ASME PALD-2009
(Revision of ASME PALD-2005)

Safety Standard for Portable Automotive Lifting Devices

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

ASME
SETTING THE STANDARD

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Date of Issuance: May 21, 2010

The next edition of this Standard is scheduled for publication in 2012. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org as they are issued.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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FOREWORD

This ASME Standard, Safety Standard for Portable Automotive Lifting Devices, has been developed under the procedures for ASME Codes and Standards development committees. This Standard had its beginning in June 1979 when the Jack Institute addressed the B30 Committee on Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings. The Jack Institute requested the B30 Committee either to develop a standard for automotive jacks or to include this equipment as part of the revision of B30.1, Jacks. The B30 Committee declined this request.

As a result, the Jack Institute petitioned ANSI in July 1979 for the formation of a committee to promulgate safety and/or performance standards for portable automotive lifting devices, requesting the designation of ASME as sponsor of the project.

In September 1979, ASME's Policy Board, Codes and Standards, approved sponsorship of the committee to operate under the procedures developed by ASME and accredited by ANSI. A nominating committee was appointed to recommend a proposed membership to the ASME Safety Codes and Standards Committee for approval. The membership was approved at the beginning of May 1980.

The inaugural meeting of the ASME Committee on Portable Automotive Lifting Devices (PALD) was held in July 1980. The committee determined that the format of this Standard would be such that separate volumes, each complete as to design, marking, identification, testing, operation, inspection, and maintenance, would cover the different types of equipment included in the PALD scope. In the 1993 edition the various volumes were combined into one Standard with common requirements in one place and the information that is specific to a particular type of equipment set out in succeeding Parts. This allowed for greater consistency in requirements and eliminated redundancy.

The 1997 edition was a further revision and consolidation of the 1993 edition and includes a Part covering automotive ramps.

The 2003 edition is a revision of the 1997 edition, and includes a Part covering forklift jacks.

This Standard presents a coordinated set of rules that may serve as a guide to manufacturers, to government and other regulatory bodies, to municipal authorities, and to commercial users responsible for the inspection, maintenance, and instruction in the use of the equipment falling within its scope.

This edition of the Standard, which was approved by the ASME Committee on Portable Automotive Lifting Devices and by ASME, was approved by ANSI and designated as an American National Standard on September 19, 2005.

Safety codes and standards are intended to enhance public health and safety. Revisions result from committee consideration of factors such as technological advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate.

ASME PALD-2009 was approved by the American National Standards Institute on November 13, 2009.

ASME PALD COMMITTEE
Portable Automotive Lifting Devices

(The following is the roster of the Committee at the time of approval of this Standard.)

STANDARDS COMMITTEE OFFICERS

D. A. Alexander, *Chair*
R. D. Claypool, *Vice Chair*
T. W. Schellens, *Secretary*

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PREFACE

GENERAL

This Standard is one of many safety standards on various subjects that have been formulated under the general auspices of The American Society of Mechanical Engineers (ASME). One purpose of the Standard is to serve as a guide to governmental authorities having jurisdiction over subjects within the scope of the Standard. It is expected, however, that the Standard will find a major application in industry, serving as a guide to manufacturers, suppliers, purchasers, and operators of the equipment. If adopted for governmental use, the references to other national standards in this Standard may be changed to refer to the corresponding regulations of the governmental authorities.

The use of portable automotive lifting devices is subject to certain hazards that cannot be precluded by mechanical means, but only by the exercise of intelligence, care, and common sense. It is therefore essential to have personnel involved in the use and operation of equipment who are careful, competent, trained, and qualified in the safe operation of the equipment and its proper use when servicing motor vehicles and their components. Examples of hazards are dropping, tipping, or slipping of motor vehicles or their components caused primarily by improperly securing loads, overloading, off-centered loads, use on other than hard level surfaces, and using equipment for a purpose for which it was not designed.

The PALD Committee fully realizes the importance of proper size, strength, and stability as safety factors in the design of this equipment. This equipment is used on various motor vehicles and their components under variable working conditions. These conditions have been considered to provide safety and flexibility in its use. The requirements given in this Standard must be interpreted accordingly and judgment should be used in determining their application.

MANDATORY AND ADVISORY RULES

Mandatory rules of this Standard are characterized by use of the word *shall*. If a provision is of an advisory nature, it is indicated by use of the word *should* and is a recommendation to be considered, the advisability of which depends on the facts in each situation.

SI (METRIC) CONVERSIONS

This Standard contains SI (metric) units as well as customary units. The values stated in U.S. Customary units are to be regarded as the standard. The SI units in the text have been directly (soft) converted from the customary units.

PROPOSING REVISIONS

Comments on the Standard's requirements and suggestions for its improvement, based on experience in the application of the rules, may be sent to the PALD Committee.

Suggestions for changes to the Standard should be submitted to the Secretary of the Committee on Portable Automotive Lifting Devices, ASME, Three Park Avenue, New York, NY 10016-5990, and should be in accordance with the following format:

(a) cite the specific part or section and paragraph designation

(b) indicate the suggested change (addition, deletion, revision, etc.)

(c) briefly state the reason or evidence for the suggested change

(d) submit suggested changes to more than one paragraph in the order in which the paragraphs appear in the Standard

The PALD Committee will consider each suggested change in a timely manner according to its procedures.

INTERPRETATIONS

Upon request, the PALD Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the PALD Committee at the address shown above.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit any request using the following format.

Subject:	Cite the applicable part or section and paragraph number, and provide a concise description.
Edition:	Cite the applicable edition of the pertinent standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for approval of a proprietary design or situation. The

inquirer also may include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee before being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

ASME PALD-2009
SUMMARY OF CHANGES

Following approval by the ASME PALD Committee and ASME, and after public review, ASME PALD-2009 was approved by the American National Standards Institute on November 13, 2009.

ASME PALD-2009 includes the following changes identified by a margin note, **(09)**.

Page	*Location*	*Change*
1	Introduction	Purpose revised
3, 4	General Requirements	(1) Paragraphs 1.3, 2.1, and 2.2 revised (2) New section 5 added (3) Old section 5 redesignated as section 6
5	1-2.3	Revised
6	Fig. 1-1	Revised
9	2-2	(1) Paragraph 2-2.4 revised (2) Paragraph 2-2.6 deleted and subsequent paragraph redesignated
11	Fig. 2-2	Revised
13	3-2.2	Revised
	3-2.3	Revised
	3-2.4	Revised
15	3-4	(1) New para. 3-4.1.3 added and subsequent paragraphs redesignated (2) Newly redesignated 3-4.1.4 revised
16, 19	4-2.7	Revised
	4-3.1	(1) Subparagraph (e) revised (2) Subparagraph (g) added
	4-3.2	Subparagraph (a) revised
	4-4.1	Revised
	4-4.1.1	Revised
20	5-1.2	Subparagraph (c) revised
22	5-2	(1) Paragraph 5-2.1 revised (2) Paragraph 5-2.4 revised (3) Paragraph 5-2.6 deleted and subsequent paragraph redesignated
23	5-4.1.4	Revised
24	Fig. 5-5	Added
	Fig. 5-6	Added

Page	*Location*	*Change*
25	6-2	(1) Paragraph 6-2.3 revised (2) Paragraph 6-2.4 deleted and subsequent paragraph redesignated
	6-2.5	Newly redesignated para. 6-2.5 revised
27	7-2.3	Revised
30	7-4	Title revised
	7-4.1.3(a)	Footnote 1 revised
31	7-4.1.5	Revised
32	8-2.4	Revised
	8-3	Title revised
34	8-4.1.1.1	Revised
	8-4.1.1.2	Revised
35	9-2.4	Revised
38	10-2.4	Revised
40	11-2.4	Revised
43	12-2.5	Revised
	12-4.1.1	Revised
47	13-4.1.2	Revised
49	14-2.7	Revised
	14-3	Title revised
50	14-4.1.1	Revised
51, 52	15-2	(1) Paragraph 15-2.3 deleted (2) Newly redesignated 15-2.3 revised and subsequent paragraph redesignated
	15-3.2	Title revised
	15-4.1.4	Revised
	15-4.1.5	Revised
53	16-2.8	Revised
56	16-4.1.2	Revised
57, 59	17-1.3	Revised
	17-2	(1) Paragraph 17-2.4 deleted (2) Newly redesignated paragraph 17-2.5 revised and subsequent paragraphs redesignated
60	17-4.1.3	Revised

SAFETY STANDARD FOR PORTABLE AUTOMOTIVE LIFTING DEVICES

Introduction

SCOPE

The scope of this Standard is the standardization of safety and performance requirements for portable automotive lifting equipment including:

(a) hydraulic hand jacks
(b) transmission jacks
(c) engine stands
(d) vehicle support stands
(e) emergency tire changing jacks
(f) upright type mobile lifts
(g) service jacks
(h) wheel dollies
(i) shop cranes
(j) swing type mobile lifts
(k) scissors type mobile lifts
(l) auxiliary stands
(m) automotive ramps
(n) high reach supplementary stands
(o) fork lift jacks
(p) high reach fixed stands
(q) vehicle transport lifts
(r) attachments, adapters, and accessories

This Standard may include requirements for safety, health, design, production, construction, maintenance, performance, or operation of equipment, and/or qualification of personnel.

APPLICATION

This Standard applies to the design, construction, marking, operation, maintenance, and owner/operator inspection of the portable automotive lifting devices listed previously, used during automotive service, maintenance, and storage. Operation and maintenance instructions in this Standard are intended for general application. The equipment manufacturer or supplier shall be consulted for specific operating and maintenance instructions.

This Standard does not apply to similar lifting devices designed and manufactured for other commercial or industrial use such as those within the scope of ASME B30.1, Jacks.

PURPOSE (09)

This Standard is designed to

(a) guard against and mitigate injury, and otherwise provide for the protection of life, limb, and property by prescribing safety requirements

(b) provide direction to purchasers, owners, employers, supervisors, and others concerned with, or responsible for, its application

(c) guide governmental and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives

DEFINITIONS

adapter: a device attached to the lift platform of a PALD which is used to support and/or stabilize those components for which it is especially designed.

alteration: any change to a PALD other than maintenance, repair, or replacement.

appointed: assigned specific responsibilities by the employer or the employer's representative.

appropriate means: the use of any device, such as blocking, cribbing, or vehicle support stands, which adequately supports a vehicle off the ground by providing a stable support preventing the vehicle from tipping over or falling down to the ground.

approved: accepted as satisfactory by a duly constituted administrative or regulatory authority.

authorized: approved by a duly constituted administrative or regulatory authority.

authorized personnel: persons who have been instructed in the operation and/or maintenance of the PALD and designated by the owner to use or maintain the equipment.

authorized service center: an independent service facility designated by the manufacturer to repair and test PALDs it has manufactured.

base: see definition for each PALD.

controls, operating: the mechanisms which must be manipulated by the operator to govern the starting, stopping, direction of motion, acceleration, speed, and retardation of the moving member(s) of the PALD.

designated: selected or assigned by the employer or the employer's representative as being competent to perform specific duties.

extender: an optional device supplied by the manufacturer to mechanically increase the PALD's height, prior to applying the load.

filler plug: a removable component to allow maintaining proper fluid level in the PALD.

frame: see definition for each PALD.

functional damage: any detrimental permanent deformation of the PALD's structure that results in the loss of sealing capability to its hydraulic and/or pneumatic components, loss of load, or failure to meet or exceed the design qualification limits established in Section 4 of each Part.

internal load limiting device: a device that limits the lifting capacity of the PALD.

lift point: the location at which the PALD's lifting member or saddle contacts the vehicle component as designated by the vehicle manufacturer.

lifting member: the moving portion of a PALD upon which saddles (if any) are mounted.

load: the total superimposed weight of force to be overcome by the PALD.

manufacturer: a company that produces goods by hand or machinery, often on a large scale.

mobile: describes a lift that is readily movable from one work area to another without a load.

overload: a load that exceeds the rated capacity of the PALD.

PALD: any one of the various types of portable automotive lifting devices listed in the scope of this Standard.

pawl: a pivoted component that, when engaged with the teeth of a ratchet, prevents undesired movement.

pneumatic power source: a device that utilizes compressed air as the force transmitting medium.

portable: not permanently fixed in one location and able to be moved from one work place to another.

proof load: a load, greater than the rated capacity, applied centrally to the lifting or attaching points of the PALD to confirm the integrity of the structure.

qualified personnel: individuals with characteristics or abilities gained through training or experience or both, as measured against established requirements, such as standards or tests, that enable them to perform a required function.

raised height: the distance from the ground to the top of the saddle at the full extension of the PALD.

ratchet: a toothed member for engagement with the pawl.

rated capacity: the maximum published operating load that the PALD is designated to lift, support, or transport throughout its range of travel.

repair: the process of rehabilitation or replacement of parts that are the same as the original for the purpose of ensuring performance in accordance with the applicable requirements.

saddle: the portion of the PALD which comes in contact with and/or engages the vehicle or vehicle component.

stability: a measure of resistance to tipping while under load.

supplier: a company that controls the performance specification and/or design of the products distributed to the general public.

travel: linear extending or retracting movement of the PALD.

