operation of the machine is resumed, to assure that the equipment will always be operated in a safe condition.

8.2.2.2 Replacement Parts — It is recommended that all replacement parts be obtained from the original equipment manufacturer in order that the strength and quality of the original machine may be maintained.

8.2.2.3 Wire Rope Replacement — A fully comprehensive and precise set of rules cannot be given for determination of exact time for rope replacement since many variable factors are involved. Safety in this respect depends largely upon the use of good judgment by competent maintenance personnel in evaluating remaining rope strength in a used rope after allowance for deterioration disclosed by inspection. However, any of the following listed conditions should be cause for rope replacement.

(1) In running ropes, six randomly distributed broken wires in one rope lay, or three broken wires in one strand in one rope lay. (A rope lay is the length along the rope in which one strand makes a complete revolution around the rope.)
(2) In pendants or standing ropes, evidence of more than one broken wire in one lay.
(3) Abrasion, scrubbing, or peening causing loss of more than 1/3 of the original diameter of the outside wires.
(4) Evidence of severe corrosion.
(5) Severe kinking, severe crushing, or other damage resulting in distortion of the rope structure.
(6) Evidence of any heat damage from a torch or arc caused by contact with electrical wires.
(7) Reduction from nominal rope diameter of more than 3/64" for diameters up to and including 3/4"; 1/16" for diameters 7/8" to 1 1/8"; 3/32" for diameters 1 1/4" to 1 1/2". Marked reduction in diameter indicates deterioration of the core, resulting in lack of proper support for the load carrying strands. Excessive rope stretch or elongation may also be an indication of internal deterioration.
(8) Evidence of "bird caging" or other distortion resulting in some members of the rope structure carrying more load than others.
(9) Noticeable rusting or development of broken wires in the vicinity of attachments. (Note: If this condition is localized in an operating rope and the section in question can be eliminated by making a new attachment, this can be done rather than replacing the entire rope.
(10) See S.A.E. Standard J959, Appendix G, Lifting-Crane Wire-Rope Strength Factors for additional recommendations.

8.2.2.4 All rope should be of proper size, grade and construction for the particular function it is to perform on the machine.

8.2.2.5 Lubrication — Regular and systematic lubrication should be maintained on the machine, in accordance with the manufacturer's lubrication charts and general recommendations. All machinery should be stopped while lubricating except in cases where the lubricating system is designed for safe application while the machinery is in motion. Any guards or panels which must be removed for access to some points for lubrication or inspection should always be replaced before resuming operation.

8.2.2.6 Maintenance Tools — Routine maintenance tools should be available at all times.

8.2.2.7 Fire Extinguisher — A carbon-dioxide or dry chemical hand fire extinguisher should be kept in the crane cab at all times.

8.3 APPLICATION AND OPERATION

8.3.1 General — This is probably the most important area relative to safety since it involves the greatest frequency of exposure to hazards. The operator should be fully competent physically, mentally and emotionally to understand and apply established operating safety rules. He should be able to exercise good judgment in dealing with the many situations which cannot be anticipated and covered herein. ***Since the manufacturer has no direct control over machine application and operation, conformance with good safety practice in this area is the responsibility of the user or his operating personnel.***

8.3.2 Application — Only machines of proper rated capacity and type should be assigned to the job to be done. Anything less constitutes a safety hazard.

8.3.3 Operation — In general, established operating safety rules where applicable should be observed in performing all operating functions. Operating safety rules are found in sources such as the following:
A. USA Standard Safety Code or Crawler, Locomotive and Truck Cranes, USAS B30.5.
B. Power Crane and Shovel Association — "125 Ways to Better Power Shovel — Crane Operation."
C. Manufacturer's Care and Operation Manuals.
It is recognized that written rules cannot cover all situations which might be encountered on the job. To meet such unanticipated situations the operator must be able to supplement his own rules based on good judgment.

8.3.3.1 Capacity Ratings — Manufacturers' ratings should never be exceeded. The stipulations pertinent to these ratings should always be carefully observed. Under some conditions even the full standard capacity ratings cannot be recommended and must be adjusted downward to compensate for special hazards. (See "Practical Working Loads" par. 7.03 [3]).

8.3.3.2 Rating Based on Hydraulic or Structural Competence — As the shorter rated radii are approached in lifting crane operation the load required to tip the crane increases very rapidly to a point where the actual tipping load is almost unlimited. Rated loads based on excessive tipping loads cannot be covered by adequate design factors since this would result in excessive machine weight and limitation of the machine's usefulness. Consequently, some of the ratings shown on the chart may be based on machine's hydraulic or structural competence rather than stability, in which cases the full use of stability in lifting loads is not intended or approved. It is therefore unsafe to apply any load, which is greater than the rated load shown on the chart for that radius. (See Par. 7.03[1]).

8.3.3.3 Counterweight—The maximum counterweight approved by the manufacturer for use on a given machine should never be exceeded. Unauthorized addition of counterweight in the field to increase lifting ability constitutes a safety hazard in two ways. First the added lifting ability and higher loading of machine parts have not been taken into account in the design. Second the backward stability margin built into the machine (see par. 7.02) for the user's protection could be reduced beyond that considered safe practice.

8.3.3.4 Level Machine — All ratings are based on levelness of the machine in both directions. Any deviation from this condition introduces a safety hazard, the degree of which

depends upon the amount of deviation, and must be taken into account by the operator in loading and handling the machine.

8.3.3.5 Traveling With Load — All crane capacity ratings are based on nonuse of the travel function while handling loads, however, Mobile hydraulic cranes may be utilized for pick and carry operations. Travelling with suspended loads involves so many variables such as ground conditions, boom length, momentum in starting and stopping, etc., that it is impossible to devise a single standard rating procedure with any assurance of safety. For such operations the user must evaluate prevailing conditions and determine safe practices, exercising precautions, such as the following:

(1) The boom shall be carried in line with the direction of motion.
(2) Travel speed reduced to suit conditions.
(3) Maintain specified tire pressures.
(4) Avoid sudden starts and stops.
(5) Provide tag or restraint lines to snub swinging of the load.

8.3.3.6 Freely Suspended Loads — All crane ratings are based on this condition and do not include allowance for the excessive side loads which could be developed in attempting to drag rated loads not free to swing. Safety in any side dragging operation is entirely dependent upon the user's judgment in making proper allowances.

8.3.3.7 Rigging or Telescoping of Booms — Booms which are being assembled or disassembled on the ground with or without support of the boom harness should be securely blocked up to prevent dropping and injury to ground personnel. Booms which are being manually telescoped should be carefully repositioned prior to pinning to prevent injury to ground personnel.

8.3.3.8 Unattended Machines — Before leaving his station the operator should land any suspended working load, place such controls in neutral position and set all locking and safety devices as necessary to safely secure the machine.

8.3.3.9 Ground or Support Conditions — Capacity ratings are based on the condition of a firm supporting surface under the machine. Operating personnel should consider and allow for unusual conditions, since yielding of the supporting surface during operation may be a safety hazard.

8.3.3.10 Operation Near Electric Power Lines — Consult references listed in paragraph 8.3.3, or possible local codes.

8.3.3.11 Hand Signals — See USA Standard Safety Code or Crawler, Locomotive and Truck Cranes, USAS B30.5 (this portion reproduced in Appendix H).

8.3.3.12 Gantry or Mast — Where gantry or mast heights on a machine can be varied, the manufacturers' recommendations as to proper height and equipment for specified operating conditions should always be carefully followed.

8.3.3.13 Suspended Loads — The operator should remain at his station ready for emergency action at all times while any suspended load is held by locked brakes or other locking means.

SECTION 9

GLOSSARY

9.0 The following is a glossary of technical terms and definitions peculiar to the power crane and shovel industry. No terms of a general mechanical engineering or design nature are listed.

For definitions pertaining to hydraulic components see USAS standard B93.2—1965 "glossary of terms for fluid power."

ACCESSORY. A secondary part or assembly of parts which contributes to the overall function and usefulness of a machine.

A-FRAME. See "GANTRY" and "MAST."

ALLOWABLE ROPE LOAD. The "nominal" breaking strength of the rope divided by a strength factor.

ANGLE INDICATOR (BOOM). An accessory which measures the angle of the boom above horizontal.

ATTACHMENT. An alternate designation for front end equipment. Also, any other device that may be added as a complete unit or assembly.

AXIS OF ROTATION. The vertical line through the axis around which the crane superstructure rotates.

AXLE. The shaft or spindle about which a wheel revolves. On truck and wheel mounted cranes it refers to an automotive type of axle assembly including housings, gearing, differential, bearings and mounting appurtenances.

AXLE (BOGIE). Two or more automotive type axles mounted in a frame so as to distribute the load between the axles and permit vertical oscillation of the wheels.

BACKFILLER. Machine used for refilling a trench or excavation. The term is applied to various machines equipped as shovel, hoe, clamshell, or dragline, and also to a small dragline with a backfiller board having chains or bridles for connection to hoist and dragline cables.

BACK HITCH GANTRY. A structural frame, located to the rear of the revolving superstructure and usually extending above the cab. Retractable means are usually available to lower to cab height for roadable convenience. Its purpose is to support the boom hoist derricking system.

BACKWARD STABILITY. Resistance to overturning of the machine in rearward direction, thereby prohibiting excessive counterweighting for a given attachment.

BAIL (BUCKET). A yoke or spreader hinged to sides of dragline bucket to which is attached connecting sheave or chain for hoisting and dragging operations.

BAIL PULL. Total pull developed at point of attachment of rope to dipper or bucket.

BALLAST. See "COUNTERWEIGHT."

BAND BRAKE. Circular type of brake either of external contracting type or internal expanding type, having a strap lined with heat and wear resistant friction material.

BAND CLUTCH. Circular type of clutch either of external contracting type or internal expanding type, having a strap lined with heat and wear resistant friction material.

BARREL. The lagging or body portion of a rope drum.

BASE (MOUNTING.) The traveling base upon which the superstructure is mounted, such as a truck, crawler or wheel platform.

BASE (ROTATING). See "REVOLVING SUPERSTRUCTURE."

BASE (TURNTABLE). See "REVOLVING SUPERSTRUCTURE."

BOGIE AXLE. See "AXLE (BOGIE)."

BOOM. See 4.07

BOOM ANGLE. See 4.07.2

BOOM CHORD. A main corner member of a lattice type boom.

BOOM HOIST. Means for controlling the angle of the boom.

BOOM LACING. Structural truss members at angles to and supporting the boom chords of a lattice type boom.

BOOM LENGTH. See 4.07.1

BOOM SECTIONS. See 4.07

BOOM SPLICES. Splicing connections for sections of basic crane boom and additional sections usually of the splice plate type, pin type or butt type.

BOOM STOP. A device used to limit the angle of the boom to the highest recommended boom angle.

BOOSTER. An auxiliary device attached to main functional clutch or brake to activate it for greater ease of operation. Also separate auxiliary device used to assist in other functions such as steering.

BRAKE. A device for retarding or stopping motion by friction or power means.

BRAKE SHOE. That part of a shoe-type brake or clutch which makes contact with brake drum or clutch drum.

BRIDLE. See "FLOATING HARNESS."

BUCKET. See "CONCRETE, CLAMSHELL AND DRAGLINE BUCKET." A material container attached to machine by flexible means, such as wire rope.

BULL GEAR. See "SWING GEAR."

CAB. A housing which covers the Operator and/or machinery.

CABLE. A flexible electrical conductor.

CAR BODY. Base frame. See par. 5.01.

CENTER PIN. Vertical pin or shaft which acts as rotation centering device and connects revolving superstructure and base mounting.

CENTER PINTLE. See "CENTER PIN."

CENTER POST. See "CENTER PIN."

CLAMSHELL. See Par. 7.21.

CLAMSHELL BUCKET. A bucket used with the clamshell attachment.

CLOSING LINE. The rope reeved from hoist drum to control closing of rope operated clamshell bucket.

CLUTCH. A friction, electromagnetic, hydraulic, pneumatic or mechanical locking device for engagement or disengagement of power.

CONCRETE BUCKET. Bucket for handling wet concrete, fitted with bail or bridle, usually handled on lifting crane and hoisted to dumping location.

CONVERTIBILITY. Ability of machine to be equipped for different types of work through interchangeability of front end equipment.

COUNTERWEIGHT. Weight used to supplement the weight of the machine in providing stability for lifting working loads and usually attached to rear of revolving superstructure. Also called "BALLAST."

CRAWLER BELT. Assembled crawler tread shoes and connecting pins around rollers and drive sprockets; that part of crawler which contacts the ground.

CRAWLER BEARING LENGTH. See Par. 5.02.

CRAWLER CHAIN. Chain used as final drive to the crawler belt.