General Requirements

1 PRODUCT MARKING AND IDENTIFICATION

1.1 Rated Capacity

All PALDs shall have the rated capacity marked in a prominent location on the PALD by casting imprint, metal stamp, or use of durable materials and attachment methods.

1.2 Identification

Each PALD shall include identification or identifying marks of the original manufacturer or supplier by casting imprint, metal stamp, or use of durable materials and attachment methods. The manufacturer or supplier shall be able to identify the date of manufacture of each PALD.

(09) 1.3 Safety Markings

Each PALD shall include safety signs and/or labels developed by the manufacturer or supplier. The signs and/or labels shall be affixed by use of durable materials and attachment methods to each PALD in a location visible to the operator. The ANSI Z535 series of standards containing guidelines for product safety signs shall be followed.

Examples of safety markings for specific types of PALDs are shown in section 3 of each Part of this Standard.

2 PRODUCT INSTRUCTIONS AND SAFETY MESSAGES

(09) 2.1 Product Instructions

Each PALD shall be provided with operator's instructions. ANSI Z535.6 shall be followed. The instructions shall specify the proper operating procedures and basic function of the components. The instructions shall contain the recommended replacement fluid, maintenance, and inspection procedures and intervals, as applicable. Copy conveying the intent of section 3 shall be included with the instructions.

(09) 2.2 Safety Messages

The instructions shall convey the safety markings and messages shown in section 3 of the applicable Part of this Standard, but need not be verbatim or limited to those listed.

3 OPERATION, MAINTENANCE, AND INSPECTION

3.1 Operation

The owner and/or operator shall have an understanding of the product, its operating characteristics, and safety operating instructions before operating the PALD. Safety information shall be emphasized and understood. If the operator is not fluent in English, the product and safety instructions shall be read to and discussed with the operator in the operator's native language by the purchaser/owner or his designee, making sure that the operator comprehends their contents.

3.2 Maintenance

The PALD shall be maintained in accordance with the product instructions.

3.3 Inspection

(a) Visual inspection shall be made before each use of the PALD by checking for abnormal conditions, such as cracked welds, leaks, and damaged, loose, or missing parts.

(b) Other inspections shall be made per product operating instructions.

(c) Each PALD shall be inspected immediately if the device is believed to have been subjected to an abnormal load or shock. It is recommended that this inspection be made by a manufacturer's or supplier's authorized repair facility.

(d) Owners and/or operators should be aware that repair of this equipment may require specialized knowledge and facilities. It is recommended that an annual inspection of the PALD be made by a manufacturer's or supplier's authorized repair facility and that any defective parts, decals, or safety labels or signs be replaced with manufacturer's or supplier's specified parts. A list of authorized repair facilities is available from the manufacturer or supplier.

3.4 Damaged Equipment

Any PALD that appears to be damaged in any way, is found to be worn, or operates abnormally SHALL BE REMOVED FROM SERVICE UNTIL REPAIRED. It is recommended that necessary repairs be made by a manufacturer's or supplier's authorized repair facility if repairs are permitted by the manufacturer or supplier.

3.5 Alterations

Because of potential hazards associated with this type of equipment, no alterations shall be made to the product.

3.6 Attachments and Adapters

Only attachments and/or adapters supplied by the manufacturer shall be used.

4 QUALITY ASSURANCE

4.1 Quality Systems

Producers of Portable Automotive Lifting Devices shall adhere to a planned, written system of policies and procedures which will assure consistent and continuing conformance to the requirements of this Standard. Conformance to this Standard shall be demonstrated by the testing requirements set forth herein. ISO/IEC Guide 22 "General Criteria for Supplier's Declaration of Conformance" may be used as a guide.

4.2 Durability Assessment

In the design of all PALDs, consideration shall be given to the anticipated useful life of each product, and the cumulative effects of repeated use and other potential changes in properties.

5 DESIGN (09)

5.1 Electrical Components

All PALD's utilizing electrical power at a minimum shall meet the following requirements:

(a) provide over current protection. The protection shall not be automatically resetting

(b) meet an applicable national standard, such as UL 201 or UL 2089

(c) provide a means to permit controlled lowering if electrical power fails

6 EFFECTIVE DATE (09)

The effective date of this Standard shall be 12 mo after the date of issuance.

Part 1
Hydraulic Hand Jacks

1-1 SCOPE, CLASSIFICATION, AND ILLUSTRATIONS

1-1.1 Scope

This Part applies to self-contained hydraulic hand jacks designed for lifting but not sustaining loads in either the vertical (primary) or horizontal (secondary) directions. This Part does not include hydraulic bumper jacks and their assorted attachments.

1-1.2 Classification

Hydraulic, self-contained jacks with or without internal load limiting devices are the classifications covered by this Part.

1-1.3 Illustrations

Figures 1-1 through 1-4 show typical jacks covered by this Part and are not intended to be all-inclusive.

1-1.4 Definitions

jack, hydraulic hand: portable self-contained device consisting of a ram, saddle, and hydraulic pump.

pump, hydraulic: a device consisting of a pump, pump handle, reservoir, and release valve, and utilizing a relatively incompressible fluid, such as oil, as the force transmitting means.

1-2 DESIGN

1-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The pump handle shall be capable of being operated to the jack's rated capacity without sustaining functional damage. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

1-2.2 Travel Limit

Each hand jack shall be provided with a positive means to prevent the load from being raised, lowered, or moved beyond the design limit of travel.

1-2.3 Proof Load (09)

All hydraulic hand jacks shall be capable of performing the proof load test of paras. 1-4.1.1, 1-4.1.4, and 1-4.1.5 with a proof load of 150% of rated capacity.

1-2.4 Carrying Handle

If provided, the carrying handle shall be affixed and capable of sustaining 150% of the jack's weight.

1-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 1-3.1 and 1-3.2.

1-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard, level surfaces.

(d) Lifting device only. Immediately after lifting, support the vehicle with appropriate means.

(e) Failure to heed these markings may result in personal injury and/or property damage.

1-3.2 Safety Messages

Additional safety messages include the following.

(a) Lift only on areas of the vehicle as specified by the vehicle manufacturer.

(b) No alterations shall be made to this product.

(c) Only attachments and/or adapters supplied by the manufacturer shall be used.

1-4 DESIGN QUALIFICATION TESTING

1-4.1 Proof Tests

For each design or design change that may affect the jack's ability to meet this Standard, sample jacks built to design specifications shall be proof tested. To conform with this Standard, the jacks shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected. Multiple rated jacks shall be tested at the full extension of the first stage and last stage.

1-4.1.1 Angular Load Test. A proof load as defined in para. 1-2.3 shall be applied to the saddle of the jack

(09)

Fig. 1-1 Typical Single-Stage Hydraulic Hand Jack

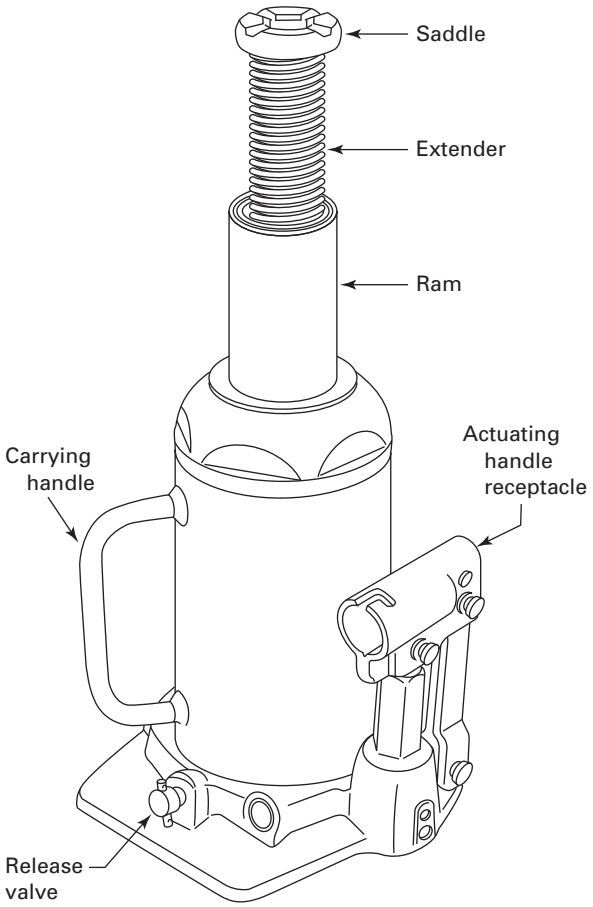


Fig. 1-2 Typical Wheeled Pneumatic/Hydraulic Hand Jack

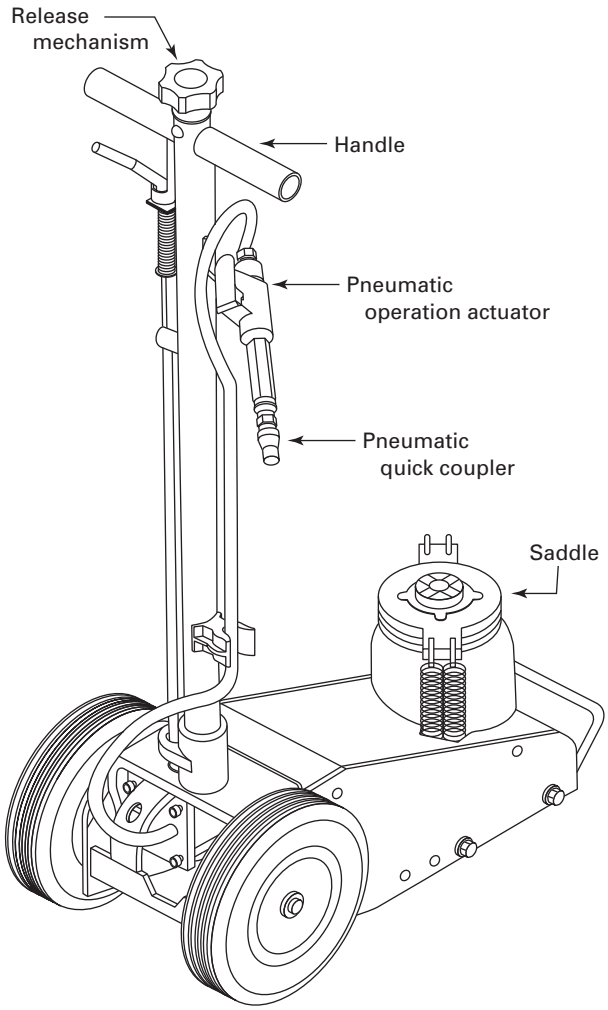


Fig. 1-3 Typical Pneumatic/Hydraulic Hand Jack

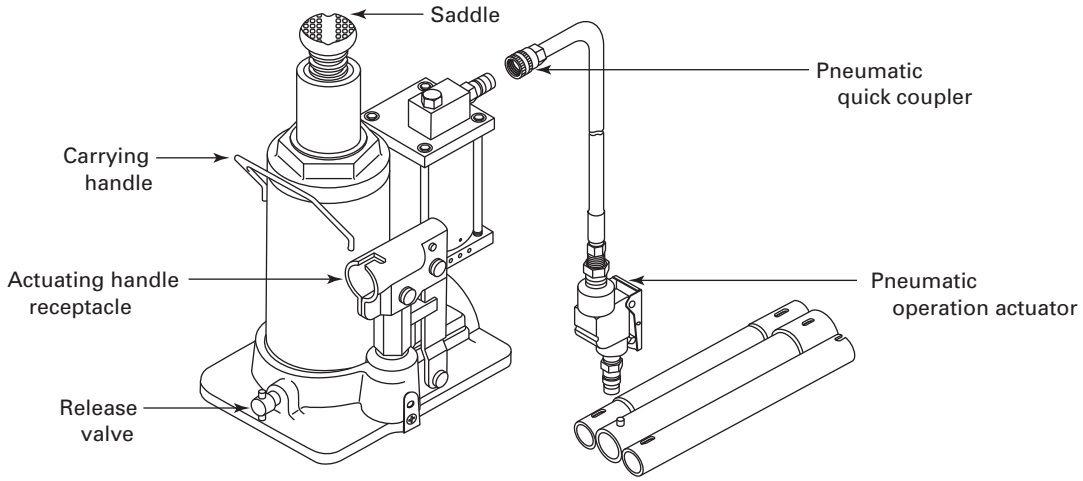
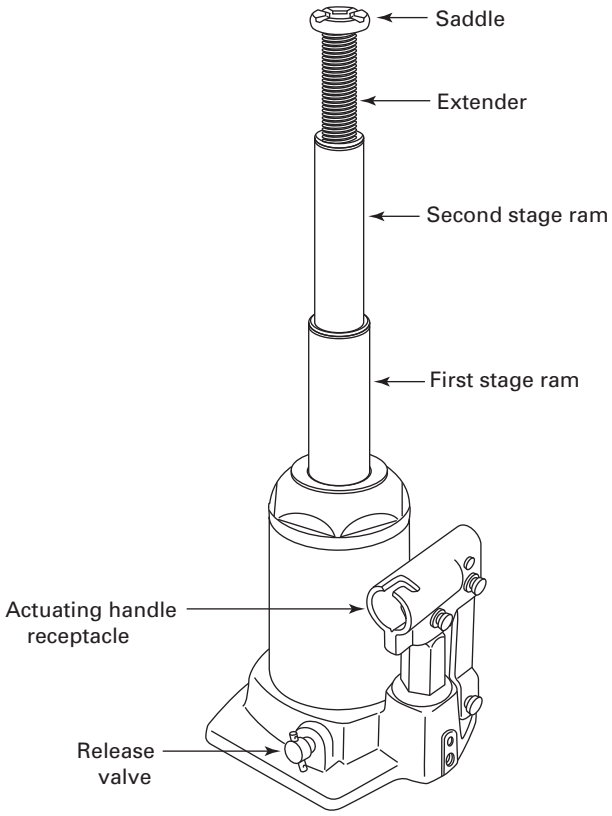


Fig. 1-4 Typical Multiple-Stage Hydraulic Hand Jack



with the extender fully extended, if so equipped, and the jack at its full extension while the jack's vertical axis is at a 5 deg angle relative to the axis of the applied load.

1-4.1.2 Load-Limiting Device Test

(a) Hand jacks equipped with internal load-limiting devices shall be pumped against a measured load until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

(b) Hand jacks with multiple stage hydraulics equipped with internal load-limiting devices shall be pumped against a measured load, with the final stage extended at least 1 in. (25.4 mm) above its low height, until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

1-4.1.3 Release Valve Test. A load equal to or greater than the rated capacity shall be applied to the saddle with the jack at its full extension. The release valve shall be operated to control the rate of descent to no more than 1.0 in./sec (25.4 mm/s).

1-4.1.4 Load-Sustaining Test. A proof load as defined in para. 1-2.3 shall be applied to the saddle of the jack with the extender fully extended, if so equipped. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute nor a total of 0.1875 in. (4.76 mm) in 10 min.

Part 2
Transmission Jacks

2-1 SCOPE, CLASSIFICATION, AND ILLUSTRATIONS

2-1.1 Scope

This Part applies to transmission jacks that are used to remove and install transmissions and differential assemblies from automobiles and trucks.

2-1.2 Classification

Hydraulic, pneumatic, and mechanical are the classifications for which this Part applies. When a combination of these force transmitting means is used, each system shall be tested to conform with this Part.

2-1.3 Illustrations

Figures 2-1 and 2-2 show typical transmission jacks covered by this Part and are not intended to be all-inclusive.

2-1.4 Definitions

controls, tilt: controls provided to adjust the angular position of the lift platform assembly about two principal independent axes (longitudinal and transverse).

jack, hydraulic transmission: a device that utilizes a hydraulic pump to raise and lower an automotive transmission into position for assembly and disassembly.

jack, mechanical transmission: a transmission jack that utilizes mechanical means, such as levers, cables, gears, screws, ratchets, and pawls.

jack, pneumatic transmission: a transmission jack that employs compressed air as the force transmitting medium.

jack, transmission: a mobile lifting device having a lift platform assembly suited to retaining an automotive transmission, and other driveline components such as transfer cases and transaxles, and designed to support and stabilize the component during its installation or removal from a vehicle.

lift platform assembly: the portion of the PALD that contacts the transmission or differential assembly and includes the brackets, adapters, and load restraints provided by the manufacturer.

load restraint: a device supplied by the manufacturer to retain the load on the lift platform.

mechanism, tilt: a device that allows the lifting member to be angularly adjusted relative to the horizontal plane.

2-2 DESIGN (09)

2-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

2-2.2 Lift Platform Assembly

The lift platform assembly shall be equipped with load restraints and adapters and shall be capable of sustaining a proof load, as defined in para. 2-2.6, at any angle within the designed tilt range to a maximum of 10 deg in all directions. Provision shall be made to prohibit separation of the jack and the lift platform assembly when the lift platform assembly is loaded.

2-2.3 Tilt Control

When tilt control adjustment mechanisms are provided, they shall require intentional positive action by the operator to change the angle of tilt.

2-2.4 Proof Load

All transmission jacks shall be capable of performing the proof load test of para. 2-4.1.3 with a proof load of 150% of rated capacity.

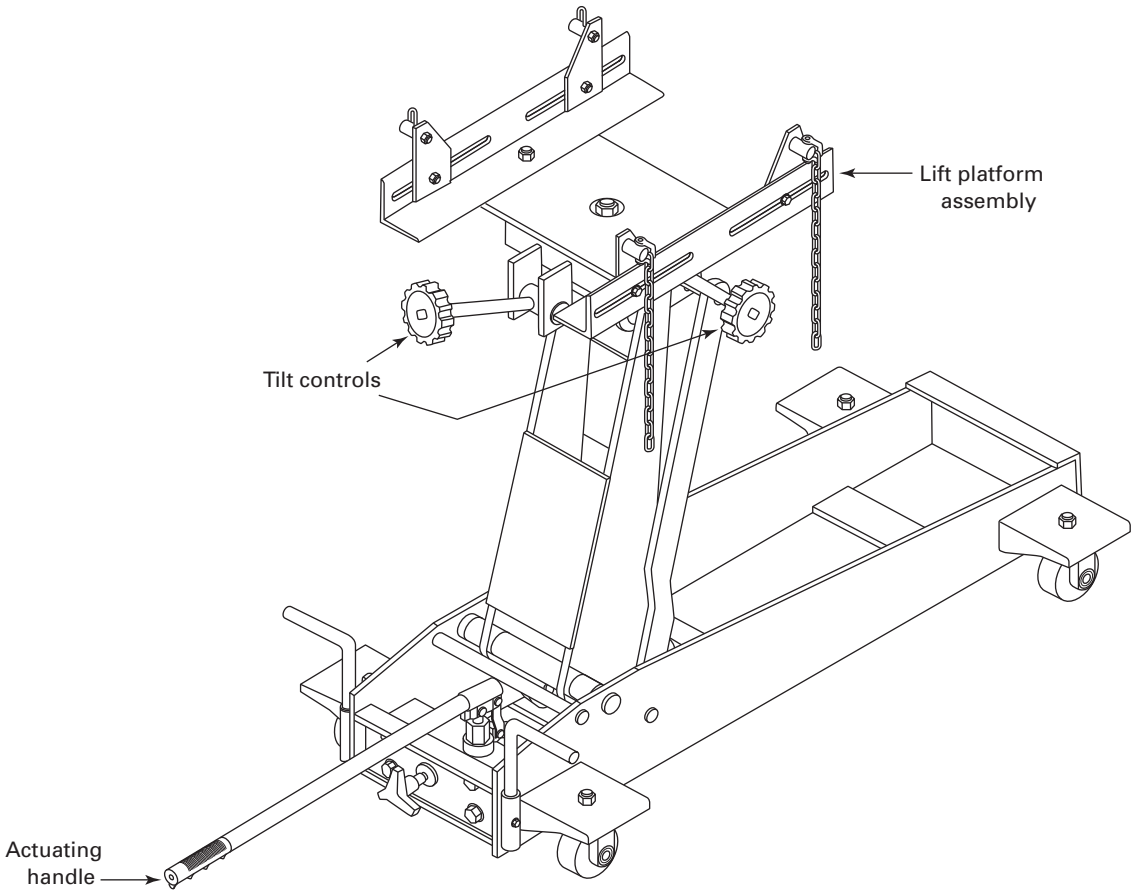
2-2.5 Travel Limit

Each transmission jack shall be provided with a positive means to prevent the load from being raised or lowered beyond the design limit of travel.

2-2.6 Adapters

All adapters manufactured specifically for a jack shall be capable of performing their intended function with that jack. All adapters shall be capable of supporting a proof load of 150% of the load they are designed to support with the lift platform at any angle within the designed tilt range to a maximum of 10 deg in all directions.

Fig. 2-1 Typical Hydraulic Transmission Jack



2-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 2-3.1 and 2-3.2.

2-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard, level surfaces.

(d) Adequately support the vehicle before starting repairs.

(e) Failure to heed these markings may result in personal injury and/or property damage.

(f) Use of this product is limited to the removal, installation, and transportation in the lowered position, of transmissions, transfer cases, and transaxles.

2-3.2 Safety Messages

Additional safety messages include the following:

(a) No alterations shall be made to this product.

(b) Only attachments and/or adapters supplied by the manufacturer shall be used.

2-4 DESIGN QUALIFICATION TESTING

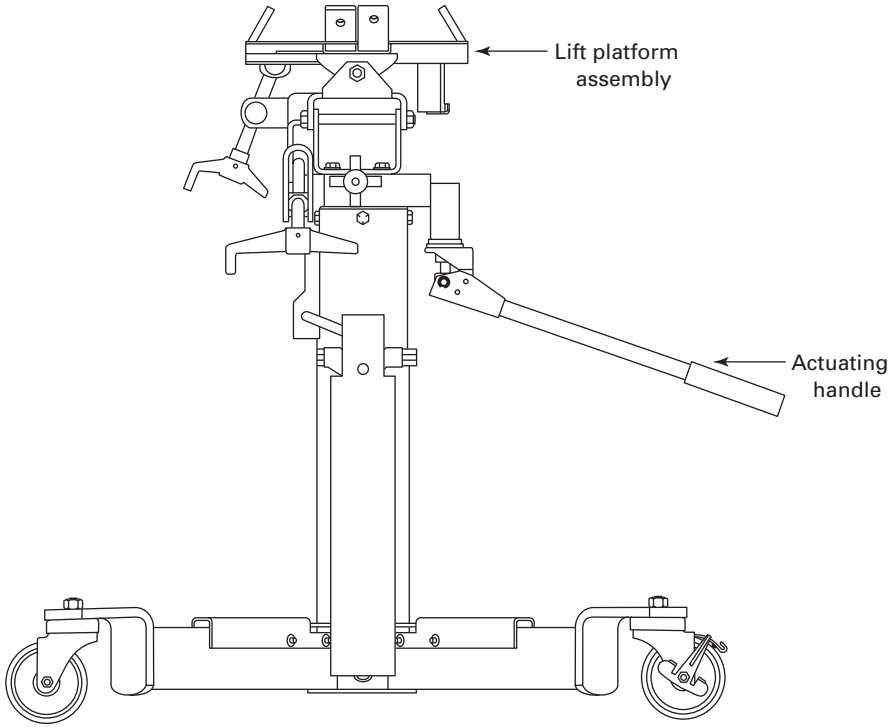
2-4.1 Proof Tests

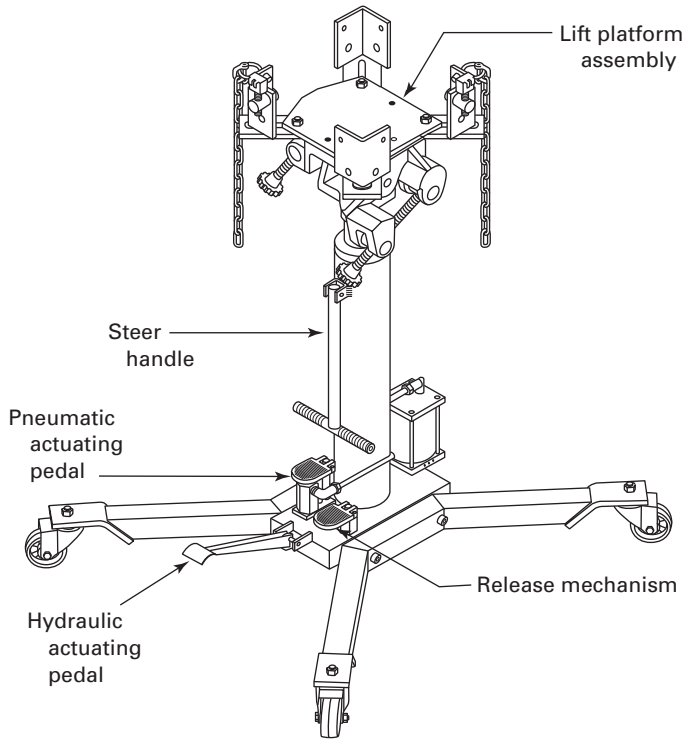
For each design or design change that may affect the jack's ability to meet this Standard, sample jacks built to design specifications shall be proof tested. To conform with this Standard, the jacks shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

2-4.1.1 Loaded Operational Test. A deadweight load not less than the rated capacity of the jack and configured such that the entire load is above the lifting platform shall be centrally located and restrained by the lifting platform and the following operational tests shall be conducted.

2-4.1.1.1 Release Mechanism Test. With the jack fully extended, the release mechanism shall be operated

Fig. 2-2 Typical Pneumatic/Hydraulic Transmission Jacks (09)





to control the rate of descent to no more than 1.0 in./sec (25.4 mm/s).

2-4.1.1.2 Tilting Test. The jack shall support the deadweight load, as defined in para. 2-4.1.1, with the lift platform at maximum height with the lift arm positioned such that the horizontal distance between the center of the pivot point and the vertical centerline of the saddle is greatest. The jack shall be moved forwards and backwards at least 1 ft (300 mm) without tipping over. The force to move the jack shall be applied closely beneath the lift platform. The center of gravity of the deadweight load shall be as listed in the table below as defined by the jack's rated capacity.