CRAWLER FRAME. See "CRAWLER MOUNTING."

CRAWLER MOUNTING. See Par. 5.01.

CRAWLER SHOES. See "TREAD SHOES."

CROSSOVER. See "FLOATING HARNESS."

CUSHION BLOCK. Wood or plastic material positioned between the pile driving hammer and pile cap to reduce impact damage.

CUTTING LIP. The edge of a bucket which penetrates material to be excavated. Teeth may or may not be attached.

DERRICKING. Operation of changing boom angle in a vertical plane. See "BOOM HOIST."

DRAG ROPE. Rope for pulling in bucket in dragline operations.

DRAGLINE. See Par. 7.41.

DRAGLINE BUCKET. A bucket used with the dragline attachment.

DRAGLINE FAIRLEAD. See Par. 7.41.3.

DRIVE TUMBLER. Roller with teeth or lugs which contact matching recesses or lugs or pins in crawler belt.

DROP HAMMER. See Par. 7.51.1.

DRUM (ROPE). A rotating cylinder with side flanges on which rope used in machine operation is wrapped.

FAIRLEAD. A device to guide wire rope for proper spooling.

FLOATING HARNESS. A frame equipped with sheaves and connected to the boom by stationary ropes usually called pendants.

FREE FALL. Lowering of the hook (with or without load), or lowering of the boom by gravity, without being coupled to the power train, with the lowering speed being controlled by a retarding device, such as a brake.

FUEL PUMP (HAND). Hand-operated pump used for filling fuel tank by pumping fuel from another receptacle.

FULL-LOAD SPEED. Revolutions per minute of power plant at rated power.

GANTRY (A-FRAME). See Par. 4.05.

GOOSENECK BOOM. A boom which has an integral upper section projecting at an angle from longitudinal axis of lower section.

GOVERNED SPEED. Engine revolutions per minute controlled by the power plant govenor.

GRADEABILITY. The slope which a machine can climb expressed as a percentage.

GROUND PRESSURE. Weight of machine divided by the area of the surface directly supporting the machine.

GROUSER. Projecting lugs attached to, or integral with, crawler tread shoes to provide additional traction.

GUY ROPE. A supporting rope which maintains a constant distance between the points of attachment to the two components connected by the rope.

HAMMER (PILE). See Par. 7.51.1.

HAMMER HEAD BOOM. A boom on which both hoist and boom suspension lines are offset from centerline of boom for load clearance.

HOIST. The process of lifting.

HOIST MECHANISM. See Par. 4.02.

HOLDING LINE. The cable reeved from second hoist drum for holding clamshell bucket or grapple suspended during dumping and lowering operations.

HOLDING MECHANISM. A mechanical or hydraulic device to prevent motion.

HOOK BLOCK. Block with hook attached used in lifting service. It may have a single sheave for double or triple line, or multiple sheaves for four or more parts of line.

HOOK ROLLERS. Rollers which prevent the lifting of the turntable from the base.

IDLER ROLLER. Rollers of tread belt mechanism which are not power driven.

IDLER TUMBLER. Large end roller of crawler belt mechanism at opposite end from drive tumbler and which is not power driven.

INDEPENDENT BOOM HOIST, SWING, AND TRAVEL. A drive independent of all other functions.

JACK SHAFT. Term applied to an intermediate shaft.

JIB. See Par. 7.11.7.

KING PIN. See "CENTER PIN."

LACING. See "BOOM LACING."

LAGGINGS. Removable and interchangeable drum spool shells for changing drum diameter to provide variation in rope speeds and line pulls.

LATTICED BOOM. Boom of open construction with angular or tubular lacing between main corner members in form of truss.

LENGTH INDICATOR (BOOM). See Par. 7.11.3.

LIFTING CAPACITY. See Par. 7.03.

LINE PULL. See Par. 4.02.2, 4.02.3.

LINE SPEED. See Par. 4.02.4

LIVE ROLLER CIRCLE. An assembly of multiple swing rollers free to roll between revolving superstructure and mounting.

LOAD (WORKING). See Par. 7.03.

LOAD BLOCK. See "HOOK BLOCK."

LOAD LINE. Another term for "HOIST LINE." In lifting crane service it refers to the main hoist. The secondary hoist is referred to as a "WHIP LINE."

LOAD LOWERING. See Par. 4.02.1.

LOAD RATINGS. See Par. 7.03.

LUFFING. See "DERRICKING."

MAGNET. See Par. 7.31.

MAGNET CONTROLLER. Electric controller for governing flow of current to magnet. Part of magnet equipment.

MAST. Frame hinged at or near the boom hinge and extending above the cab for use in connection with supporting a boom. Head of mast is usually supported and raised or lowered by the boom hoist ropes.

MATS. Supports or floats used for supporting machine on soft ground. Usually of timber construction.

NET LOAD. See Par. 7.03.

OPERATING PRESSURE. The pressure that the pump delivers, determined by the pump relief.

OUTRIGGERS. Extendible or fixed arms attached to the mounting base, which rest on supports at the outer ends to increase stability.

OVERHAUL. Ability of a weight on end of hoist line to unwind cable from drum when brake is released.

PAY LOAD. See "NET LOAD."

PENDANT. Another term for "GUY ROPE."

PILE. Usually a long slender member driven into the ground.

PILE CAP. An adapter between the pile driving unit and the upper end of the pile.

PILE LEAD. A structure on which the pile driving unit and pile cap may operate.

PITCH DIAMETER. Root diameter of drum, lagging or sheave, plus the diameter of the rope.

POWER PLANT. See Par. 3.01.3.

POWER CONTROLLED LOWERING. See Par. 4.02.1.

POWER TAKEOFF. See Par. 6.03.

POWER TRAIN. The transfer of energy from one point to another and is accomplished by a mechanical couple, such as gears, chains, etc. or a hydraulic pump and motor couple, or a combination thereof.

PRIME-MOVER. See Par. 6.02.

RADIUS (OF LOAD). See Par. 7.01.2.

RATED LOAD. See Par. 7.03(1).

REAR END RADIUS. Clearance distance from center of rotation to maximum rear extension of revolving superstructure. Also called "TAIL SWING."

REEVING. A rope system where the rope travels around drums and sheaves.

REMOTE CONTROL. See Par. 5.19.

REVOLVING SUPERSTRUCTURE. See Par. 4.01.

RING GEAR. See "SWING GEAR."

ROLLER PATH. The surface upon which run the rollers that support revolving superstructure. It may accommodate either cone rollers, cylindrical rollers, or live rollers.

ROPE. Refers to wire rope unless otherwise specified. See "WIRE ROPE."

ROTATING BASE. See "REVOLVING SUPERSTRUCTURE."

SHOES. See "TREAD SHOES."

SIDE LOADING. A load applied at an angle to the vertical plane of the boom.

SLEWING. See "SWING."

SPREADER BAR. See "FLOATING HARNESS."

STABILITY. The ability of a mobile machine to resist tipping. Does not normally apply to a stationary mounting. Also see Par. 7.02.

STAY. See Guy Rope.

STEAM HAMMER. Steam driven pile hammer.

STRUCTURAL COMPETENCE. The ability of the machine and its components to withstand the stresses imposed by applied loads.

SUPERSTRUCTURE. See "REVOLVING SUPERSTRUCTURE."

SWAY BRACES. Stiffening ropes or rods with or without turnbuckles, sometimes used on each side of boom.

SWING. See Par. 4.04.

SWING BEARING. A combination of rings with balls or rollers capable of sustaining radial, axial, or overturning loads of the revolving superstructure.

SWING BRAKE. See Par. 4.04.2.

SWING CIRCLE. See "SWING BEARING."

SWING GEAR. External or internal gear with which swing pinion on revolving superstructure meshes to provide swing motion.

SWING LOCK. See Par. 4.04.2.

SWING MECHANISM. The machinery involved in providing dual directional rotation of the revolving superstructure.

SWING SPEED. See Par. 4.04.1.

TACKLE (HOIST). Assembly of ropes and sheaves arranged for pulling.

TAGLINE. See Par. 7.21.4.

TAIL SWING. See "REAR END RADIUS."

TELESCOPIC BOOM. A boom from which one or more boom extensions are telescoped to vary the length.

TIPPING CONDITION. See Par. 7.01.

TIPPING LOAD. See Par. 7.01.3.

TIRE SIZES. These are specified by diameter of casing, diameter of wheel and ply rating, i.e., 9.00 x 20-10 ply is a 9 inch diameter casing on a 20 inch diameter wheel or rim, and is of 10 ply construction.

TOOTH BASE. Main part of bucket tooth to which removable tooth points are fastened.

TOOTH POINTS. Removable and replaceable points for dipper or bucket teeth.

TOPPING SPEED. See boom hoist time 4.03.5.

TORQUE CONVERTER. Auxiliary hydraulic device connected to prime mover which multiplies engine torque as load increases with a corresponding decrease in speed.

TOWER ATTACHMENT. A crane attachment usually adaptable to a basic crane machine. The attachment consists of a vertical tower with a working boom affixed to the upper part of tower.

TRACK. See "CRAWLER BELT."

TRAVEL. The function of the machine moving from one location to another.

TRAVEL MECHANISM. The machinery involved in providing travel.

TREAD BELT. See "CRAWLER BELT."

TREAD SHOES. Hinged steel pads joined to form a continuous crawler belt which supports the machine.

TRENCH HOE. Another term for hoe.

TRUCK CRANE. Crane mounted on independent engine-driven rubber-tire carrier. See Par. 5.08.

TUMBLER. One of the large rollers for a crawler belt. See "IDLER TUMBLER" and "DRIVE TUMBLER."

TURNING CIRCLE. See Figure 1, Appendix A.

TURNTABLE. See "REVOLVING SUPERSTRUCTURE."

WHIP LINE. Secondary hoist line. Also see "LOAD LINE."

WIRE ROPE. A flexible, multi-wired member usually consisting of core member around which a number of multi-wired strands are "laid" or helically bent.

WORKING WEIGHT. Weight of machine in working order with complete front end equipment.

APPENDICES

APPENDIX A

NOMENCLATURE AND DIMENSIONS FOR MOBILE HYDRAULIC CRANES

This Standard includes names of major components and parts peculiar to this type equipment. Illustrations are not intended to show all existing commercial machines or to be exactly descriptive of any particular machine. They have been selected to depict principles used in identifying specific mechanism and to identify useful dimensional relationships.

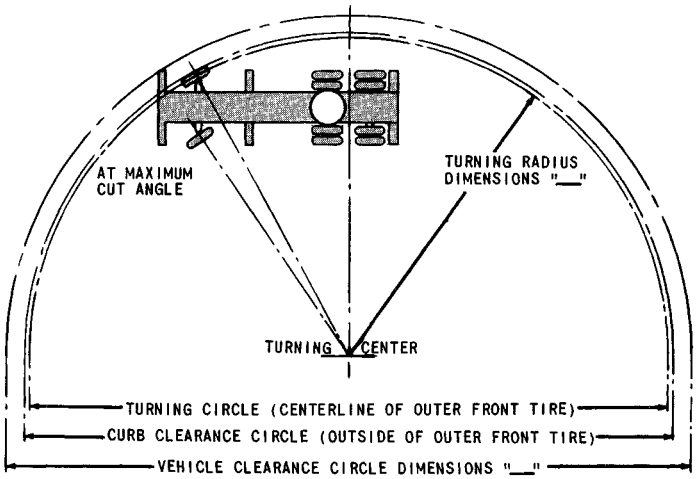


FIG. 1

NOTE: (DISREGARD OVERHANG OF FRONT END ATTACHMENT SINCE IT MAY BE SWUNG TO CLEAR)

DIMENSIONS

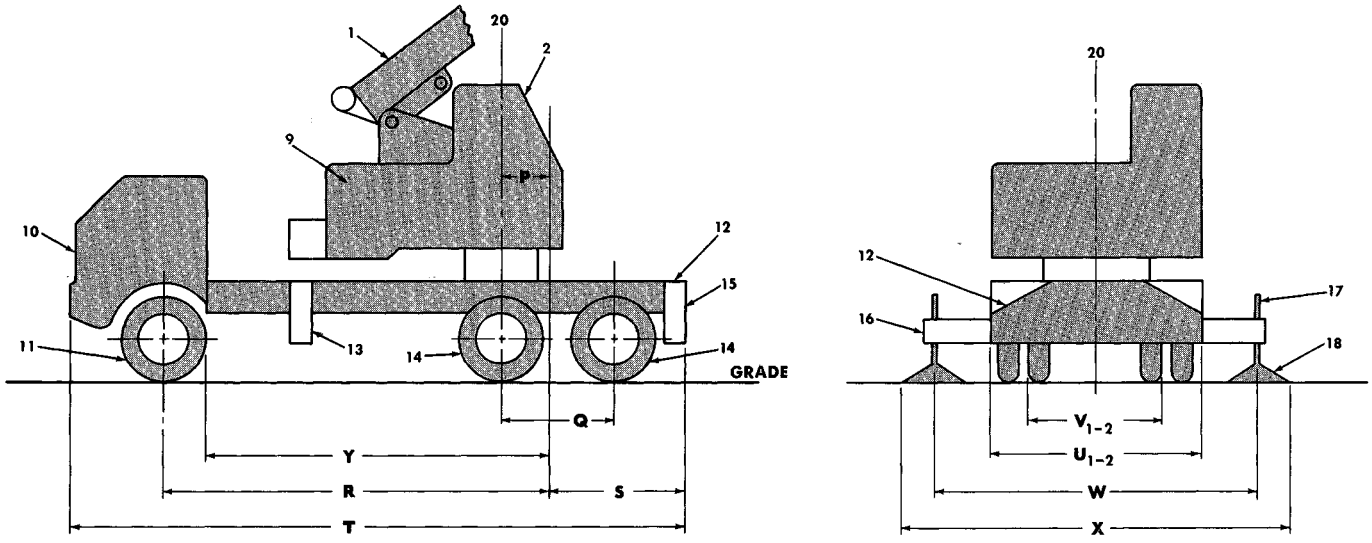
For revolving superstructure dimensions, see Fig. 4 & 5

- P DISTANCE FROM CENTER OF REAR AXLE OR BOGIE TO AXIS OF ROTATION
- Q DISTANCE BETWEEN CENTERS OF AXLES OF TANDEM AXLE BOGIE
- R WHEELBASE (WHEELBASE FOR TANDEM FRONT AXLE IS MEASURED TO TANDEM CENTER PIVOT POINT)
- S DISTANCE FROM CENTER OF REAR AXLE OR BOGIE TO REAR END OF FRAME
- T OVERALL LENGTH OF CARRIER
- U_1 MAXIMUM OVERALL WIDTH WITH RETRACTED OUTRIGGERS (FLOATS REMOVED)
- U_2 MAX. OVERALL WIDTH WITH RETRACTED OUTRIGGERS (FLOATS ATTACHED)
- V_1 TRACK OR TREAD WIDTH, REAR AXLE
- V_2 TRACK OR TREAD WIDTH, FRONT AXLE
- W EFFECTIVE LENGTH OF EXTENDED OUTRIGGERS
- X OVERALL WIDTH OVER FLOATS WITH OUTRIGGERS EXTENDED
- Y DISTANCE FROM BACK OF CARRIER CAB TO CENTER OF REAR AXLE OR BOGIE (KNOWN AS CA DISTANCE IN TRUCKING INDUSTRY)

DEFINITIONS

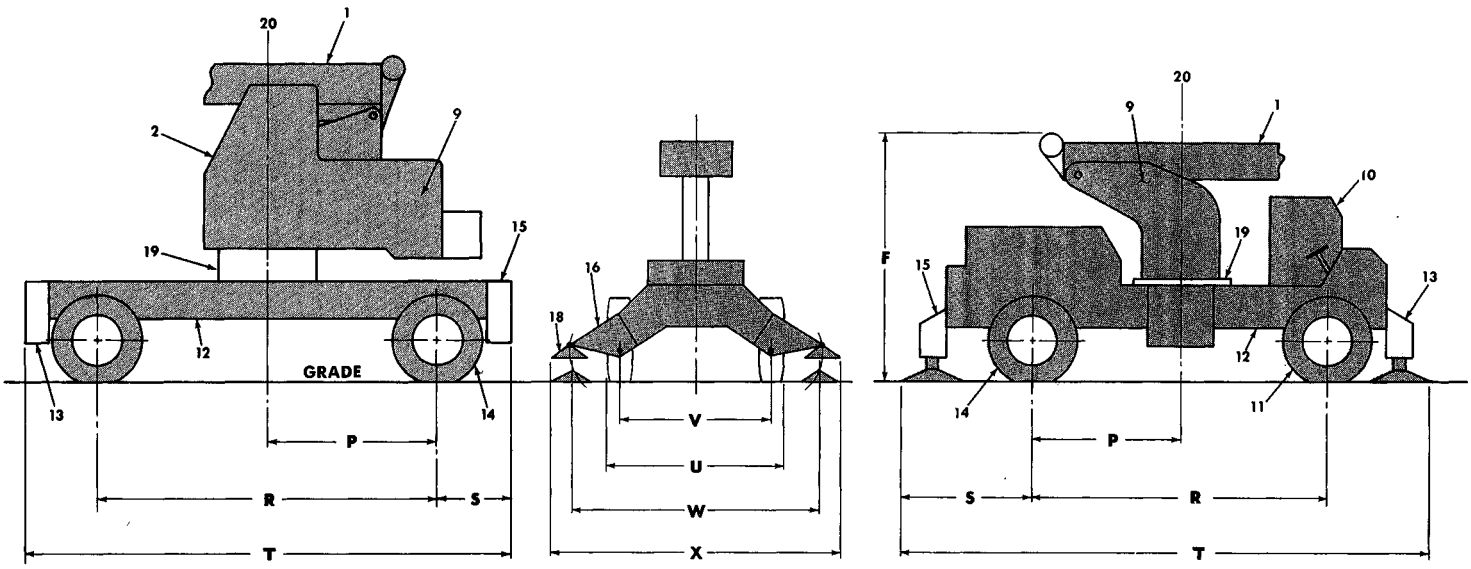
For revolving superstructure definitions, see Fig. 4 & 5

1. BOOM
2. CAB
9. REVOLVING SUPERSTRUCTURE
10. CARRIER CAB
11. FRONT AXLE
12. CARRIER FRAME
13. FRONT OUTRIGGER BOX
14. REAR AXLE
15. REAR OUTRIGGER BOX
16. OUTRIGGER BEAM
18. OUTRIGGER FLOAT
19. SWING CIRCLE OR ROLLER PATH
20. AXIS OF ROTATION



TRUCK TYPE MOUNTING (6x4 OR 6x6 SHOWN)

FIG. 2 — RUBBER TIRE CARRIER MOUNTINGS WITH REVOLVING SUPERSTRUCTURE



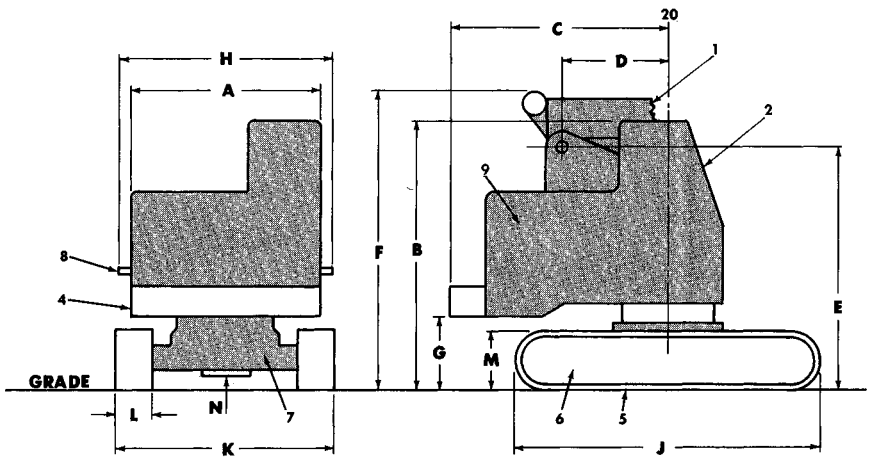
DIMENSIONS

F MAXIMUM HEIGHT OF ATTACHMENT WHEN IN TRAVEL POSITION
P DISTANCE FROM CENTER OF REAR AXLE TO AXIS OF ROTATION
R WHEELBASE
S DISTANCE FROM CENTER OF REAR AXLE TO REAR END OF FRAME
T OVERALL LENGTH OF CARRIER
U MAXIMUM OVERALL WIDTH WITH RETRACTED OUTRIGGERS
V TRACK OR TREAD WIDTH
W EFFECTIVE LENGTH OF EXTENDED OUTRIGGERS
X OVERALL WIDTH OVER FLOATS WITH OUTRIGGERS EXTENDED

DEFINITIONS

1. BOOM
2. CAB
9. REVOLVING SUPERSTRUCTURE
10. CARRIER CAB
11. FRONT AXLE
12. CARRIER FRAME
13. FRONT OUTRIGGER BOX
14. REAR AXLE
15. REAR OUTRIGGER BOX
16. OUTRIGGER BEAM
18. OUTRIGGER FLOAT
19. SWING CIRCLE OR ROLLER PATH
20. AXIS OF ROTATION

FIG. 3 — RUBBER TIRE CARRIER MOUNTING SELF-PROPELLED WITH REVOLVING SUPERSTRUCTURE



DIMENSIONS

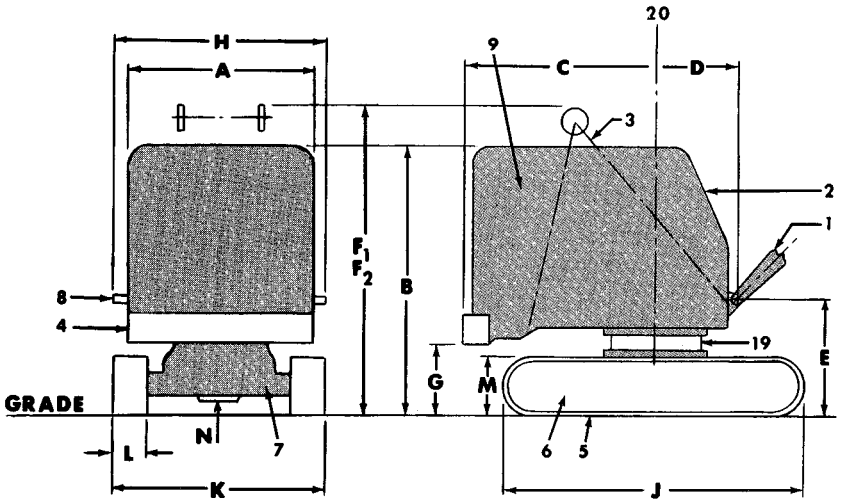
A WIDTH OF REVOLVING SUPERSTRUCTURE
B MAXIMUM HEIGHT OF CAB ABOVE GRADE
C SWING CLEARANCE (RADIUS OF REAR END FROM AXIS OF ROTATION
D DISTANCE OF BOOM FOOT PIN TO AXIS OF ROTATION
E HEIGHT OF BOOM FOOT PIN ABOVE GRADE
F MAX. HEIGHT OF ATTACHMENT WHEN IN TRAVEL POSITION
G DISTANCE UNDER COUNTERWEIGHT TO GRADE
H OVERALL WIDTH WHEN RUNNING BOARDS ARE USED
J OVERALL LENGTH OF CRAWLER
K_1 OVERALL WIDTH OF CRAWLER RETRACTED
K_2 OVERALL WIDTH OF CRAWLER EXTENDED
L WIDTH OF CRAWLER TREAD SHOES
M HEIGHT OF CRAWLER TREAD BELT AT CENTER OF END TUMBLERS
N MINIMUM CLEARANCE UNDER CRAWLER BASE TO GRADE

NOTE: For ground clearance dimensions see SAE J894.