Capacity, lb (kg)	Load CG Above the Lift Platform, in. (mm)
500 (227)	5.5 (139.7)
1,000 (454)	7.5 (190.5)
2,000 (907)	10 (254.0)
4,000 (1 814)	13 (330.2)

2-4.1.1.3 Mobility Test. The jack, with the lift platform at the lowest possible lift height, shall be moved in any direction over the floor surface. The jack shall, while loaded as above, be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) across a 0.5 in. (12.7 mm) high, 15 deg slope rise in the floor, and a 0.5 in. (12.7 mm) drop to the floor, at an approach angle that will bring only one caster or wheel at a time in contact with the rise and drop. The jack shall traverse the rise and drop without loss of load or tipping over.

2-4.1.1.4 Stability Test. The jack, with the lift platform at the lowest possible lift height, shall be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) against a 2.0 in. (51 mm) high vertical rise 90 deg to the direction of movement at an approach angle that will bring two wheels or casters in contact with the rise at the point of greatest instability. The jack shall not lose the load or tip over.

2-4.1.1.5 Load-Sustaining Test. With the lift platform at its maximum height, the jack shall sustain the load and shall not lower more than 0.125 in. (3.18 mm) in the first minute nor a total of 0.1875 in. (4.76 mm) in 10 min.

2-4.1.2 Load-Limiting Device Test

(a) Hydraulic transmission jacks with a single-stage hydraulic cylinder equipped with internal load-limiting devices shall be pumped against a measured load with the lifting platform within 1.0 in. (25.4 mm) above its low height until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

(b) Hydraulic transmission jacks with multiple-stage hydraulics equipped with internal load-limiting devices shall be pumped against a measured load with final stage extended 1.0 in. (25.4 mm) to 2.0 in. (51 mm) above its low height until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

(c) Hydraulic transmission jacks equipped with lift arms and internal load-limiting devices shall be pumped against a measured load with the lift arm in the horizontal position until the load-limiting device is activated, at which time the jack must have been supporting 100% of its rated capacity and no more than 125% of its rated capacity.

2-4.1.3 Proof Load Test. A proof load, as defined in para. 2-2.6, shall be applied centrally to the lifting platform of the jack. The load shall be lifted and sustained throughout the lifting range. For purposes of this test, any internal load limiting device may be deactivated.

Part 3
Engine Stands

3-1 SCOPE, CLASSIFICATION, AND ILLUSTRATIONS

3-1.1 Scope

This Part applies to self-contained portable engine stands, designed primarily to support an automobile engine while being rebuilt or repaired. This Part does not apply to permanently mounted engine stands.

3-1.2 Classification

This Part applies to self-contained portable engine stands of single- or twin-post construction.

3-1.3 Illustrations

Figures 3-1 through 3-3 show typical engine stands covered by this Part and are not intended to be all-inclusive.

3-1.4 Definitions

attachments: a means to adapt to various automotive components and engine bolt patterns through the use of separate adapters or adjustable arms that fasten to a mounting plate.

engine stand: an automotive engine mounting device, equipped with suitable means to support, rotate, and lock the engine in a working position.

frame: a structure consisting of at least one upright column, equipped with a means to accept a mechanical rotating mechanism.

mechanical rotating mechanism: a device which provides controlled rotation of the mounting plate.

mounting attachments: a means to adapt to various engine bolt patterns through the use of separate adapters or adjustable arms that fasten to the mounting plate.

plate, mounting: a component of the PALD lifting or rotating mechanism equipped with slots or holes to accept the use of mounting attachments or direct mounting of an automotive component.

rotational locking device: a means to prevent unintentional movement of the mounting plates.

3-2 DESIGN

3-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. Stands shall be equipped with a handle or friction device to permit controlled rotation of the mounting plate. The release system shall require intentional positive action by the operator for release to prevent unintentional rotation of the load.

3-2.2 Proof Load (09)

Engine stands shall be capable of performing the proof load test of para. 3-4.1.4 with a proof load of 200% of rated capacity.

3-2.3 Rotational Locking Device (09)

The stand shall be equipped with a means to prevent rotation of the mounting plate and shall require intentional positive action by the operator to activate the device. Friction-type locking devices shall be functional in at least six equal rotational increments. The loaded rotational locking device shall remain functional in any position provided during the test of para. 3-4.1.4.

3-2.4 Special Purpose Attachments/Adapters (09)

All special purpose attachments/adapters shall be capable of supporting a proof load of 200% of the load they are designed to support.

3-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 3-2.1 and 3-3.2.

3-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

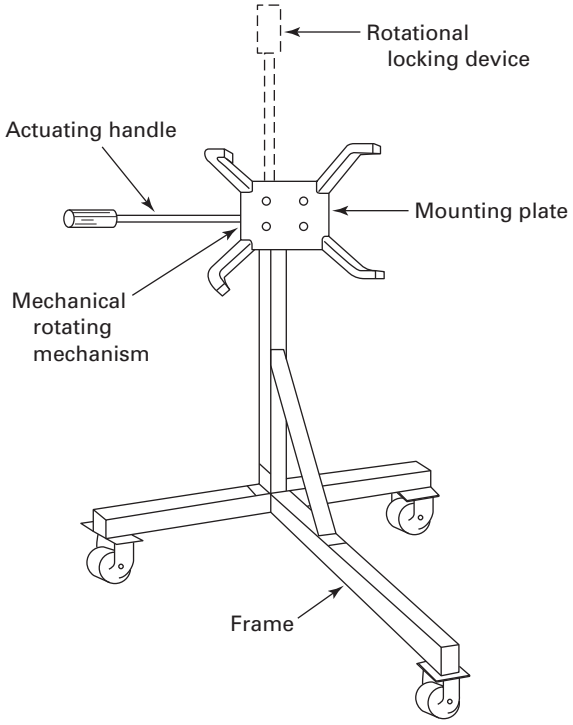
(c) Use only on hard level surface.

(d) Lock mounting plate rotating mechanism before applying a load.

(e) Assure load is centered and secured to mounting attachments.

(f) Failure to heed these markings may result in personal injury and/or property damage.

Fig. 3-1 Typical "T"-Style Single-Post Engine Stand



Single Post

Fig. 3-2 Typical "H"-Style Single-Post Engine Stand

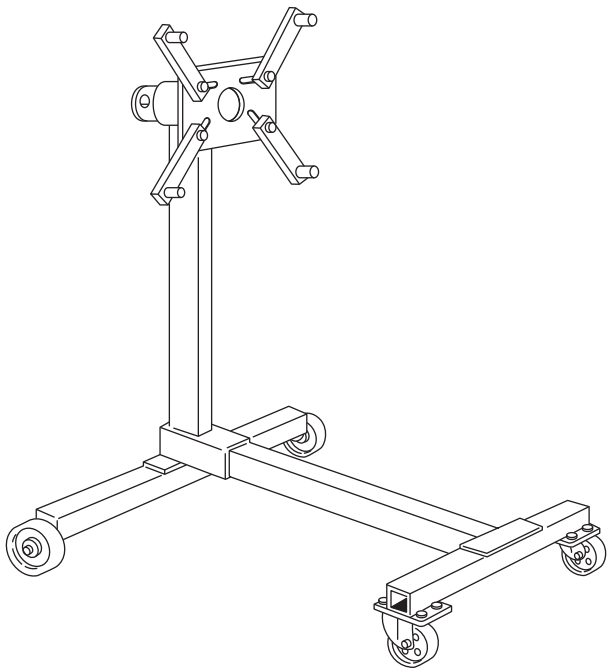
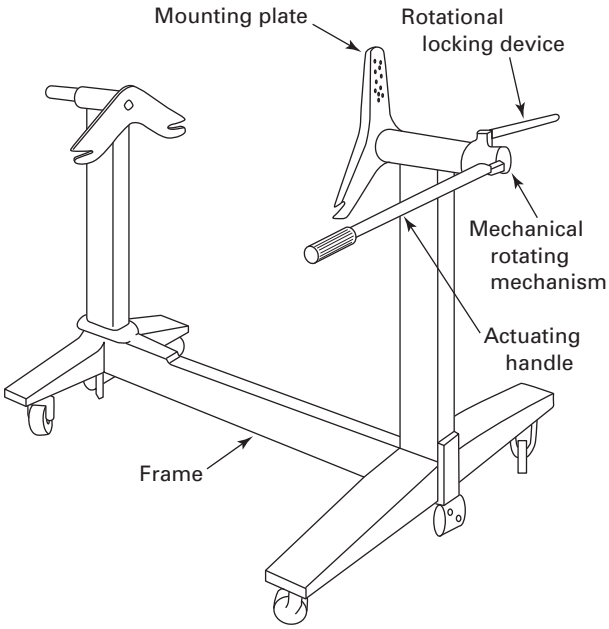


Fig. 3-3 Typical Twin-Post Engine Stand



Twin Post

3-3.2 Safety Messages

Additional safety messages include the following:

(a) Off-center loads may make the load and handle rotate in either direction when the rotational locking device is released.

(b) Release rotational locking devices slowly and carefully.

(c) No alterations shall be made to this product.

(d) Only attachments and/or adapters supplied by the manufacturer shall be used.

(09) 3-4 DESIGN QUALIFICATION TESTING

3-4.1 Proof Tests

For each design or design change that may affect the stand's ability to meet this Standard, sample stands built to design specifications shall be proof tested. The load shall be positioned a minimum of 14.5 in. (368 mm) from the mounting plate and as close as possible to the rotational axis of the mounting plate. To conform with this Standard, the stands shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

3-4.1.1 Mobility Test. The stand, while loaded to rated capacity, shall be moved in any direction for which the stand was designed. The stand shall, while loaded as above, be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) across a 0.5 in. (12.7 mm) high, 15 deg slope rise in the floor, and a 0.5 in. (12.7 mm) drop to the floor, at an approach angle that will bring only one caster or wheel at a time in contact with the rise and drop. The stand shall traverse the rise and drop without loss of load or tipping over.

3-4.1.2 Stability Test. The stand, while loaded to rated capacity, shall be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) against a 2.0 in. (51 mm) high vertical rise 90 deg to the direction of movement at an approach angle that will bring two wheels or casters into contact with the rise at the point of greatest instability. The stand shall not lose the load or tip over.

3-4.1.3 Rotating Mechanism Test. The mounting plate, while loaded to rated capacity, shall be rotated throughout the range of rotation. This shall be performed using the supplied actuating handle.

3-4.1.4 Rotational Locking Device Test. The rotational locking device, while fully engaged, shall be subjected to a torsional load not less than 150 lbf (667 N). The load shall be applied to the rotating handle located 1.0 ft (305 mm) off the centerline of the rotational mechanism's normal axis. The device shall sustain the load without radial movement.

3-4.1.5 Proof Load Test. A horizontally constrained vertical load, as described in para. 3-2.2, shall be applied to the stand for 10 min. The centerline of the rotational axis shall not exceed a total of 5 deg permanent deformation from the initially established angle of the rotational axis. A preload of no more than 100% of rated capacity may be applied to establish the initial condition.

Part 4
Vehicle Support Stands

4-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

4-1.1 Scope

This Part applies to stands used for supporting types of vehicles, as recommended by the stand manufacturer or supplier, at predetermined heights for the purpose of maintenance or storage. This Part does not include auxiliary stands used as supports for vehicle components or other special usage.

4-1.2 Classification

This Part applies to vehicle-support stands with or without an adjustable column, used for support at one end only.

4-1.3 Illustration

Figure 4-1 shows typical vehicle support stands covered by this Part and is not intended to be all-inclusive.

4-1.4 Definitions

base: that portion of the stand that rests on the ground and holds the adjustable column in an upright position. In the case of fixed height stands, which do not have adjustable columns, the entire stand (except for the saddle) is considered to be the base.

locking device: the mechanism used to hold the column in the selected height position.

vehicle support stands: devices for supporting a vehicle at fixed heights, but lacking the means for raising and lowering the vehicle.

4-2 Design

4-2.1 Base

The base may be of any configuration that provides the equivalent of three or more points of contact with the ground. A circular, triangular, or polygonal base shape (see Fig. 4-2) is considered equivalent to the above. The upper portion of the base structure shall be designed to house and guide the column or support the saddle in the case of fixed height stands.

4-2.2 Column

A means shall be provided to prevent the inadvertent separation of the column from the base. In the fully retracted position, the lower end of the column shall not extend below the plane made where the base contacts the ground.

4-2.3 Locking Device

The locking device shall prevent adjustment of the column height after the load has been applied. If the column is supported by means of a locking pin, the pin must be secured to the stand to prevent its loss.

4-2.4 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof.

4-2.5 Saddle

The saddle configuration shall be such as to aid in the proper positioning, supporting, and retaining of the load.

4-2.6 Stability

The stands shall be designed so that the minimum horizontal distance from the projected edge of the saddle to the nearest edge of the base shall be at least 8% of the maximum extended vertical height when the column is moved by hand to remove all slack in the direction of the vertical measurement. See Fig. 4-2, in which the horizontal dimension is shown as H and the vertical height as V.

4-2.7 Proof Load (09)

All vehicle support stands shall be capable of performing the proof load test of para. 4-4.1.2 with a load of 200% of rated capacity.

4-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 4-3.1 and 4-3.2.

4-3.1 Safety Markings (09)

Safety markings shall conform to the ANSI Z535 series of standards.

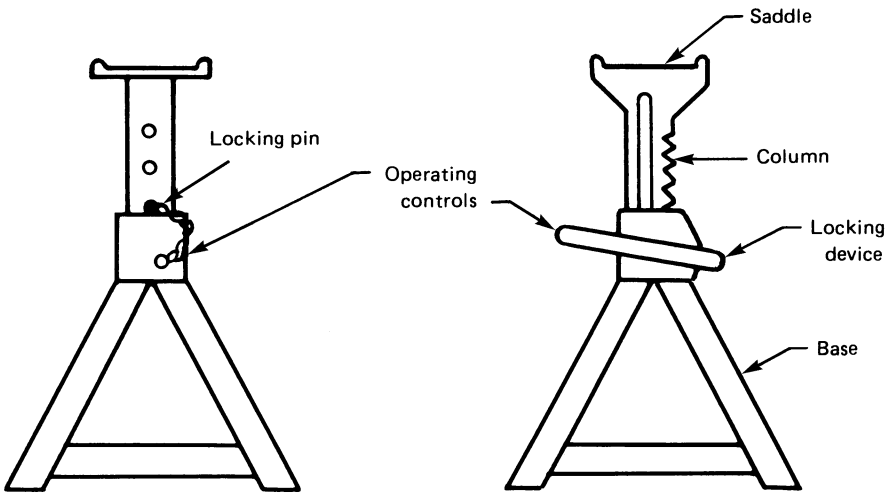
(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Center load on saddle.

Fig. 4-1 Typical Vehicle Support Stands



Pin-Type Lock

Rack- and Pawl-Type Lock

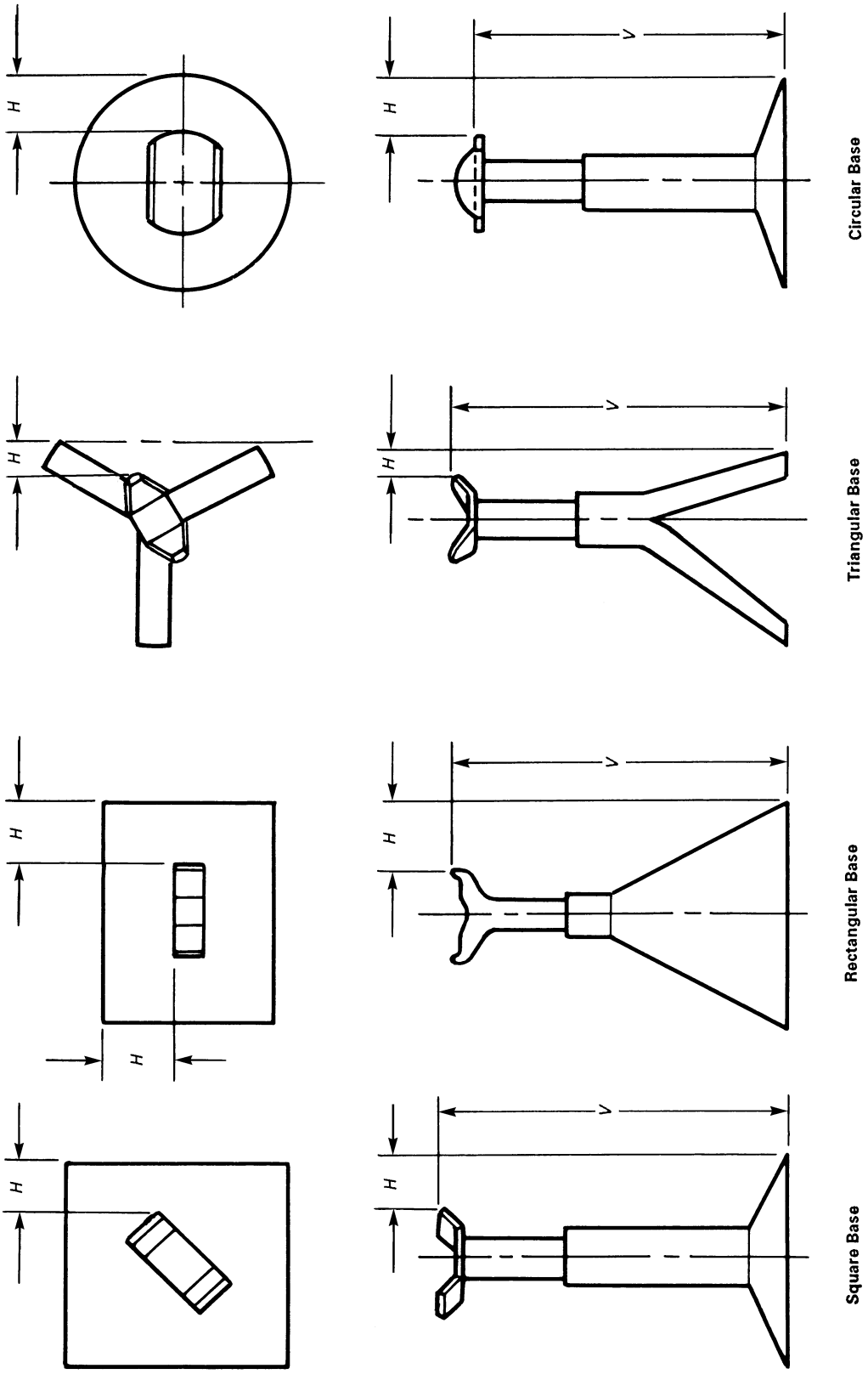


Fig. 4-2 Horizontal Dimensions and Vertical Heights for Stability Considerations

Fig. 4-3 Application of Load for Off-Center Load Test

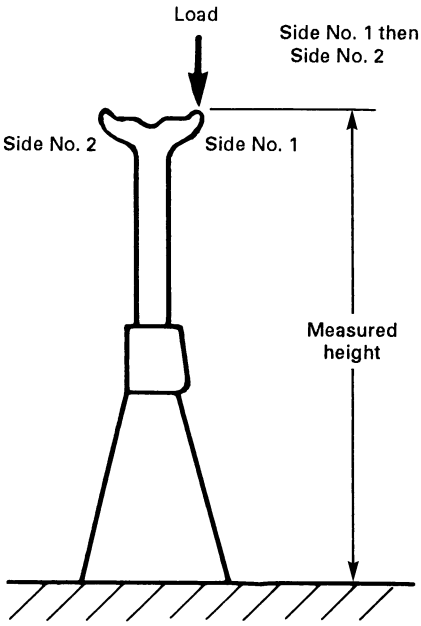
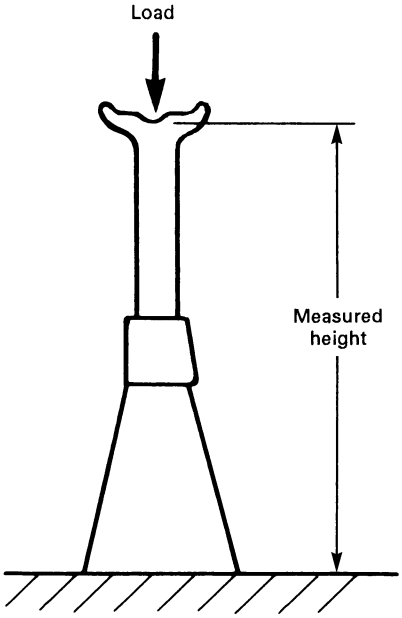


Fig. 4-4 Application of Load for Centered Load Test



(e) Use as a matched pair only.

(f) Failure to heed these markings may result in personal injury and/or property damage.

(g) Stands are not to be used to simultaneously support both ends of a vehicle.

(09) 4-3.2 Safety Messages

Additional safety messages include the following:

(a) Stands are not to be used to simultaneously support both ends of a vehicle.

(b) No alterations shall be made to this product.

4-4 DESIGN QUALIFICATION TESTING

(09) 4-4.1 Proof Tests

For each design or design change that may affect the stand's ability to meet this Standard, sample stands built to design specifications shall be proof tested. To conform with this Standard, the stands shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected. For stands that incorporate multiple load holding devices within a single assembly, each device shall be tested independently.

4-4.1.1 Off-Center Load Test. A horizontally constrained vertical load equal to rated capacity shall be applied. The column shall be moved by hand to remove all slack laterally toward the point of load application, in both the fully extended position and fully retracted position for at least 10 min on the lug or edge of the saddle as shown in Fig. 4-3. The saddle's ability to retain the load shall not be adversely affected by this test. A permanent reduction in height, measured after the removal of the load, at the point of load contact as shown in Fig. 4-4 shall not exceed 0.125 in. (3.18 mm). The test shall be repeated on all lugs and edges. A preload of no more than 100% of rated capacity may be applied to establish initial overall height. **(09)**

4-4.1.2 Proof Load Test. A proof load, as defined in para. 4-2.7, shall be applied centrally to the saddle, with the column in both the fully extended and the fully retracted position, with the base resting on a hard level surface. The load shall be applied as shown in Fig. 4-4 for at least 10 min. A permanent reduction in overall height, measured after the removal of the load, at the point of load contact shall not exceed 0.125 in. (3.18 mm). A preload of no more than 100% of rated capacity may be applied to establish initial overall height.

Part 5
Emergency Tire Changing Jacks

5-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

5-1.1 Scope

This Part applies to self-contained, emergency, tire changing jacks designed for lifting one wheel clear of the ground for emergency tire changing, and for mounting tire chains, on passenger cars, vans, and light duty trucks.

(09) **5-1.2 Classification**

The classifications for which this Part applies are the following:

(a) mechanical screw jacks consisting of concentric telescoping screws, or a single screw, that actuate a rocker panel adaptor, extended and retracted by a gear system, for engaging a vehicle frame or unibody

(b) mechanical bumper jacks consisting of a lever actuated ratchet or a screw and nut system, for engaging a vehicle bumper system

(c) scissors jacks (mechanical, hydraulic or pneumatic actuation) consisting of linkages united by pivotal joints for engaging a vehicle frame or unibody

(d) mechanical frame jacks consisting of a lever actuated ratchet for engaging a vehicle frame or unibody

5-1.3 Illustrations

(a) Figure 5-1 shows a typical screw jack covered by this Part and is not intended to be all-inclusive.

(b) Figure 5-2 shows a typical bumper jacks covered by this Part and is not intended to be all-inclusive.

(c) Figure 5-3 shows a typical scissors jack covered by this Part and is not intended to be all-inclusive.

(d) Figure 5-4 shows a typical frame jack covered by this Part and is not intended to be all-inclusive.

5-1.4 Definitions

bumper adapter: that portion of the jack that engages the vehicle manufacturer's specified lift point on the bumper.

durability test: a test to verify the jack's minimum cycle life and its load lifting and sustaining capabilities.

front and rear GAWR (passenger car): the passenger car front and rear Gross Axle Weight Rating as supplied by the vehicle manufacturer. This is model specific. In addition, the GAWR includes the sum of the weight reactions shared by the appropriate wheels of the following:

(a) the vehicle weight

(b) all fluid weight

(c) the sum of the weights of all options weighing 5 lbm (2.27 kg) or more

(d) the total luggage or cargo weight

(e) the total passenger load

front and rear GAWR (truck): the maximum load carrying capacity of the front and rear axle systems as supplied by the vehicle manufacturer. This rating is model specific.