DEFINITIONS

1. BOOM
2. CAB
4. COUNTERWEIGHT
5. CRAWLER TREAD BELT
6. CRAWLER SIDE FRAME
7. CARBODY OR CRAWLER BASE
8. RUNNING BOARD
9. REVOLVING SUPERSTRUCTURE
19. SWING CIRCLE OR ROLLER PATH
20. AXIS OF ROTATION

FIG. 4 — CRAWLER MOUNTING WITH REVOLVING SUPERSTRUCTURE (See Appendix B)



DIMENSIONS

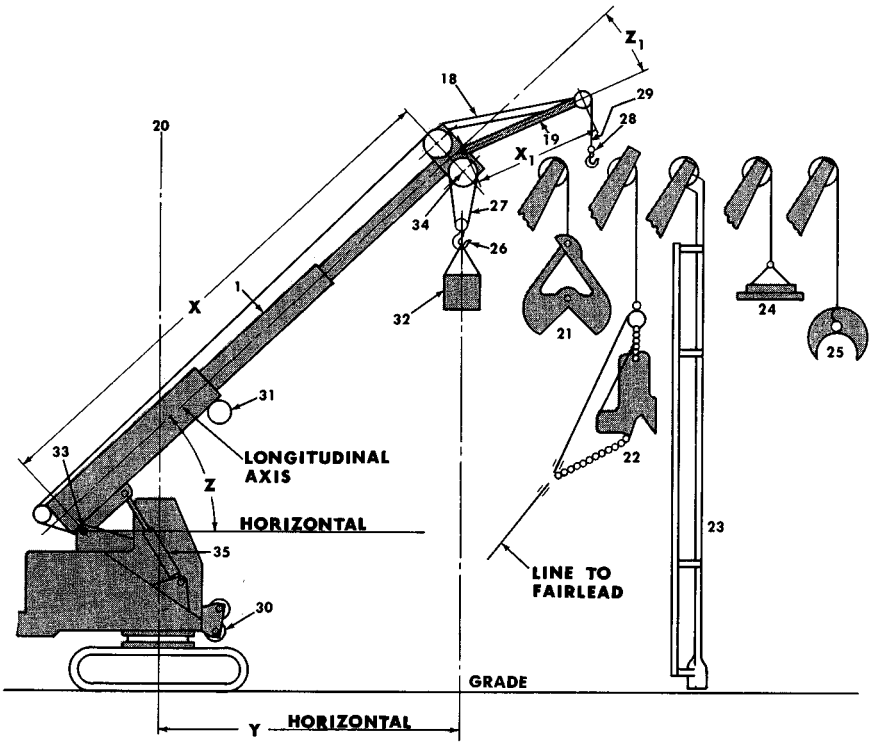
A WIDTH OF REVOLVING SUPERSTRUCTURE
B MAXIMUM HEIGHT OF CAB ABOVE GRADE
C SWING CLEARANCE (RADIUS OF REAR END FROM AXIS OF ROTATION
D DISTANCE OF BOOM FOOT PIN TO AXIS OF ROTATION
E. HEIGHT OF BOOM FOOT PIN ABOVE GRADE
F_1 GANTRY HEIGHT ABOVE GRADE WHEN IN LOWERED POSITION
F_2 GANTRY HEIGHT ABOVE GRADE WHEN IN RAISED OPERATING POSITION
G DISTANCE UNDER COUNTERWEIGHT TO GRADE
H OVERALL WIDTH WHEN RUNNING BOARDS ARE USED
J OVERALL LENGTH OF CRAWLER
K_1 OVERALL WIDTH OF CRAWLER RETRACTED
K_2 OVERALL WIDTH OF CRAWLER EXTENDED
L WIDTH OF CRAWLER TREAD SHOES
M HEIGHT OF CRAWLER TREAD BELT AT CENTER OF END TUMBLERS
N MINIMUM CLEARANCE UNDER CRAWLER BASE TO GRADE

DEFINITIONS

1. BOOM
2. CAB
3. GANTRY OR A-FRAME
4. COUNTERWEIGHT
5. CRAWLER TREAD BELT
6. CRAWLER SIDE FRAME
7. CARBODY OR CRAWLER BASE
8. RUNNING BOARD
9. REVOLVING SUPER-STRUCTURE
19. SWING CIRCLE OR ROLLER PATH
20. AXIS OF ROTATION

NOTE: For ground clearance dimensions see SAE J894.

FIG. 5 — CRAWLER MOUNTING WITH REVOLVING SUPERSTRUCTURE (See Appendix B)
ROPE SUPPORT TYPE



DIMENSIONS

X BOOM LENGTH PIN
X_1 JIB LENGTH FROM JIB FOOT PIN TO JIB HEAD SHEAVE PIN
Y RADIUS OF LOAD (ALSO APPLIES TO JIB HOOK LOAD)
Z BOOM ANGLE
Z_1 OFFSET ANGLE OF JIB (ALSO CAN BE GIVEN AS AN OFFSET DIMENSION)

DEFINITIONS

1. CRANE BOOM
18. JIB FRONT STAY LINES OR BRACE
19. JIB
20. AXIS OF ROTATION
21. CLAMSHELL BUCKET
22. DRAGLINE BUCKET
23. PILE DRIVER LEADS
24. MAGNET
25. GRAPPLE
26. MAIN LIFT HOOK BLOCK
27. MAIN HOIST LINE
28. JIB OR WHIPLINE HOOK
29. JIB OR AUXILIARY HOIST LINE
30. DRAGLINE FAIRLEAD
31. TAGLINE
32. CONCRETE BUCKET
33. BOOM PIVOT PIN
34. LOAD HOIST SHEAVE PIN
35. BOOM HOIST CYLINDER

FIG. 6 — COMMON CRANE BOOM EQUIPMENT

APPENDIX B

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TERMINOLOGY—CONSTRUCTION AND INDUSTRIAL MACHINERY—SAE J894

SAE Standard

Report of Construction and Industrial Machinery Technical Committee approved June 1964.

This SAE Standard includes terminology common to the usage of construction and industrial machinery. All measurements of physical dimensions shall be made with the vehicle equipped and loaded on a level surface with zero surface penetration, unless otherwise specified. Vehicle and equipment are to be in normal position.

1. Width—The distance between the vertical planes parallel to the vehicle axis through the farthest points on the two sides of the vehicle.

2. Length—The distance between the vertical planes perpendicular to the vehicle axis through the farthest points on the front and rear of the vehicle.

3. Height—The vertical distance to a plane parallel to the ground through the highest point on the vehicle.

4. Track Gage—The distance from the center of the sprocket teeth on one side of the vehicle to the center of the sprocket teeth on the other side.

5. Tread—The distance between the left and right tire center lines of each axle of the vehicle. Center line for dual tires is midway between tire centers.

6. Wheel Base—The horizontal longitudinal distance from the center of the front wheel to the center of the rear wheel. For tandem axles the distance is measured to a line midway between the two axles.

7. Angle of Approach— (See Fig. 1.) The angle between the horizontal and a plane, tangent to the forward tires or tracks of a vehicle and passing through lowest point of any structure or component forward of the tires or tracks, which limits the magnitude of the angle.

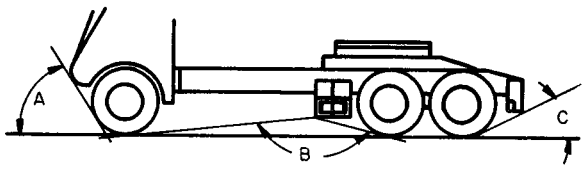

FIG. 1—A, ANGLE OF APPROACH; B, INTER-AXLE OF INTERFERENCE; C, ANGLE OF DEPARTURE

8. Inter-Axle Angle of Interference— (See Fig. 1.) The maximum angle between two planes intersecting on a downward projection of the vehicle where the first plane is tangent to the tires ahead of the intersection and the second plane is tangent to the tires behind the intersection.

9. Angle of Departure— (See Fig. 1.) The angle between the horizontal and a plane, tangent to the rear tires or tracks of a vehicle and passing through the lowest point of any structure or component behind the tires or tracks, which limits the magnitude of the angle.

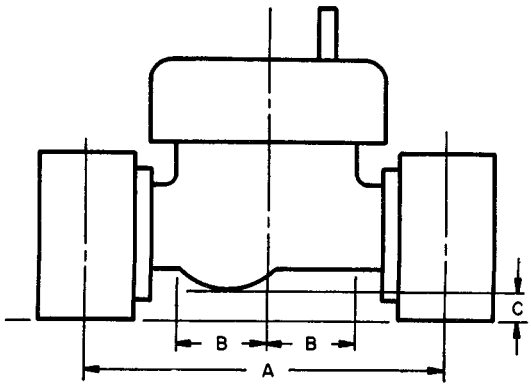

FIG. 2—A, TRACK GAGE OR TREAD; B, 25% OF A; C, GROUND CLEARANCE

10. Ground Clearance— (See Fig. 2.) The ground clearance is the perpendicular distance from the ground line to the lowest point of the center portion of the vehicle. The center portion of the vehicle is defined as 25% of the track gage or tread width to either side of the midpoint.

11. Inter-Track Angle of Interference— (See Fig. 3.) The maximum angle between two planes intersecting on a downward projection of the vehicle where the first plane passes through the inner edge of the left side track and the second plane passes through the inner edge of the right side track.

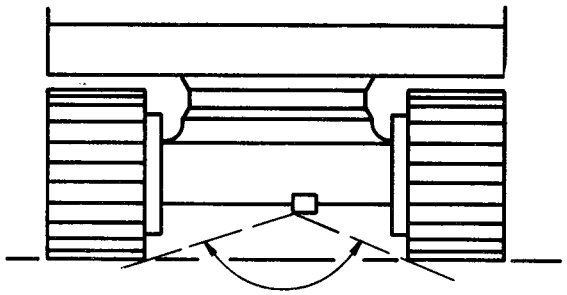

FIG. 3—INTER-TRACK ANGLE OF INTERFERENCE

12. Inter-Wheel Angle of Interference— (See Fig. 4.) The maximum angle between two planes intersecting on a downward projection of the vehicle where the first plane is tangent to the tire on the left side and the second plane is tangent to the tire on the right side.

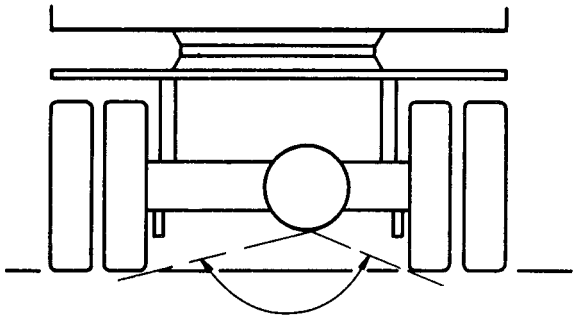

FIG. 4—INTER-WHEEL ANGLE OF INTERFERENCE

13. Ground Contact Area—The area of the tires or tracks in contact with the ground. Ground contact area depends on load, penetration, ground material and tire pressure or track adjustment; hence, all pertinent conditions should be specified or carefully described.

The gross contact area on a hard flat surface is the total area within the periphery of the contact pattern of the tire treads or tracks.

The net contact area on a hard flat surface is the sum of individual actual contacts between ground and tire treads or tracks.

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APPENDIX C

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TRUCK ABILITY PREDICTION PROCEDURE—SAE J688

SAE Recommended Practice

Report of Transportation and Maintenance Technical Committee approved October 1951 and last revised May 1958. Reaffirmed without change June 1963.

INTRODUCTION—The procedure has been developed to provide a practical method for the prediction of truck performance using accepted data. It is designed to help anyone concerned with the problem of truck selection.

By following directions, it is possible to determine the necessary information for intelligent truck selection without being concerned with the origin or derivation of the complex factors involved. With readily available specifications of a truck, information provided in the tables, and a minimum of calculation, it is possible to predict:

(a) The performance obtainable from a truck of given characteristics under given operating conditions.

(b) The characteristics required in a truck to meet different performance requirements under given operating conditions.

This report comprises a procedure form and 10 tables of data. A complete explanation of the truck ability prediction procedure is contained in SAE Technical Report TR-82, Truck Ability Prediction Procedure. Part 1 of TR-82 contains, in addition to the procedure form and tables, work sheets[1] and an example. Part 2 demonstrates by practical examples how to obtain some of the answers other than grade ability, and presents a detailed procedure for computing instantaneous acceleration and the time or distance required to accelerate between specified limits of speed. Part 3 gives terminology, the fundamental relations, and the formulas which form the basis for the procedure, a discussion of the reliability of factors and methods, and presents a method for evaluating the effect of wind on air resistance.