Fig. 5-1 Typical Screw Jack

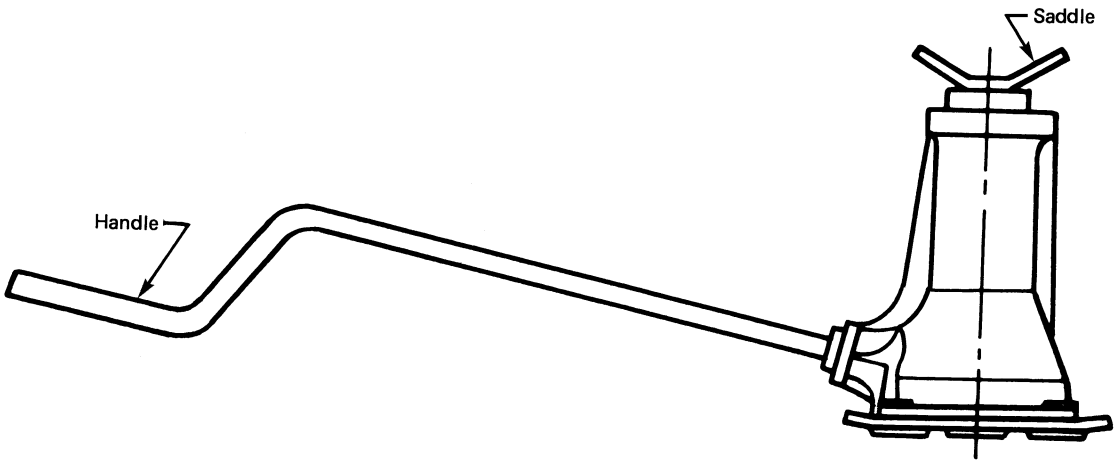


Fig. 5-2 Typical Bumper Jack

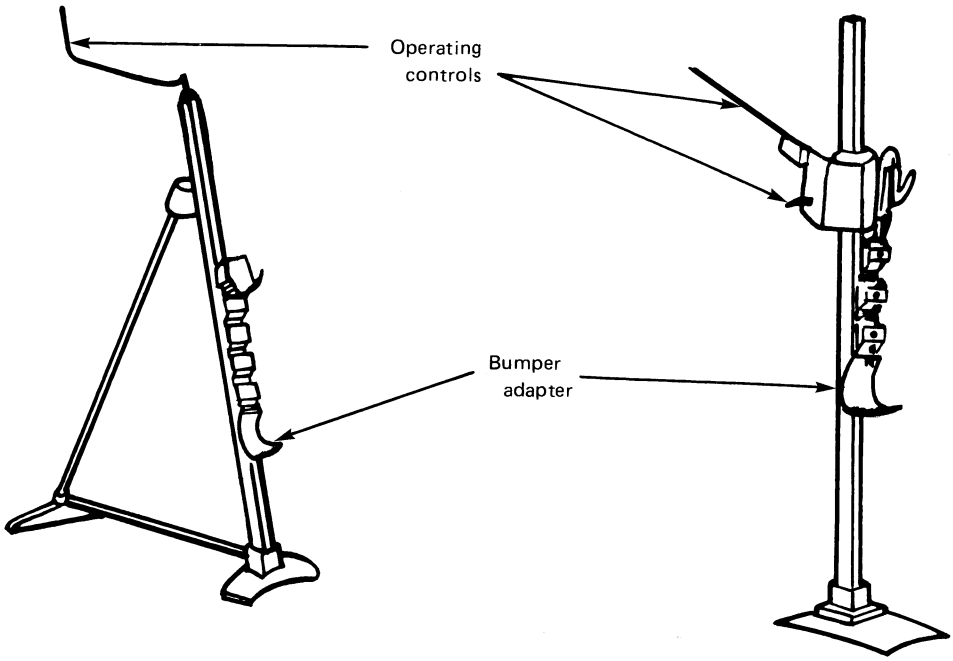


Fig. 5-3 Typical Scissors Jack

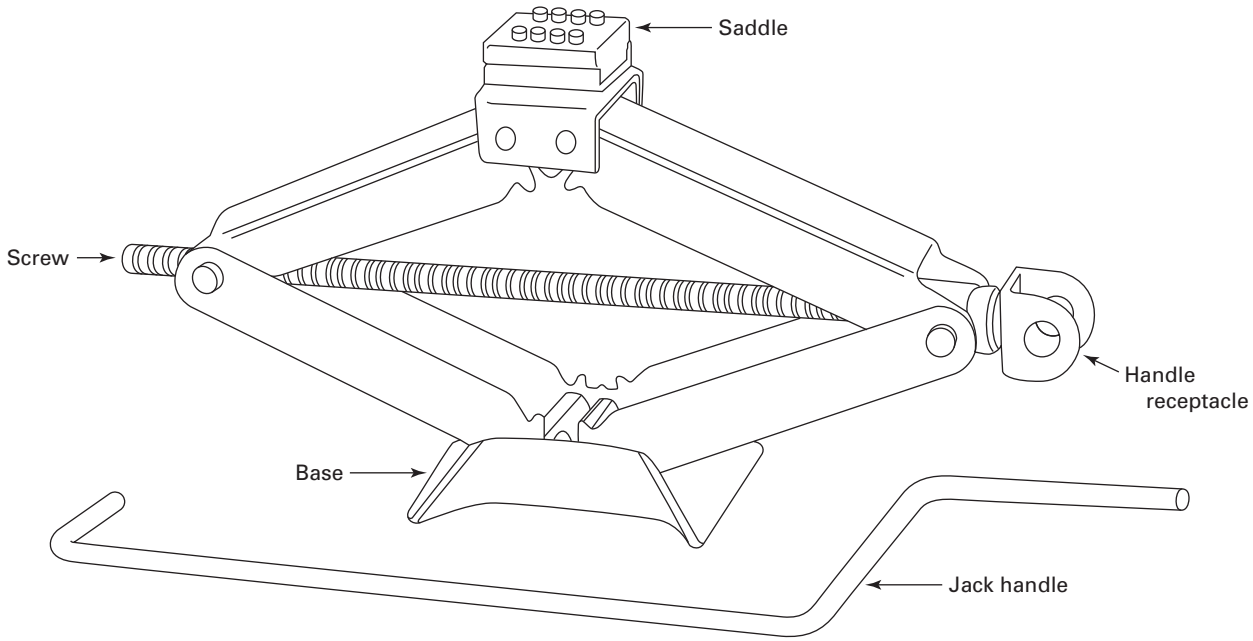
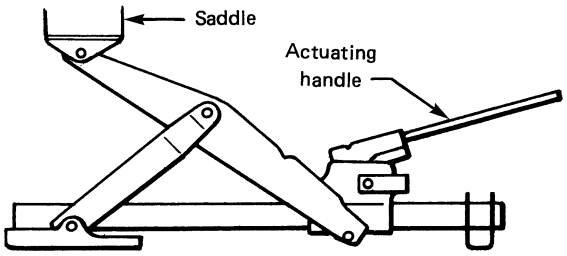


Fig. 5-4 Typical Frame Jack



GVWR (truck): the maximum Gross Vehicle Weight Rating of a fully loaded vehicle as supplied by the vehicle manufacturer. This is predicated on the equipment ratings of the front and rear axles, but is always less than the arithmetic sum of the front and rear GAWRs.

maximum GVWR (passenger car): the passenger car maximum Gross Vehicle Weight Rating as supplied by the manufacturer. This is model specific and usually includes the sum of the following:

(a) the vehicle base weight

(b) all fluid weight

(c) the sum of the weights of all options weighing 5 lbm (2.27 kg) or more

(d) the total luggage or cargo weight

(e) the total passenger load

(f) the same "added factor" or similar fixed weight that was assigned to either the front or rear to account for the additive effect of small weight increases not anticipated during the model run

rocker panel adapter: that portion of the jack that engages the vehicle manufacturer's specified lift point on the rocker panel.

(09) 5-2 DESIGN

5-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The handle shall be capable of being operated to the jack's rated capacity without sustaining functional damage. To prevent accidental lowering, the jack shall require intentional positive action by the operator for lowering the load.

Reciprocating handles shall require no more than 100 lbf (444 N) to operate and rotating handles shall require no more than 30 lbf (133 N) to operate.

5-2.2 Design Requirement

(a) The minimum jack rated capacity shall be equal to 50% of the GVWR of the intended vehicle.

(b) The jack may have a detachable handle, saddle or rocker panel adapter so configured to enable proper engagement with the vehicle frame or unibody at the lift points recommended by the vehicle manufacturer.

(c) The jack shall be capable of lifting and sustaining its rated capacity throughout its range of travel.

(d) Jack design shall accommodate the path of travel of the vehicle manufacturer's recommended jacking points throughout the full range of travel.

(e) It shall not be possible to assemble the jack incorrectly.

(f) Each jack shall be provided with a positive means to prevent inadvertent disassembly.

(g) The projected area of the base shall be sufficient to result in a maximum bearing pressure of 50 psi (7.25 kPa) when the jack is loaded to rated capacity.

5-2.3 Travel Limits

Each jack shall be provided with a positive means to prevent the load from being raised or lowered beyond the designed limit of travel.

5-2.4 Proof Load

Each jack shall be capable of performing the proof load test of para. 5-4.1.6 with a proof load of 200% of rated capacity.

5-2.5 Hinge Points

All hinge points shall be designed and assembled to resist lateral movement detrimental to the jack's performance.

5-2.6 Lubrication

The jack shall be lubricated by the manufacturer.

5-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 5-3.1 and 5-3.2.

5-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

The jack shall include marking to identify those vehicles with which the jack must be used.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Use only for emergency tire changing or mounting tire chains.

(e) Never get beneath the vehicle when it is supported by the jack.

(f) If vehicle is pushed off of jack, discard jack. Do not reuse.

(*g*) Failure to heed these markings may result in personal injury and/or property damage.

5-3.2 Safety Messages

Additional safety messages include the following:

(*a*) Activate the hazard warning flasher, turn off ignition, set parking brake, move automatic shift selector to park position. In case of a manual transmission, move gear selector into reverse position. In addition, the wheel diagonally opposite from the wheel being lifted shall be chocked in both directions.

(*b*) Place jack only at points of the vehicle as specified by the vehicle manufacturer.

(*c*) Follow tire changing procedure or tire chain mounting procedure specified in the vehicle manufacturer's owner's manual.

(*d*) No alterations shall be made to this product.

5-4 DESIGN QUALIFICATION TESTING

5-4.1 Proof Tests

For each design or design change that may affect the jack's ability to meet this Standard, sample jacks built to design specifications shall be proof tested. To conform with this Standard, the jacks shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

5-4.1.1 Laboratory Test. A new jack assembly shall be used to raise a load applied to the saddle, bumper adapter or rocker panel adapter, through contact with a fixture simulating the vehicle jacking point. For mechanical screw jacks and mechanical bumper jacks the load shall be equal to or greater than the rated capacity throughout 28 lifts. For scissors jacks and mechanical frame jacks, the load shall be equal to the load specified by the height-weight curve ±10% throughout 28 lifts. The operating handle force shall be measured during this test.

5-4.1.2 Vehicle Test. A new jack assembly shall be tested on an appropriately loaded passenger car in which the jacks's maximum rated capacity is equal to 50% of the GVWR.

On vans and light duty trucks, the rear axle shall be loaded to its rear GAWR. Additional weight shall be added to the front of the vehicle to attain front GAWR.

The test vehicle shall be raised on a hard level surface from a flat tire position to a 2.0 in. (51 mm) ground clearance, with an inflated maximum size tire/wheel combination, for a total of 28 lifts, with an equal number of lifts at each jacking point recommended by the vehicle manufacturer.

5-4.1.3 Stability Test (Push Off). A new jack assembly shall be tested on an appropriately loaded passenger car in which the jack's maximum rated capacity is equal to 50% of the GVWR.

On vans and light duty trucks, the rear axle shall be loaded to its rear GAWR. Additional weight shall be added to the front of the vehicle to attain front GAWR.

The test vehicle shall be raised on a hard level surface from a flat tire position to a 2.0 in. (51 mm) ground clearance, with an inflated maximum size tire/wheel combination. This test shall be performed with the transmission in neutral, the parking brake released and wheel chocks stowed. A force of 50 lbf (222 N) shall be applied in a longitudinal direction to the vehicle, forward for 30 sec and rearward for 30 sec. The same force shall then be applied in the transverse direction to the raised side of the vehicle, at least 30.0 in. (762 mm) above the pavement near the jacking point, inward for 30 sec and outward for 30 sec. This test shall be performed at each jacking point recommended by the vehicle manufacturer. This stability test shall then be repeated on the same unloaded vehicle. Inability of the jack to support the vehicle during this test constitutes failure.

5-4.1.4 Stability Test (Compound Slope). A new jack assembly shall be tested on an appropriately loaded passenger car in which the jack's maximum rated capacity is equal to 50% of the GVWR. (09)

On vans and light duty trucks, the rear axle shall be loaded to its rear GAWR. Additional weight shall be added to the front of the vehicle to attain front GAWR.

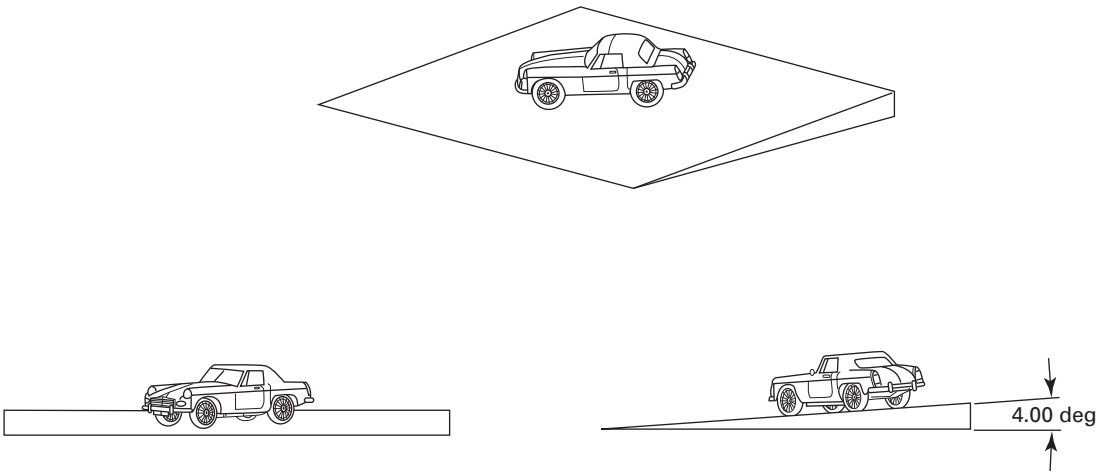
The test vehicle shall be raised on a hard level surface from a flat tire position to a 2.0 in. (51 mm) ground clearance, with an inflated, vehicle manufacturer recommended, maximum size tire/wheel combination. This test shall be performed with the automatic transmission in park or the manual transmission in the lowest gear, the parking brake set and wheel chocks deployed, if supplied by the vehicle manufacturer. Park the test vehicle with the front driver side upgrade at a 45 deg angle on a 4 deg (7%) grade. See Figs. 5-5 and 5-6.

A force of 100 lbf (444 N) shall be applied in a longitudinal direction to the vehicle, forward for 30 sec and rearward for 30 sec. The same force shall then be applied to the raised side of the vehicle, at least 30.0 in. (762 mm) above the pavement near the jacking point, inward for 30 sec and outward for 30 sec. This test shall be performed at each jacking point recommended by the vehicle manufacturer. Inability of the jack to support the vehicle during this test constitutes failure.

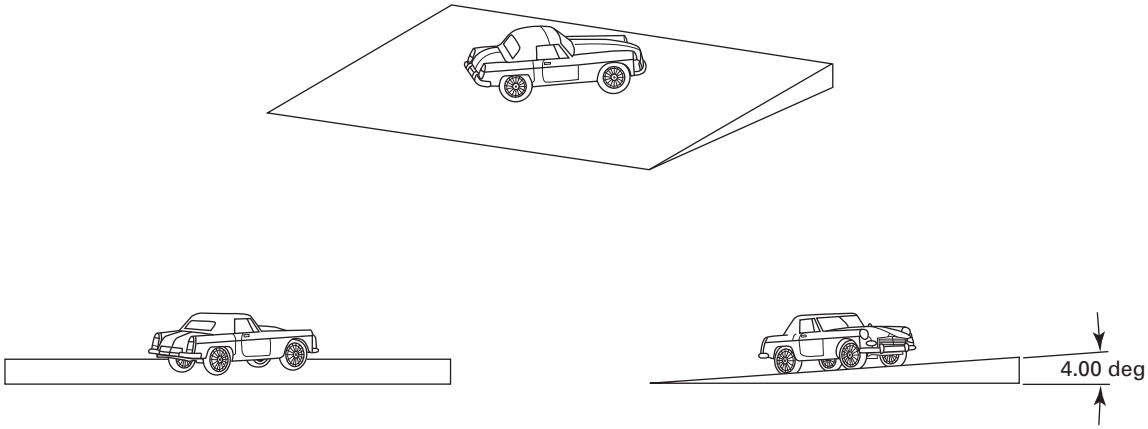
Repeat these tests with the front driver side parked downgrade at a 45 deg angle on a 7% grade. Inability of the jack to support the vehicle during this test constitutes failure.

5-4.1.5 Proof Load Test. For mechanical screw jacks and mechanical bumper jacks, a proof load, as defined in para. 5-2.4, shall be applied to the saddle, bumper

(09) **Fig. 5-5 Stability Test — Compound Slope (Down Grade)**



(09) **Fig. 5-6 Stability Test — Compound Slope (Up Grade)**



adapter or rocker panel adapter. The load shall be lifted, sustained, and lowered throughout the range of travel. Should the originally supplied handle not be capable of activating the jack mechanism, a substitute handle may be used for the performance of this test. Inability of the jack to return, unloaded, to within 0.5 in. (12.7 mm) of the fully raised, pretest, position at the completion of this test constitutes failure.

For scissors jacks and mechanical frame jacks, the jack shall sustain a proof load, applied to the saddle, for 10 min equal to 150% of the rated capacity based on the height to weight curve at the following positions: 35%, 60%, and 100% of the range of travel. Inability of the jack to return, unloaded, to within 0.5 in. (12.7 mm) of the fully raised, pretest, position at the completion of this test constitute failure.

Part 6
Upright-Type Mobile Lifts

6-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

6-1.1 Scope

This Part applies to hydraulic, pneumatic, and mechanical upright-type mobile lifts characterized by a pair of laterally spaced lifting members that raise and lower in unison, and are so arranged as to contact the vehicle at two points across its axis of symmetry on the bumper, bumper supports, or frame members for the purpose of raising the wheels of one end of the vehicle free of the ground.

6-1.2 Classification

Hydraulic (with and without internal load limiting devices), pneumatic (with and without dynamic restraints), and mechanical are the three classifications for which this Part applies.

6-1.3 Illustration

Figure 6-1 shows a typical upright-type mobile lift covered by this Part; it is not intended to be all-inclusive.

6-1.4 Definitions

base: the stationary portion of a lift to which lifting members are attached.

dynamic restraint: a device used to prevent the lifting member from extending to its full stroke in an unrestrained manner if the load is suddenly removed from the lift.

lift, hydraulic: a lift that is actuated by a hydraulic power source.

lift, pneumatic: lift that is actuated by a pneumatic power source.

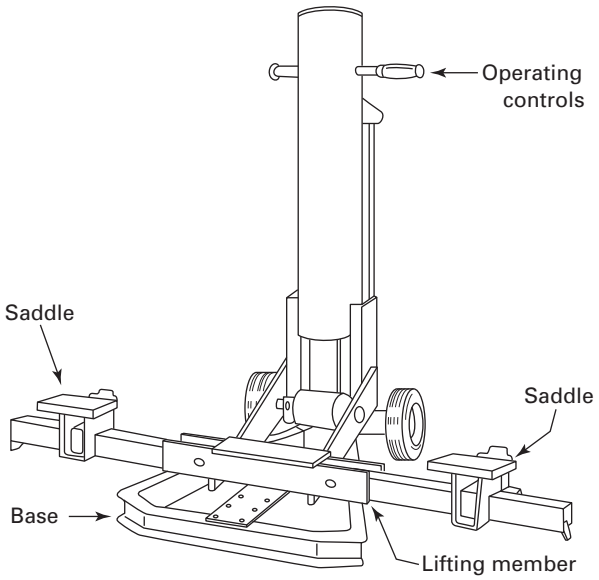
load limiting device: device that limits the lifting capacity of the lift.

(09) 6-2 DESIGN

6-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator, and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination

Fig. 6-1 Typical Upright-Type Mobile Lift



thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

6-2.2 Travel Limits

Each lift shall be provided with a positive means to prevent the load from being raised or moved beyond the design limit of travel.

6-2.3 Proof Load

All upright mobile lifts shall be capable of performing the proof load test of para. 6-4.1.6 with a proof load of 150% of rated capacity.

6-2.4 Secondary Load Holding Means

Lifts shall be equipped with a device to prevent unrestricted lowering of the load in the event of loss of pressure.

6-2.5 Saddles

The saddles shall have raised protrusions, such as a tang or rail, on the leading and trailing edges to act as a load restraint. Means shall be incorporated to limit the outward lateral adjustment of the saddles.

6-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 6-3.1 and 6-3.2.

6-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Load saddles equally.

(e) Lifting device only. Immediately after lifting, support the vehicle with appropriate means.

(f) Failure to heed these markings may result in personal injury and/or property damage.

6-3.2 Safety Messages

Additional safety messages include the following:

(a) Only attachments and/or adapters supplied by the manufacturer shall be used.

(b) Lift only on areas of the vehicle as specified by the vehicle manufacturer.

(c) No alterations shall be made to this product.

6-4 DESIGN QUALIFICATION TESTING

6-4.1 Proof Tests

For each design or design change that may affect the lift's ability to meet this Standard, sample lifts built to design specifications shall be proof tested. To conform with this Standard, the lifts shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

6-4.1.1 Instantaneous Load Loss Test. Pneumatic lifts shall be loaded to rated capacity and the lifting member raised to a height determined to provide the maximum momentum to the lifting member, should the load be removed. The load shall be removed in such a manner that the vertical height of the lifting member shall not change until the load is completely removed. The lift shall not leave the ground more than 1.0 ft (305 mm). The lifting member, saddles, and attachments shall remain affixed to the lift assembly.

6-4.1.2 Load-Limiting Device Test. Lifts equipped with internal load-limiting devices shall be raised against a measured load until the load-limiting device is activated, at which time the lift must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

6-4.1.3 Load-Sustaining Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range with the secondary load holding means deactivated. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

6-4.1.4 Secondary Load Holding Means Test. Lifts shall be loaded to not less than rated capacity and operated to raise the load. When the internal pressure is released, the secondary load holding means shall automatically stop the lift and hold the load within a descent of 7.0 in. (178 mm).

6-4.1.5 Release Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range. The release mechanism shall be operated to control the rate of descent to no more than 3.0 in./sec (76 mm/s).

NOTE: In normal use, a rate of descent greater than 3.0 in./sec (76 mm/s) is expected.

6-4.1.6 Proof Load Test. A proof load as defined in para 6-2.4 shall be applied to the saddles. The load shall be lifted, sustained, and lowered throughout the range of travel at full extension of all saddles. For purposes of this test, any load-limiting device may be deactivated.

Part 7
Service Jacks

7-1 SCOPE, CLASSIFICATION, AND ILLUSTRATIONS

7-1.1 Scope

This Part applies to self-contained service jacks used for lifting, but not sustaining, a partial vehicular load.

7-1.2 Classification

Hydraulic, pneumatic, pneumatic/hydraulic, and mechanical are the four classifications for which this Part applies.

7-1.3 Illustrations

Figures 7-1 and 7-2 show typical jacks covered by this Part and are not intended to be all-inclusive.

7-1.4 Definitions

jack, hydraulic service: a device in which the lift arm is actuated by a hydraulic pump.

jack, mechanical service: a service jack in which the lift arm is actuated by mechanical means such as levers, cables, gears, screws, ratchets, and pawls.

jack, pneumatic/hydraulic service: a service jack in which the lift arm is actuated by a mechanism that utilizes a relatively incompressible fluid, such as oil, as the force transmitting means, actuated by a pneumatic power source.

jack, pneumatic service: a service jack in which the lift arm is actuated by a mechanism that utilizes compressed air as the force transmitting medium.

jack, service: a self-contained device designed for lifting, but not sustaining, a partial vehicular load, consisting of a frame with wheels and/or swivel casters supporting a mechanism that actuates a pivoting lift arm equipped with a saddle.

lift arm: the main lifting member through which the force is transferred from the power unit to the saddle.

saddle periphery: the highest points of contact between the saddle and the load on the outermost edge of the saddle, including any upward protrusion such as lugs, lips, or tangs.

7-2 DESIGN

7-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

7-2.2 Travel Limits

Each jack shall be provided with a positive means to prevent the load from being raised or lowered beyond the designed limit of travel.

7-2.3 Proof Load (09)

All service jacks shall be capable of performing the proof load test of para. 7-4.1.5 with a proof load of 150% of rated capacity.

7-2.4 Saddle Periphery

The jack shall be designed to ensure that the saddle remains within 3 deg parallel (before and after performing each saddle periphery test of 7-4.1.4) to the surface that the jack is supported by throughout the entire lifting range. The saddle periphery, throughout the entire lifting range, shall not move outside the imaginary perimeter established by lines connecting centerlines of the front and rear wheels and/or caster pivot points (see Fig. 7-3).

7-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 7-3.1 and 7-3.2.

7-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Lifting device only. Immediately after lifting, support the vehicle with appropriate means.