TABLE 1—TIRE FACTOR

Tubeless Tire Size	Conventional Tire Size	Ply Rating	Tire Factor
6.00–16	6.00–16	6	12.40
6.50–16	6.50–16	6	11.85
7–17.5	7.00–15, 7.00–16	6	11.75
7–17.5	7.00–15, 7.00–16	8	11.75
7–22.5	6.50–20	6	10.15
7–22.5	6.50–20, 7.00–20	8	10.15
8–17.5	7.00–16, 7.50–15 7.50–16	6	11.45
8–17.5	7.00–16, 7.50–15 7.50–16	8	11.45
8–19.5	7.00–17, 7.50–17	6	10.50
8–19.5	7.00–17, 7.50–17	8	10.50
8–22.5	7.50–20	8	9.50
8–22.5	7.50–20	10	9.50
9–22.5	8.25–20	10	9.20
9–22.5	8.25–20	12	9.20
10–22.5	9.00–20	10	8.80
10–22.5	9.00–20	12	8.80
11–22.5	10.00–20	12	8.55
11–22.5	10.00–20	14	8.55
11–24.5	10.00–22	12	8.15
12.00–21	12.00–20	14	8.05
12.00–25	12.00–24	14	7.35
12–22.5	11.00–20	12	8.30
12–22.5	11.00–20	14	8.30
12–24.5	11.00–22	12	7.90
12–24.5	11.00–22	14	7.90
13.00–21	13.00–20	16	7.75
13.00–25	13.00–24	16	7 10
14.00–21	14.00–20	16	7.35
14.00–24	14.00–24	16	6.75

$$\text{Tire Factor} = \frac{168}{\text{Loaded Radius}}$$

TABLE 2—ALTITUDE FACTOR (FOR NET HP CORRECTION

Altitude, ft	Altitude Factor	Altitude, ft	Altitude Factor
0	1.00	8,000	0.68
1,000	0.96	9,000	0.64
2,000	0.92	10,000	0.60
3,000	0.88	11,000	0.56
4,000	0.84	12,000	0.52
5,000	0.80	13,000	0.48
6,000	0.76	14,000	0.44
7,000	0.72	15,000	0.40

PROCEDURE FORM FOR DETERMINING GRADE ABILITY AT A GIVEN ROAD SPEED AND EQUIVALENT ACCELERATION RATE

Data Pertaining to Vehicle and Conditions of Operation

Item

1. Vehicle identification [Make, model, and type of vehicle(s)]
2. Vehicle overall maximum dimensions (a) Height.....ft (b) Width.....ft
3. Total gross weight in thousand lb .....
4. Manufacturer's maximum gross vehicle weight rating for power unit in pounds .....
5. Gear ratios (a) Transmission..... (b) Auxiliary transmission..... (c) Axle.....
(d) Total gear reduction.....
6. Tire size (driving wheels).....
7. Net engine power at sea level (a) .....hp at (b) .....rpm engine speed
8. Altitude .....ft
9. Road surface type and condition .....

PROCEDURE

Steps	Procedure	Value
1. Apparent road speed in mph [a]	$\frac{\text{(Item 7b)}}{\text{(Item 5d)} \times \left(\frac{\text{Tire factor,}}{\text{Table 1}}\right)}$	
2. Net engine hp corrected for altitude	$\left(\frac{\text{Altitude factor,}}{\text{Table 2}}\right) \times$ (Item 7a)	
3. Rolling resistance hp	$\left(\frac{\text{Rolling factor,}}{\text{Table 3}}\right) \times$ (Item 3)	
4. Air resistance hp	$\left(\frac{\text{Area factor,}}{\text{Table 4}}\right) \times \left(\frac{\text{Velocity factor,}}{\text{Table 5}}\right) \times \left(\frac{\text{Altitude factor,}}{\text{Table 6}}\right)$	
5. Chassis friction hp	(Chassis factor, Table 7)	
6. Level road hp	Sum of values 3, 4, and 5	
7. Reserve hp[b]	(Value 2) minus (Value 6)	
8. Grade resistance hp per 1000 lb weight	$\frac{\text{(Value 7)}}{\text{(Item 3)}}$	
9. Grade ability on Class I roads (good) [c]	(Value 8) $\times \left(\frac{\text{Grade factor,}}{\text{Table 8}}\right)$	
10. Grade deduction for road type and and condition	(Road factor, Table 9)	
11. Net grade ability at apparent road speed [b]	(Value 9) minus (Value 10)	
12. Approximate acceleration rate on level at apparent road speed in mph per sec (total gear reduction less than 10.0)	(0.2) × (Value 11)	

[a] Apparent road speed can be attained under given conditions only if sufficient net hp is available.
[b] If this value is negative, the net hp is insufficient to attain apparent road speed.
[c] Correct value using Table 8A if 20% or above.

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TABLE 3—ROLLING FACTOR

Mph	Rolling Factor	Mph	Rolling Factor	Mph	Rolling Factor	Mph	Rolling Factor	Mph	Rolling Factor	Mph	Rolling Factor	Mph	Rolling Factor
1	0.020	11	0.252	21	0.531	31	0.859	41	1.234	51	1.658	61	2.129	71	2.649
2	0.041	12	0.278	22	0.562	32	0.894	42	1.275	52	1.703	62	2.179	72	2.703
3	0.063	13	0.304	23	0.593	33	0.930	43	1.315	53	1.748	63	2.229	73	2.758
4	0.085	14	0.331	24	0.625	34	0.967	44	1.356	54	1.794	64	2.280	74	2.814
5	0.107	15	0.358	25	0.657	35	1.003	45	1.398	55	1.841	65	2.331	75	2.870
6	0.130	16	0.386	26	0.689	36	1.041	46	1.440	56	1.888	66	2.383	76	2.927
7	0.154	17	0.414	27	0.722	37	1.078	47	1.483	57	1.935	67	2.435	77	2.983
8	0.177	18	0.443	28	0.756	38	1.117	48	1.526	58	1.983	68	2.488	78	3.041
9	0.202	19	0.472	29	0.790	39	1.155	49	1.569	59	2.031	69	2.541	79	3.099
10	0.227	20	0.501	30	0.824	40	1.195	50	1.613	60	2.080	70	2.595	80	3.157

$$\text{Rolling factor} = \frac{(7.6 + 0.09 \text{ mph}) \times \text{mph}}{375}$$

TABLE 4—AREA FACTOR

Maximum Vehicle Height, ft	Max Vehicle Width, ft						
	5	5-1/2	6	6-1/2	7	7-1/2	8
5	0.057	0.062	0.068	0.074	0.079	0.085	0.091
5-1/2	0.063	0.070	0.076	0.082	0.089	0.095	0.101
6	0.070	0.077	0.084	0.091	0.098	0.105	0.112
6-1/2	0.077	0.084	0.092	0.100	0.107	0.115	0.123
7	0.083	0.092	0.100	0.108	0.117	0.125	0.133
7-1/2	0.090	0.099	0.108	0.117	0.126	0.135	0.144
8	0.097	0.106	0.116	0.126	0.135	0.145	0.155
8-1/2	0.103	0.114	0.124	0.134	0.145	0.155	0.165
9	0.110	0.121	0.132	0.143	0.154	0.165	0.176
9-1/2	0.117	0.128	0.140	0.152	0.163	0.175	0.187
10	0.123	0.136	0.148	0.160	0.173	0.185	0.197
10-1/2	0.130	0.143	0.156	0.169	0.182	0.195	0.208
11	0.137	0.150	0.164	0.178	0.191	0.205	0.219
11-1/2	0.143	0.158	0.172	0.186	0.201	0.215	0.229
12	0.150	0.165	0.180	0.195	0.210	0.225	0.240
12-1/2	0.157	0.172	0.188	0.204	0.219	0.235	0.251
13	0.163	0.180	0.196	0.212	0.229	0.245	0.261
13-1/2	0.170	0.187	0.204	0.221	0.238	0.255	0.272

$$\text{Area factor} = \frac{(\text{height} - \tfrac{5}{4}) \times \text{width}}{375}$$

TABLE 5—VELOCITY FACTOR

Mph	Velocity Factor	Mph	Velocity Factor	Mph	Velocity Factor	Mph	Velocity Factor
1	0.00	21	18.5	41	138	61	454
2	0.02	22	21.3	42	148	62	477
3	0.05	23	24.3	43	159	63	500
4	0.13	24	27.6	44	170	64	524
5	0.25	25	31.3	45	182	65	549
6	0.43	26	35.1	46	195	66	575
7	0.69	27	39.4	47	208	67	601
8	1.02	28	43.9	48	221	68	629
9	1.46	29	48.8	49	235	69	657
10	2.00	30	54.0	50	250	70	686
11	2.66	31	59.6	51	265	71	716
12	3.46	32	65.5	52	281	72	746
13	4.39	33	71.9	53	298	73	778
14	5.49	34	78.6	54	315	74	810
15	6.75	35	85.7	55	333	75	844
16	8.19	36	93.3	56	351	76	878
17	9.83	37	101	57	370	77	913
18	11.7	38	110	58	390	78	949
19	13.7	39	119	59	411	79	986
20	16.0	40	128	60	432	80	1024

$$\text{Velocity factor} = 0.002 \text{ (mph)}^2$$

TABLE 6—ALTITUDE FACTOR (FOR AIR RESISTANCE)

Altitude, ft	Altitude Factor
0	1.00
1,000	0.97
2,000	0.94
3,000	0.91
4,000	0.89
5,000	0.86
6,000	0.83
7,000	0.81
8,000	0.78
9,000	0.76
10,000	0.74
11,000	0.71
12,000	0.69
13,000	0.67
14,000	0.65
15,000	0.63

TABLE 7—CHASSIS FRICTION HORSEPOWER[a]

Manufacturer's Max Gross Vehicle Weight Rating of Power Unit	Engine Rpm													
	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400
10,000	2.6	3.0	3.4	3 8	4.2	4.6	5.0	5.4	5.8	6.2	6.6	7.0	7.4	7.8
11,000	2.7	3.2	3.6	4.1	4.5	4.9	5.4	5.8	6.3	6.7	7.1	7.6	8.0	8.5
12,000	2.9	3.4	3.9	4.4	4.8	5.3	5.8	6.3	6.8	7.2	7.7	8.2	8.7	9.2
13,000	3.0	3.6	4.1	4.6	5.1	5.6	6.2	6.7	7.2	7.7	8.2	8.8	9.3	9.8
14,000	3.2	3.8	4.4	4.9	5.5	6.0	6.6	7.2	7.7	8.3	8.8	9.4	10.0	10.5
15,000	3.4	4.0	4.6	5.2	5.8	6.4	7.0	7.6	8.2	8.8	9.4	10.0	10.6	11.2
16,000	3.6	4.2	4.8	5.5	6.1	6.8	7.4	8.0	8.7	9.3	10.0	10.6	11.2	11.9
17,000	3.7	4.4	5.0	5.7	6.4	7.1	7.8	8.4	9.1	9.8	10.6	11.2	11.8	12.5
18,000	3.9	4.6	5.3	6.0	6.8	7.5	8.2	8.9	9.6	10.4	11.1	11.8	12.5	13.2
19,000	4.0	4.8	5.5	6.3	7.1	7.8	8.6	9.3	10.1	10.9	11.6	12.4	13.1	13.9
20,000	4.2	5.0	5.8	6.6	7.4	8.2	9.0	9.8	10.6	11.4	12.2	13.0	13.8	14.6
22,000	4.5	5.4	6.3	7.1	8.0	8.9	9.8	10.7	11.5	12.4	13.2	14.2	15.1	15.9
24,000	4.8	5.8	6.8	7.7	8.7	9.6	10.6	11.6	12.5	13.5	14.4	15.4	16.4	17.3
26,000	5.1	6.2	7.2	8.2	9.3	10.3	11.4	12.4	13.4	14.5	15.5	16.6	17.6	18.6
28,000	5.5	6.6	7.7	8.8	9.9	11.1	12.2	13.3	14.4	15.5	16.7	17.8	18.9	20.0
30,000	5.8	7.0	8.2	9.4	10.5	11.8	13.0	14.2	15.4	16.5	17.8	19.0	20.2	21.3
32,000	6.1	7.4	8.7	10.0	11.2	12.5	13.8	15.1	16.4	17.6	18.9	20.2	21.5	22.7
36,000	6.8	8.2	9.6	11.1	12.5	13.9	15.4	16.8	18.3	19.7	21.2	22.6	24.0	25.5
40,000	7.4	9.0	10.6	12.2	13.8	15.4	17.0	18.6	20.2	21.8	23.4	25.0	26.6	28.2
45,000	8.2	10.0	11.8	13.6	15.4	17.2	19.0	20.8	22.6	24.4	26.2	28.0	29.8	31.6
50,000	9.0	11.0	13.0	15.0	17.0	19.0	21.0	23.0	25.0	27.0	29.0	31.0	33.0	35.0
60,000	10.6	13.0	15.4	17.8	20.2	22.6	25.0	27.4	29.8	32.2	34.6	37.0	39.4	41.8

[a] These values are tentative and apply only to rear wheel driven vehicles.

TABLE 8—GRADE FACTOR

(use with correction Table 8A for grades over 20%)

Mph	Grade Factor	Mph	Grade Factor	Mph	Grade Factor	Mph	Grade Factor
1	37.50	21	1.78	41	0.91	61	0.61
2	18.75	22	1.70	42	0.89	62	0.60
3	12.50	23	1.63	43	0.87	63	0.60
4	9.38	24	1.56	44	0.85	64	0.59
5	7.50	25	1.50	45	0.83	65	0.58
6	6.25	26	1.44	46	0.82	66	0.57
7	5.36	27	1.39	47	0.80	67	0.56
8	4.68	28	1.34	48	0.78	68	0.55
9	4.17	29	1.29	49	0.77	69	0.54
10	3.75	30	1.25	50	0.75	70	0.54
11	3.41	31	1.21	51	0.74	71	0.53
12	3.12	32	1.17	52	0.72	72	0.52
13	2.88	33	1.14	53	0.71	73	0.51
14	2.68	34	1.10	54	0.69	74	0.51
15	2.50	35	1.07	55	0.68	75	0.50
16	2.34	36	1.04	56	0.67	76	0.49
17	2.20	37	1.01	57	0.66	77	0.49
18	2.08	38	0.99	58	0.65	78	0.48
19	1.97	39	0.96	59	0.64	79	0.47
20	1.87	40	0.94	60	0.62	80	0.47

$$\text{Grade Factor} = \frac{37.5}{\text{mph}}$$

TABLE 8A—CORRECTION FOR VALUES OF GRADE ABILITY ABOVE 20%

Computed Grade Ability	Cotrected Grade Ability	Computed Grade Ability	Corrected Grade Ability
20	20.4	37	39.8
21	21.5	38	41.1
22	22.6	39	42.4
23	23.6	40	43.6
24	24.7	41	45.0
25	25.8	42	46.3
26	26.9	43	47.6
27	28.0	44	49.0
28	29.2	45	50.4
29	30.3	46	51.8
30	31.5	47	53.2
31	32.6	48	54.7
32	33.8	49	56.2
33	35.0	50	57.7
34	36.2	51	59.3
35	37.4	52	60.9
36	38.8		

TABLE 9—ROAD FACTOR

Road Class	Road Surface Type	Factor		
		Condition of Surface		
		Good	Fair	Poor
I	Cement concrete Brick Asphalt block Asphalt plank Granite block Sheet asphalt Asphaltic concrete Bituminous macadam (high type) Wood block	0.0	0.1	0.2
II	Bituminous macadam (low type) Bituminous (tar) Oil mats (oiled macadam) Treated gravel	0.2	0.6	1.0
III	Sand clay Gravel Crushed stone Cobbles	0.5	1.0	1.5
IV	Earth Sand	1.0	1.5	2.5

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APPENDIX D

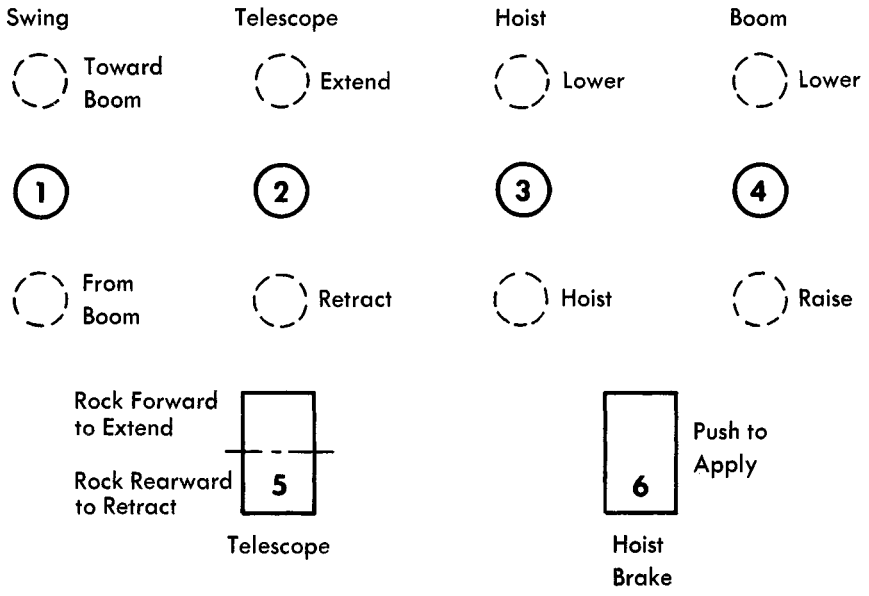
SUGGESTED MOBILE HYDRAULIC CRANE BASIC OPERATING CONTROL ARRANGEMENT

The following control arrangement applies to mobile hydraulic crane hand and foot controls.

GENERAL NOTES:

1. The arrangement of the basic controls should be as shown in the hydraulic crane control diagram. Controls 1, 2, 3 and 4 are levers for hand operation; controls 5 and 6 are pedals for foot operation if applicable.
2. Controls for auxiliary functions, such as telescope and hoist, should be located adjacent to the main controls. Controls for all other functions shall be positioned to avoid operator confusion and physical interference. Nothing in this recommended practice precludes the use of additional controls subject to the recommendations herein.
3. All basic controls should operate as specified in the control diagram. It is not the intent to limit the use of, or to apply to combination, automatic, or other special operating control requirements.
4. All controls shall return to their released positions automatically upon operator release when not intentionally restrained for functional purposes.

HYDRAULIC CRANE CONTROL DIAGRAM
(Viewed from Operator's Seat)



Control	Operation
1. Swing Control	Push forward to swing toward boom, swinging left for right side operator position and right for left side operator position. For centrally located operator, same as left side operator position. Pull rearward to reverse action.
2. Telescope Control (If Applicable)	Push forward to extend telescopic boom. Center position to hold. Pull rearward to retract telescopic boom.
3. Hoist Control	Pull rearward to hoist. Center position may be hold. Push forward to lower by power.
4. Boom Control	Pull rearward to raise boom. Center position to hold. Push forward to lower boom.
5. Telescope Pedal (If Applicable)	Rock pedal forward to extend telescopic boom. Center position to hold. Rock pedal rearward to retract telescopic boom.
6. Hoist Brake (If Applicable)	Push to stop or hold lowering load. Release to lower load.

APPENDIX E

(Reproduced by permission of Society of Automotive Engineers, Inc.)

LIFTING CRANE SHEAVE AND DRUM SIZES—SAE J881

SAE Standard

Report of Construction and Industrial Machinery Technical Committee approved April 1964.

Scope— This SAE Standard covers minimum dimensional relations for sheaves, drums and wire rope for mobile, construction type lift cranes.

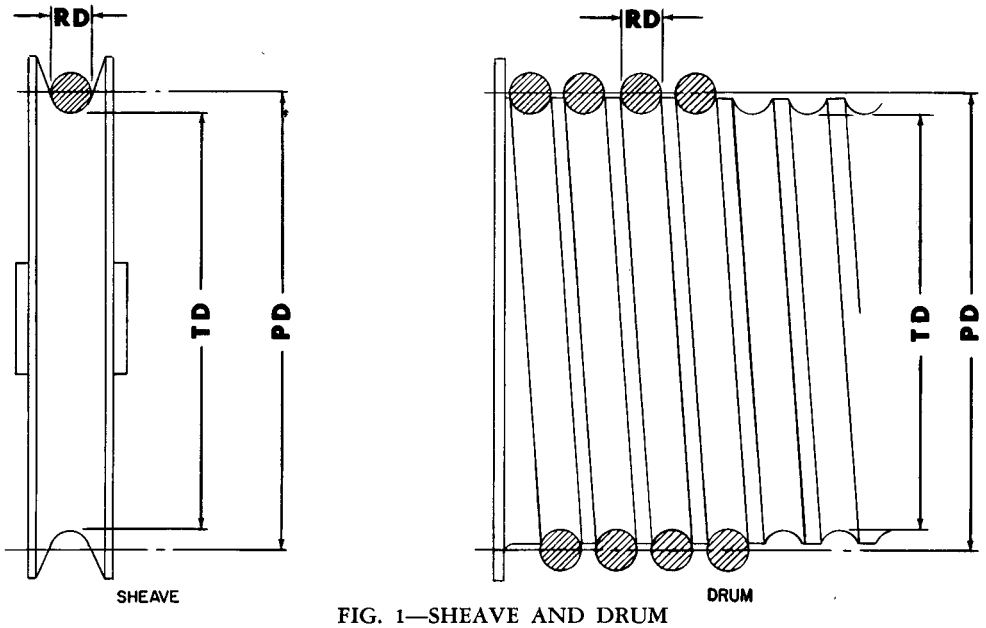


FIG. 1—SHEAVE AND DRUM

PD = Pitch diameter of sheave or drum, measured to centerline of rope.

TD = Tread diameter of sheave or drum, measured to bottom of groove (TD + RD = PD)

RD = Nominal rope diameter

TABLE 1

Use	Minimum Ratio PD/RD
Load hoisting sheaves, on boom	18.0 to 1
Load hoisting sheaves, in traveling blocks	16.0 to 1
Load hoisting drum	18.0 to 1
Boom hoisting sheaves	15.0 to 1
Boom hoisting drum	15.0 to 1

APPENDIX F

(Reproduced from 1967 SAE Handbook by permission of Society of Automotive Engineers, Inc.)

CRANE LOAD STABILITY TEST CODE—SAE J765

SAE Recommended Practice

Report of Construction and Industrial Machinery Technical Committee approved April 1961.

1. Purpose—The purpose of this test is to determine the maximum capacity of a crane to counterbalance loads applied on its hook block. The capacity of the crane is reported in terms of the load in pounds and its corresponding radius in feet for a specified position of the superstructure with respect to the mounting.

2. Scope—This test may be used for all revolving cranes wherein the capacity of the crane to support loads is based on its resistance to overturning. It is not applicable to cranes wherein the capacity of the crane is based on structural strength or available hoisting power.

3. Definitions

3.1 Balance Point—The condition of crane loading wherein the load moment acting to overturn the crane is equal to the maximum moment

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of the crane available to resist overturning. On wheel mounted cranes where balance loads are supported over an end of the mounting equipped with free-oscillating dual axles, the balance point, without outriggers set, is determined with the oscillating center of the axles or "bogieaxle" functioning as the fulcrum.

3.2 Axis of Rotation—A vertical line thru the axis around which the crane superstructure rotates, before load is applied to the crane hook.

3.3 Load—The force acting to unbalance a crane; it results from (1) the gravitational force created by hook block and all items suspended from the hook block; (2) force exerted by hoisting on a fixed anchor; or (3) a combination of the above forces.

3.4 Radius of Load—The horizontal distance from a projection of the axis of rotation to the supporting surface, before loading, to the center of vertical hoist line or tackle with load applied.

3.5 Specified—The term specified, where used herein, is construed to mean the recommendation of the manufacturer, the user, the testing agency or any agreement between these parties.

4. Limitations—It is critically important that the manufacturer's maximum permissible load and radius limitations are not exceeded since these limitations are frequently based on structural strength rather than resistance to overturning. In no case should users of this code perform balance capacity lifts with the load supported on one outrigger or support point because of the structural limitations and safety hazards involved.

5. Methods—Two methods for conducting these tests are covered. In the first, the load is applied by suspending a weight of predetermined magnitude and adjusting its position horizontally to the balance point. In the second, the load is applied by hoisting on a fixed anchor and adjusting the hoisting force and boom so that the hoist line is vertical while the force necessary to bring the crane to the balance point is applied to the hoist line.

6. Facilities—Apparatus and Materials.

6.1 Facilities common to both suspended-load and anchor-load methods:

6.1.1 A concrete or other firm supporting surface, level within ± 1% of grade.

6.1.2 Steel tape.

6.1.3 Tire pressure gage; accuracy ± 3% of measured pressure.

6.1.4 Means for projecting the crane axis of rotation to the test course surface.

6.1.5 Means for measuring the horizontal distance from the axis of rotation to the center of gravity of the load.

6.1.6 Means for determining the weight of test weights, hook block, slings and other auxiliary equipment; accuracy ± ½% of measured load.

6.2 Facilities necessary for the suspended-load method only:

6.2.1 Test weights, as required to make-up specified loads, and to provide additional load in ten pound increments.

6.3 Facilities necessary for the anchor-load method only:

6.3.1 Means for measuring the force in pounds exerted by the hoist line on the hoisting anchor; accuracy ± ½% of the force measured.

6.3.2 Means for determining that hoisting lines are vertical.

7. Procedure

7.1 Common to both suspended-load and anchor-load methods:

7.1.1 Service and adjust the crane as applicable to assure specified onditions of:

(a) Lubrication
(b) Fuel supply
(c) Tire inflation
(d) Coolant supply
(e) Track tension
(f) Bolts, pins, cable fittings, and other load bearing components
(g) Clutches, brakes, and other power transmission components
(h) Boom length and rigging.

7.1.2 Operate the crane under partial load sufficiently long to assure operator proficiency and proper machine function. In the absence of specific recommendations, a new machine should be operated for at least four hours. Service and adjust the machine to specified tolerances at conclusion of the "Limbering-Up" operation.

7.1.3 Locate the crane on the test course in position for loading and lock the travel brakes.

7.1.4 Set outriggers, if used, and jack the crane to a position where the tires or tracks within the boundary of the outriggers are unloaded.

7.1.5 Vertically project the superstructure axis-of-rotation to the surface of the test course and mark its location.

7.2 Procedure for suspended loads:

CRANE LOAD STABILITY
TEST SUMMARY

Testing Agency_____ Location_____
Make_____ Model_____ Serial No._____
Condition: New_____ Used_____ Hours_____
Mounting: Type_____ Size_____
Tires: Size_____ Ply_____ Pressure (psi)_____
Boom: Type_____ Length (ft)_____
Boom Jib: Type_____ Length (ft)_____ Angle to the Boom_____
Engine: Make_____ Model_____ Serial No._____
Counterweight: Type_____ lb_____
Test Method: Suspended Weights_____ Anchor_____

BALANCE POINTS

Position of Superstructure	Without Outriggers		With Outriggers	
	Load (lb)	Radius (ft)	Load (lb)	Radius (ft)

Remarks:

Test Engineer:_____ Date of Test:_____

FIG. 1—PAGE 1 OF TEST SUMMARY

7.2.1 Prepare test load including test weights, hook block, slings, and other auxiliary equipment, such as load basket, that make up the specified load weight within ± 1%. Record this value.

7.2.2 With the crane superstructure in the specified position, hoist the load free of the test course at a radius where the crane is stable; then, boom the load out to a radius near the balance point.

NOTE: The load should be kept near the test course surface in order to avoid excessive tipping of the crane. Also, the crane should be safeguarded—by blocking or other means—from overturning backward should the load line or other tackle fail while under load.

7.2.3 Alternately measure the radius of load and add a ten pound increment to the load until the load overcomes the stability of the crane. The radius of load and load weight last obtained, before the load overcame the stability of the crane, shall be recorded as the balance point condition.

7.3 Procedure for anchor-load method:

7.3.1 Determine the weight of the hook block and any part of the force measuring means that will be suspended by the hook block. Record these values.

7.3.2 Install the force measuring means between the hook and anchor.

7.3.3 With the crane in the specified position for lift and with the load line kept vertical while under load:

(a) Apply hoisting force to the anchor until the indicated magnitude of force tends to diminish with continued hoisting.

(b) Record the observed hoisting force and the radius of load. The peak hoisting force in pounds plus the weight of the hook block and other equipment suspended between the hook block and anchor constitutes the load for record.

8. Computations and Records

8.1 Capacity Curve—Where it is desired to determine the balance point capacity of a crane throughout a range of loads or radii, follow

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procedures as outlined for individual determinations, making sure that load and radius are determined for each extreme of the range and at a sufficient number of intermediate points to permit plotting a curve. Plot a curve showing the maximum capacity of the crane with the load in pounds as ordinate and radii in feet as abscissa.

8.2 Test Records—Record a description of the crane, positions for test, load data and radius of load data on the Physical Dimensions Test Summary sheets.

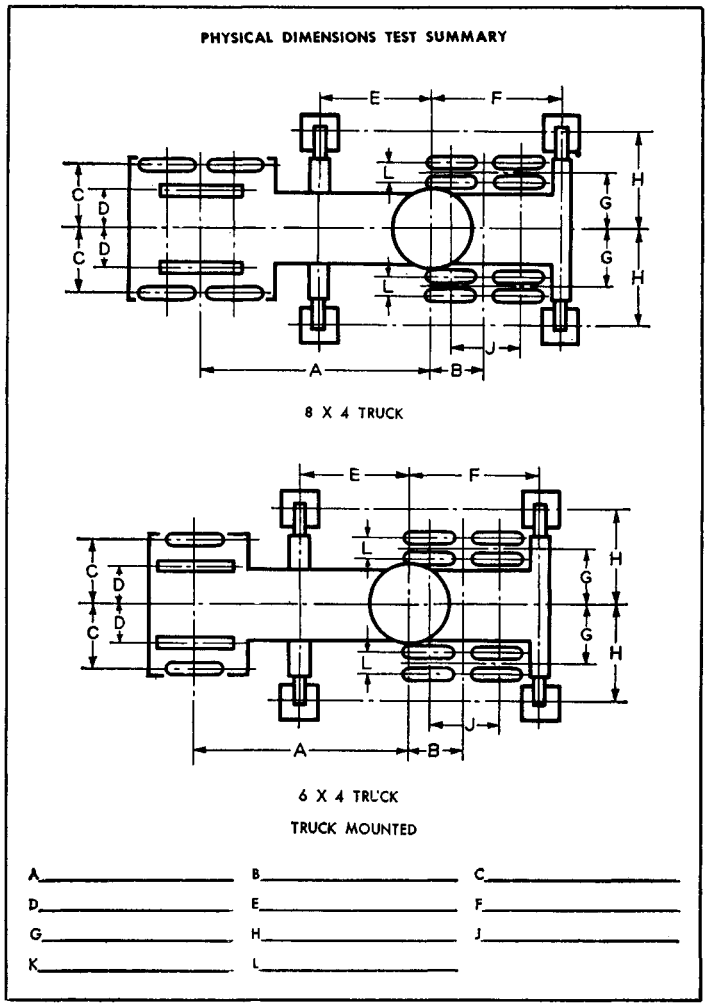

FIG. 2—PAGE 2 OF TEST SUMMARY.

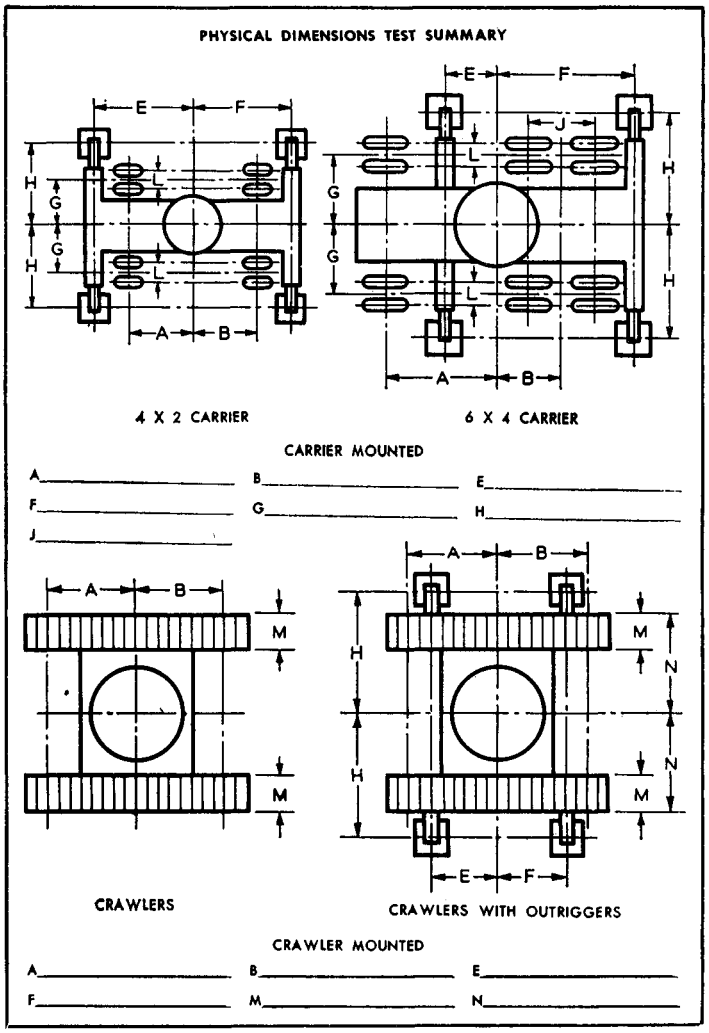

FIG. 3—PAGE 3 OF TEST SUMMARY

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APPENDIX G

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LIFTING CRANE, WIRE-ROPE STRENGTH FACTORS — SAE J959

SAE Standard

Report of Construction and Industrial Machinery Technical Committee approved June 1966.

1. Purpose—The purpose of this SAE Standard is to set forth wire-rope strength factors that have been proved by design and operating practice to be consistent with safety, economy, space, weight and other requirements peculiar to mobile, construction-type, lifting cranes.

2. Scope—This standard applies to all mobile, construction-type, lifting cranes as equipped for operation with hook, clamshell, magnet and grapple attachments. It is not applicable to excavating and demolition attachments such as shovels, hoes, draglines and wrecking balls.

3. Basis for Determinations—

3.1 Strength Factors—Strength factors shall be based on the numerical values obtained by dividing the nominal breaking strength of the rope in a load supporting system by the total force applied to the system.

3.2 Wire-Rope Strength Factors—Wire-rope strength factors shall be not less than those specified in paragraph 4 of this standard with the combination of listed boom length, recommended wire rope, listed operating radius, and rated load or other recommended operating condition that produces the maximum force in the particular rope system under consideration.

3.3 Forces—All forces shall be considered static as produced by the boom and suspended load without the effects of motion from lifting, lowering, swinging, or traveling.

3.4 Total Force—Total force in the rope system under consideration shall be the force resulting from the effects of the suspended load and structures.

4. Wire-Rope Strength Factors—

4.1 For Supporting Rated Loads (Including Boom Suspensions)—

(a) The strength factor for live or running ropes that wind on drums or pass over sheaves shall be not less than 3.5.

(b) The strength factor for standing or guy ropes shall be not less than 3.0.

4.2 For Supporting the Boom and the Working Attachments at Recommended Travel Positions and Boom Lengths—

(a) The strength factor for live or running ropes shall be not less than 3.5.

(b) The strength factor for standing or guy ropes shall be not less than 3.0.

4.3 For Supporting the Boom under Recommended Erection Conditions—

(a) The strength factor for live or running ropes shall be not less than 3.0.

(b) The strength factor for standing or guy ropes shall be not less than 2.5.

5. Wire-Rope Inspection—Assurance of safety and economy in use of construction-type cranes dictates the requirement for a program of periodic inspections of the condition of all load supporting wire-rope. Environmental and use factors such as abrasion, wear, fatigue, corrosion, improper reeving and kinking, are often of greater significance in determining the safely usable life of wire-rope than are conservative strength factors based on new-rope conditions. Appendices A and B of this standard set forth recommended considerations for inspection of wire-rope and a suggested format for recording pertinent observations. The crane operator should inspect wire-rope daily when the crane is in service and prior to operation after a period of standby. Critical inspection of all ropes should be made by a competent rope inspector and pertinent observations recorded not less often than weekly when the crane is in continuous service and prior to operation when the crane is removed from storage.

APPENDIX A—WIRE-ROPE INSPECTION

1. Evidence of rope deterioration from corrosion should be cause for replacement.

2. More than one broken wire in any one strand should be cause for caution. Breaks that occur on the worn crowns of the outside wires indicate normal deterioration. Breaks that occur in the valleys between strands indicate some abnormal condition, possibly fatigue and breakage of other wires not readily visible. One or more valley breaks should be cause for replacement.

3. Wire breaks generally occur in those portions of a wire rope which pass over sheaves, wind onto drums, or receive mechanical abuse. Breaks that occur near attached fittings are apt to result from fatiguing stresses concentrated in these localized sections. Breaks of the latter type should be cause for replacement of the rope or renewal of the attachment to eliminate the locally fatigued area.

4. Heavy wear or broken wires may occur in sections under equalizer sheaves or other sheaves where rope travel is limited, or in contact with saddles. Particular care should be taken to inspect ropes at these points.

5. Rope stretch is generally greatest during initial stages of operation when the strands are becoming adjusted and seated. This is accompanied by some reduction in rope diameter, but not to the extent that the condition of the rope can be judged on this basis.

6. Time for rope replacement is indicated by the extent of abrasion, scrubbing and peening on the outside wires, broken wires, evidence of pitting or severe corrosion, kink damage, or other mechanical abuse resulting in distortion of the rope structure.

7. Sheaves, guards, guides, drums, flanges and other surfaces contacted by wire rope during operation should be examined at the time of inspections. Any condition harmful to the rope in use at the time should be corrected. The same equipment, and particularly sheave and drum grooves, should be inspected and placed in proper condition before a new rope is installed.

8. Any of the following listed conditions should be cause for rope replacement:

(a) In running ropes, six randomly distributed broken wires in one rope lay, or three broken wires in one strand in one rope lay. (A rope lay is the length along the rope in which one strand makes a complete revolution around the rope. See Fig. 1.)

(b) In pendants or standing ropes, evidence of more than one broken wire in one rope lay.

(c) Abrasion, scrubbing or peening causing loss of more than 1/3 the original diameter of the outside wires.

(d) Evidence of rope deterioration from corrosion.

(e) Severe kinking, severe crushing, or other damage resulting in distortion of the rope structure.

(f) Evidence of any heat damage resulting from a torch or arc caused by contact with electrical wires.

(g) Reduction from nominal diameter of more than 3/64 in. for diameters up to and including 3/4 in.; 1/16 in. for diameters 7/8 to 1 1/8 in.; 3/32 in. for diameters 1 1/4 to 1 1/2 in. Marked reduction in diameter indicates deterioration of the core resulting in lack of proper support for the load carryng strands. Excessive rope stretch or elongation may also be an indication of internal deterioration.

(h) Evidence of "bird-caging" or other distortion resulting in some members of the rope structure carrying more load than others. See Fig. 2

(i) Noticeable rusting or development of broken wires in the vicinity of attachments.

NOTE: If this condition is localized in an operating rope and the section in question can be eliminated by makng a new attachment, this can be done rather than replacing the entire rope.

APPENDIX B—WIRE ROPE INSPECTION LOG

See Fig. 3.

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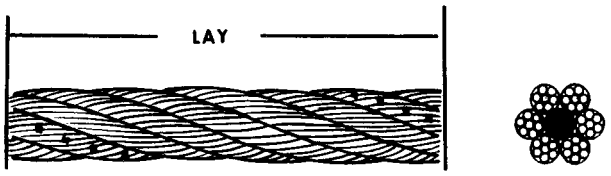

FIG. 1—TYPICAL ROPE CONSTRUCTION

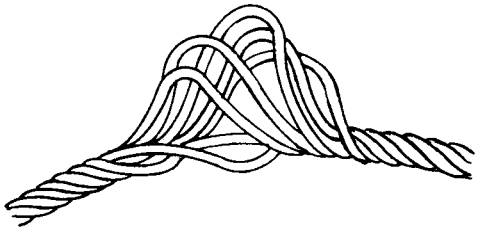

FIG. 2—BIRD CAGING

APPENDIX

PLACE OF INSPECTION: _____ DATE: _____

DESCRIPTION OF CRANE:

Make: _____ Model: _____ Serial No _____

Type and Arrangement of Attachments: _____

DATE OF LAST ROPE INSPECTION: _____

HOURS AND TYPE OF SERVICE SINCE LAST INSPECTION:

RESULTS OF INSPECTION:

Rope Inspected	Type and Size	Conditions Noted	Recommendation

INSPECTOR: _____

FIG. 3—WIRE ROPE INSPECTION LOG

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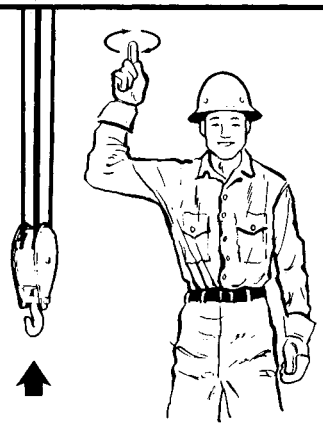
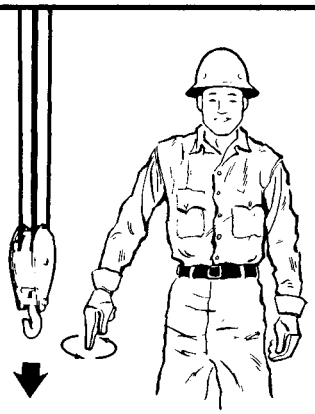
APPENDIX H
HAND SIGNALS

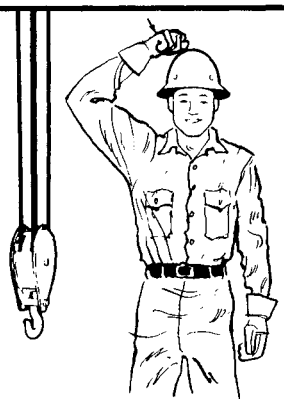
(Recommended by USA Standards Committee B30, Safety Code for Cranes, Derricks, Hoists, Jacks and Slings, and reproduced from the Proposed USA Standard Safety Code for Crawler, Locomotive and Truck Cranes, USAS B30.5 with the permission of the Publisher, The American Society of Mechanical Engineers.)



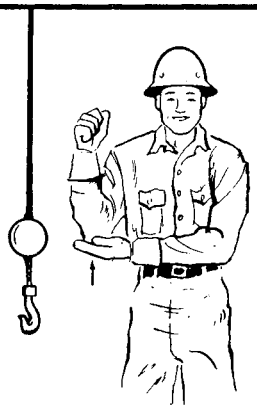
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle



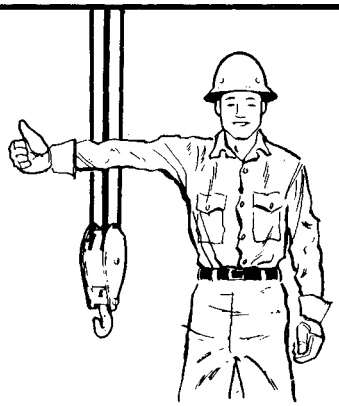
LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.



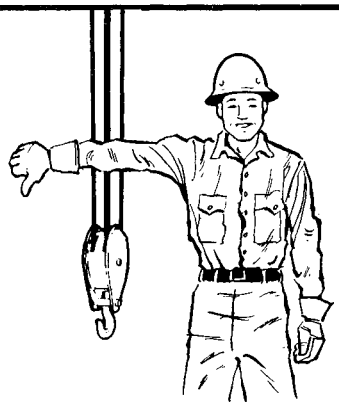
USE MAIN HOIST. Tap fist on head; then use regular signals.



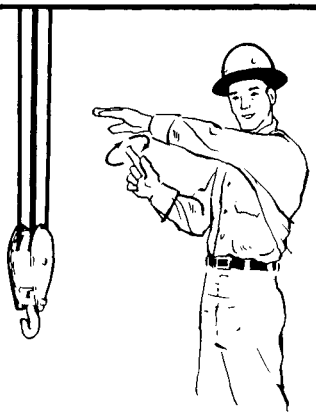
USE WHIP LINE. (Auxiliary Hoist) Tap elbow with one hand; then use regular signals.



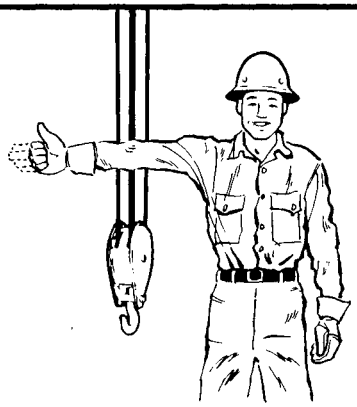
RAISE BOOM. Arm extended, fingers closed, thumb pointing upward



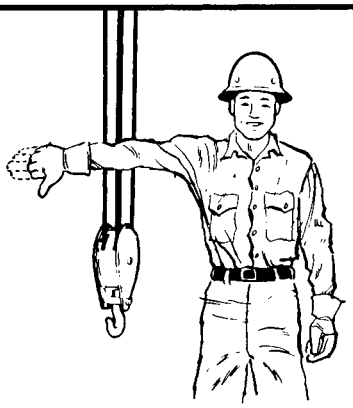
LOWER BOOM. Arm extended fingers closed, thumb pointing downward.



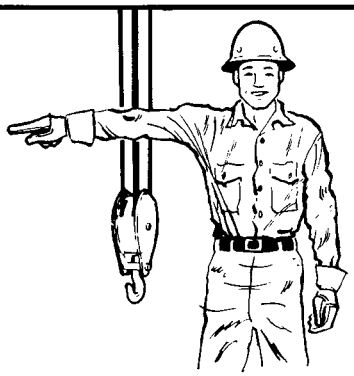
MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly shown as example)



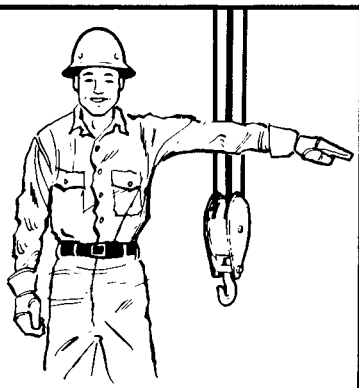
RAISE THE BOOM AND LOWER THE LOAD. With arm extended thumb pointing up, flex fingers in and out as long as load movement is desired.



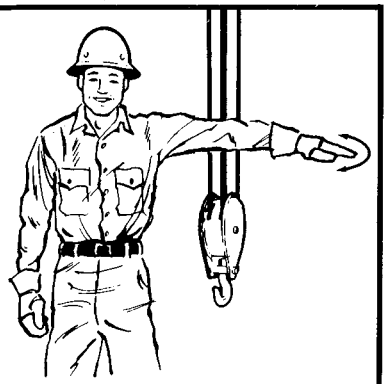
LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.



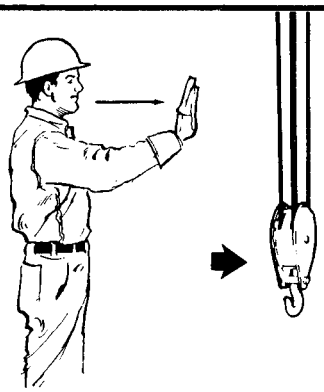
SWING. Arm extended point with finger in direction of swing of boom.



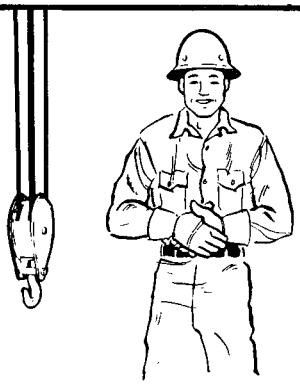
STOP. Arm extended, palm down, hold position rigidly.



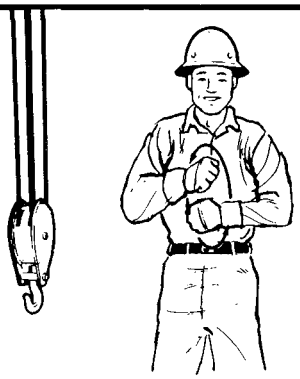
EMERGENCY STOP. Arm extended, palm down, move hand rapidly right and left.



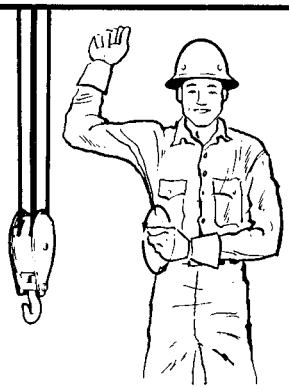
TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.



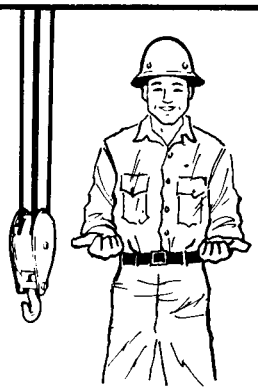
DOG EVERYTHING. Clasp hands in front of body.



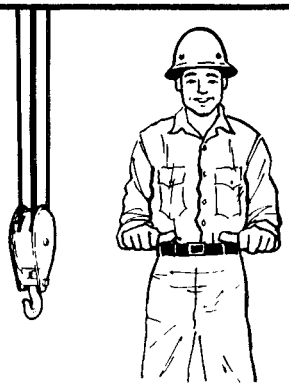
TRAVEL. (Both Tracks) Use both fists, in front of body, making a circular motion, about each other, indicating direction of travel; forward or backward. (For crawler cranes only)



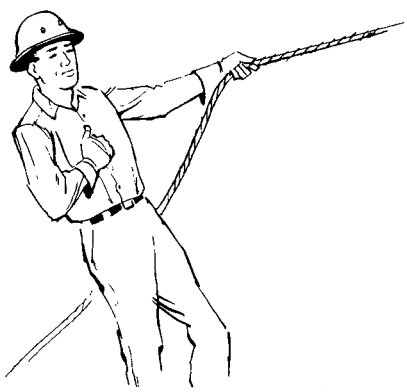
TRAVEL. (One Track) Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body. (For crawler cranes only)



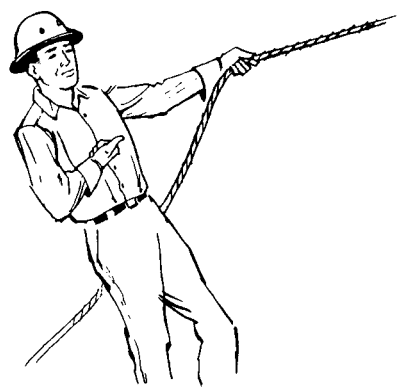
EXTEND BOOM. (Telescoping Booms) Both fists in fromt of body with thumbs pointing outward.



RETRACT BOOM. (Telescoping Booms) Both fists in front of body with thumbs pointing toward each other.



EXTEND BOOM. (Telescoping Boom) One Hand Signal. One fist in front of chest with thumb tapping chest.



RETRACT BOOM. (Telescoping Boom) One Hand Signal. One fist in front off chest, thumb pointing outward and heel of fist tapping chest.

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