Fig. 7-1 Typical Hydraulic Service Jacks

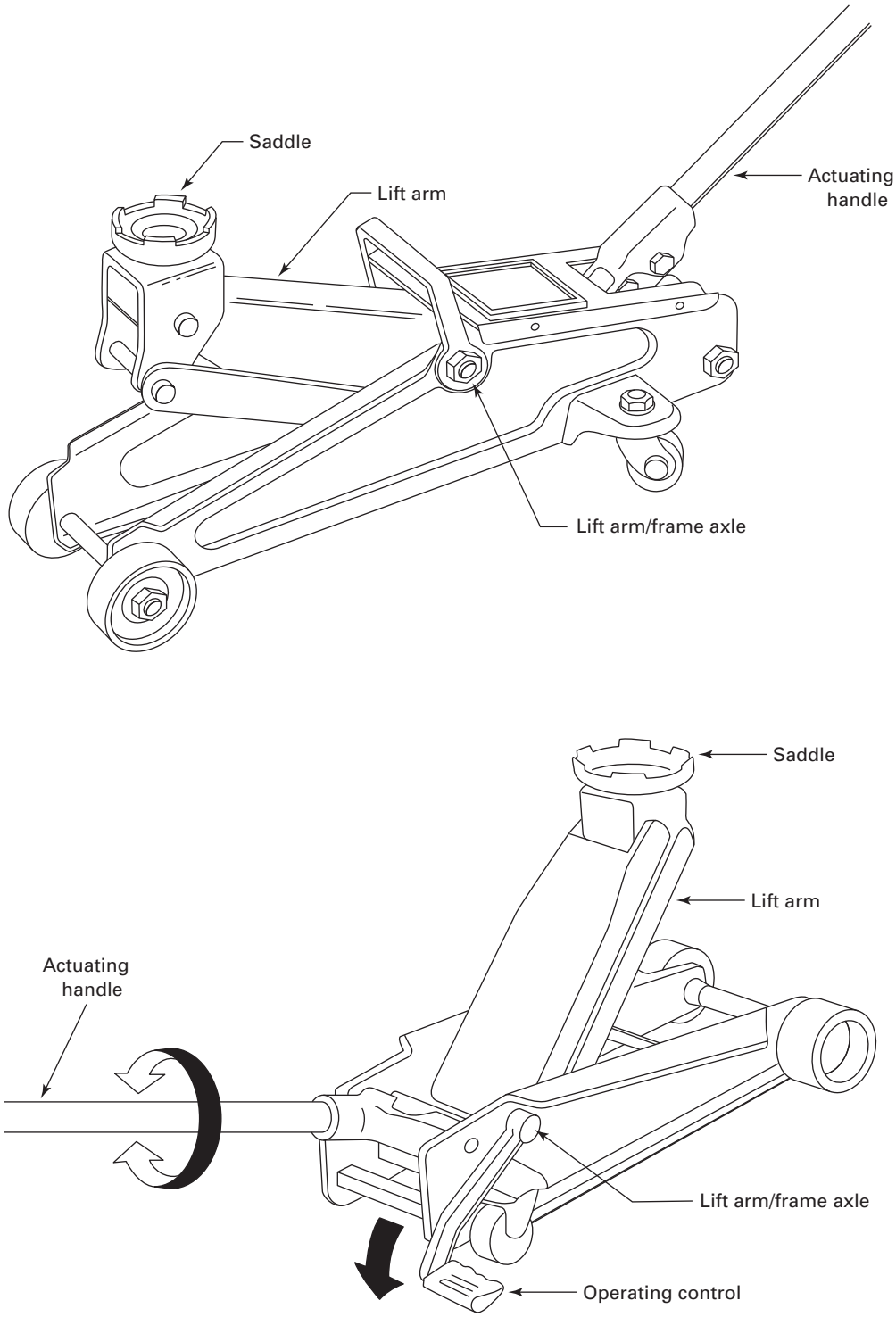
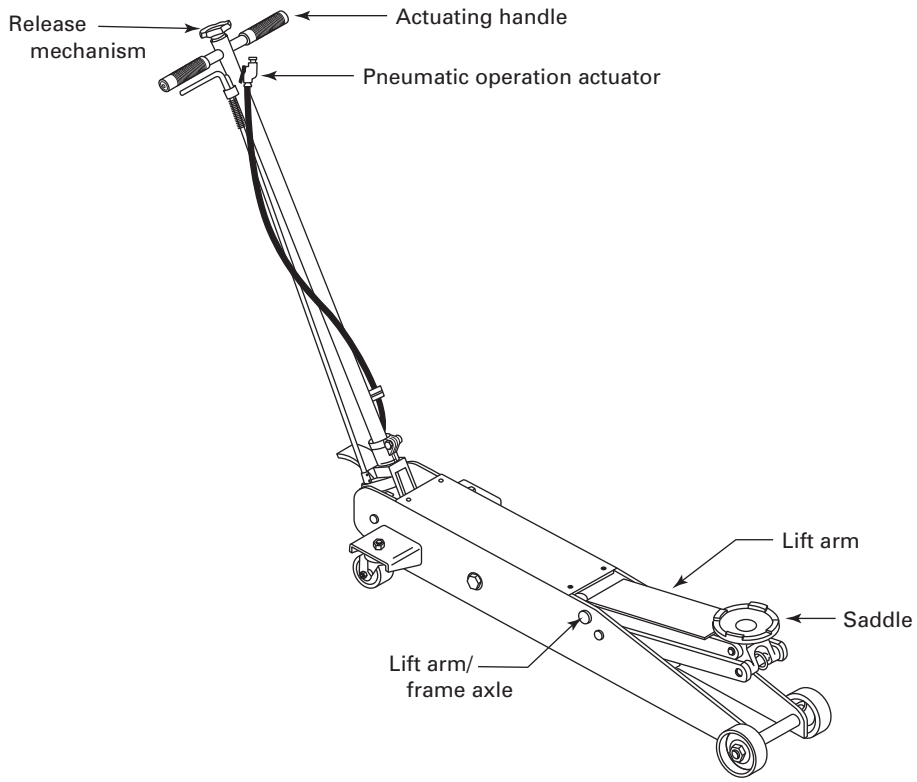


Fig. 7-2 Typical Pneumatic/Hydraulic Service Jacks



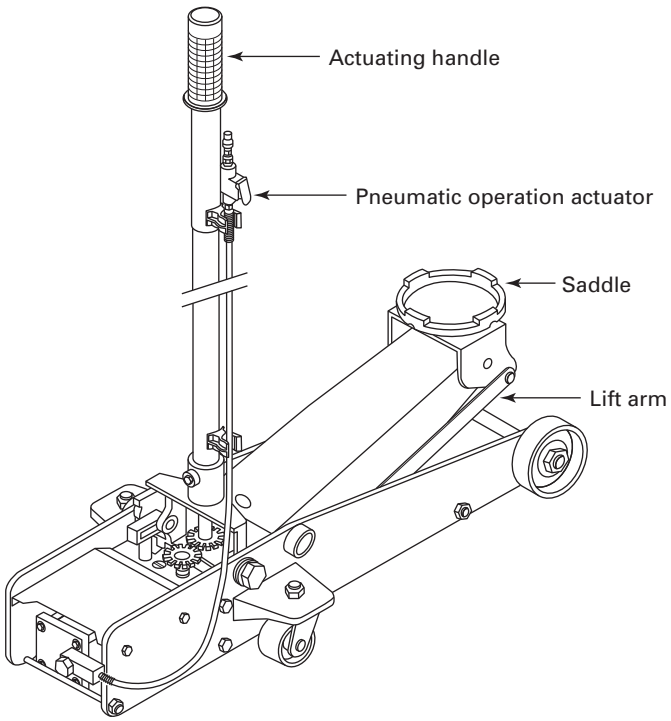


Fig. 7-3 Saddle Periphery Limits

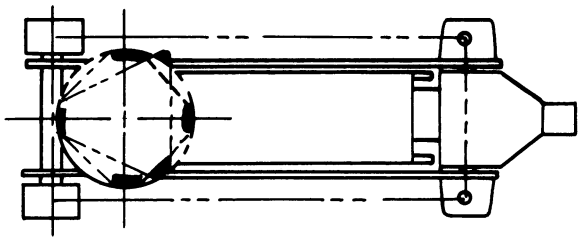
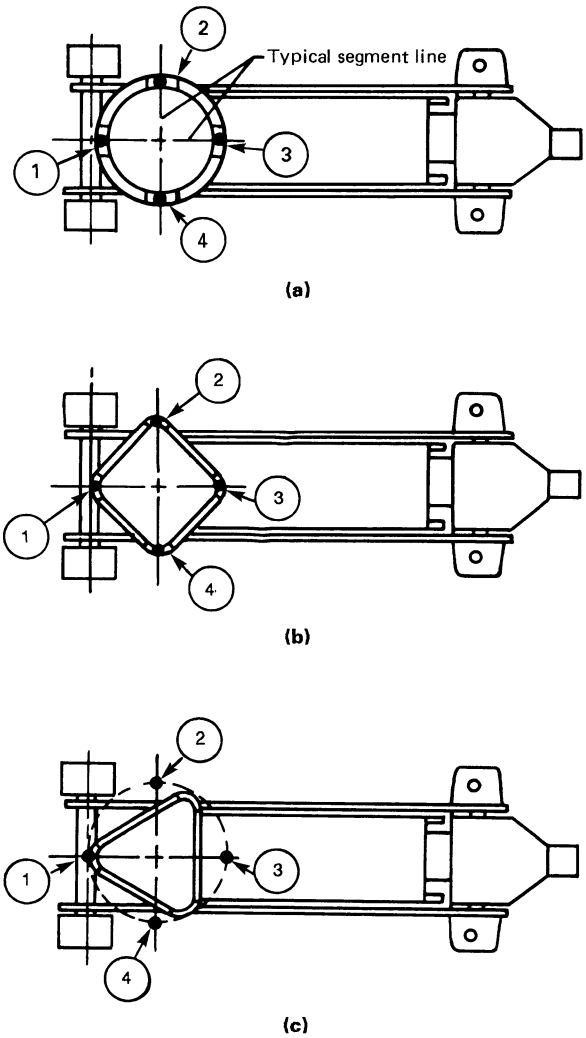


Fig. 7-4 Saddle Periphery Test



(e) Do not move or dolly the vehicle while on the jack.

(f) Failure to heed these markings may result in personal injury and/or property damage.

7-3.2 Safety Messages

Additional safety messages include the following:

(a) Lift only on areas of the vehicle as specified by the vehicle manufacturer.

(b) No alterations shall be made to this product.

(09) 7-4 DESIGN QUALIFICATION TESTING

7-4.1 Proof Tests

For each design or design change that may affect the jack's ability to meet this Standard, sample jacks built to design specifications shall be proof tested. To conform with this Standard, the jacks shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected. Prior to each test below, the jack shall be placed on a smooth, flat surface with the rear wheels or casters in contact with the surface and loaded with sufficient force to remove all vertical play in the wheels or casters.

7-4.1.1 Load-Limiting Device Test. Service jacks equipped with internal load-limiting devices shall be pumped against a measured load with the lift arm in the horizontal position until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of the rated capacity nor more than 125% of rated capacity.

7-4.1.2 Load-Sustaining Test. A load not less than the rated capacity shall be applied centrally to the saddle of the jack with the lift arm in the horizontal position. The load shall not lower more than $\frac{1}{8}$ in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

7-4.1.3 Release Mechanism Test. A load not less than the jack's rated capacity shall be applied centrally to the saddle and the test performed at three points:

(09) *(a)* lift arm horizontal[1]

(b) full extension

(c) a position measured midway between points (a) and (b)

The release mechanism shall be operated through 1 in. (25.4 mm) of travel to control the rate of descent to no more than 1.0 in./sec (25.4 mm/s) at each specified point.

7-4.1.4 Saddle Periphery Test. The lift point of the jack at the saddle shall be divided, using imaginary lines, into segments as shown in Fig. 7-4, sketches (a), (b), and (c). Lift point No. 1 of the saddle periphery (see Definitions in Introduction) shall be loaded to rated capacity, the load to be applied over a contact area not greater than 1.0 in.^{2} (645 mm^2). The jack shall be tested throughout the range of the jack. The load shall be removed and the jack checked for compliance with para. 7-2.4. The procedure shall be repeated until all remaining

[1] For jacks with arched or curved lifting arms, the measurement for determining when the lift arm is in the horizontal position shall be taken when the number one saddle lug is in its forward most position.

lift points of the saddle periphery have been tested in lift point Nos. 2 through 4. The orientation of the lift points of saddles that are neither square nor circular shall be rotated for each successive test to provide the maximum distance from the saddle centerline to the load point on the segment line. This test shall be repeated with the extender in the fully extended position and/or with the adapter in place.

7-4.1.5 Proof Load Test. A proof load as defined in para. 7-2.3 shall be applied centrally to the saddle of the jack. The load shall be lifted throughout the lifting range. For purposes of this test, any internal load limiting device may be deactivated. This test shall be repeated with the extender in the fully extended position with the adapter in place. (09)

Part 8
Wheel Dollies

8-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

8-1.1 Scope

This Part applies to hydraulic and mechanical wheel dollies characterized by a pair of laterally spaced lifting members that raise and lower in unison and are so arranged as to contact the vehicle wheel(s) at two areas on its circumference for the purpose of raising, removing, transporting, and replacing wheel and tire assemblies.

8-1.2 Classification

Hydraulic and mechanical are the two classifications for which this Part applies.

8-1.3 Illustration

Figure 8-1 shows typical wheel dollies covered by this Part and is not intended to be all-inclusive.

8-1.4 Definitions

lift: a PALD characterized by a pair of laterally spaced lifting members that raise and lower in unison, used to raise the wheels of one end of the vehicle free of the ground.

lifting frame: the stationary portion of a wheel dolly to which the lifting member is attached and on which it operates.

load restraint: a device supplied by the manufacturer to retain the load on the lift platform.

rollers: mechanisms attached to the lifting member that rotate about the lifting member.

wheel dolly: a PALD characterized by a pair of laterally spaced lifting members that are used to raise, remove, transport, and replace automotive wheel and tire assemblies.

wheel dolly, hydraulic: a wheel dolly that employs a hydraulic pump.

wheel dolly, mechanical: a wheel dolly that employs mechanical means such as cables, gears, screws, or chains as the force transmitting medium.

8-2 DESIGN

8-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and shall be designed so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

8-2.2 Travel Limit

Each wheel dolly shall be provided with a positive means to prevent the load from being raised or lowered beyond the design limit of travel.

8-2.3 Overload Capacity

All wheel dollies shall be designed to meet the requirements of para. 8-2.4 as minimum overload capacity.

8-2.4 Proof Load (09)

Wheel dollies shall be capable of performing the proof load test of para. 8-4.1.2 with a proof load of 200% of rated capacity.

8-2.5 Rollers

The lifting member shall be equipped with rollers to permit the rotation of wheel assemblies for the purpose of aligning bolt holes to their mating wheel studs.

8-2.6 Load Restraint

The load restraint shall be so designed and positioned as to prevent the inadvertent loss of the load during operation and movement of the wheel dolly.

8-2.7 Tilt Mechanism

When a tilt mechanism is provided, it shall be so designed to allow the lifting member to be adjusted relative to the horizontal plane, and it shall require intentional positive action by the operator to change the angle of tilt.

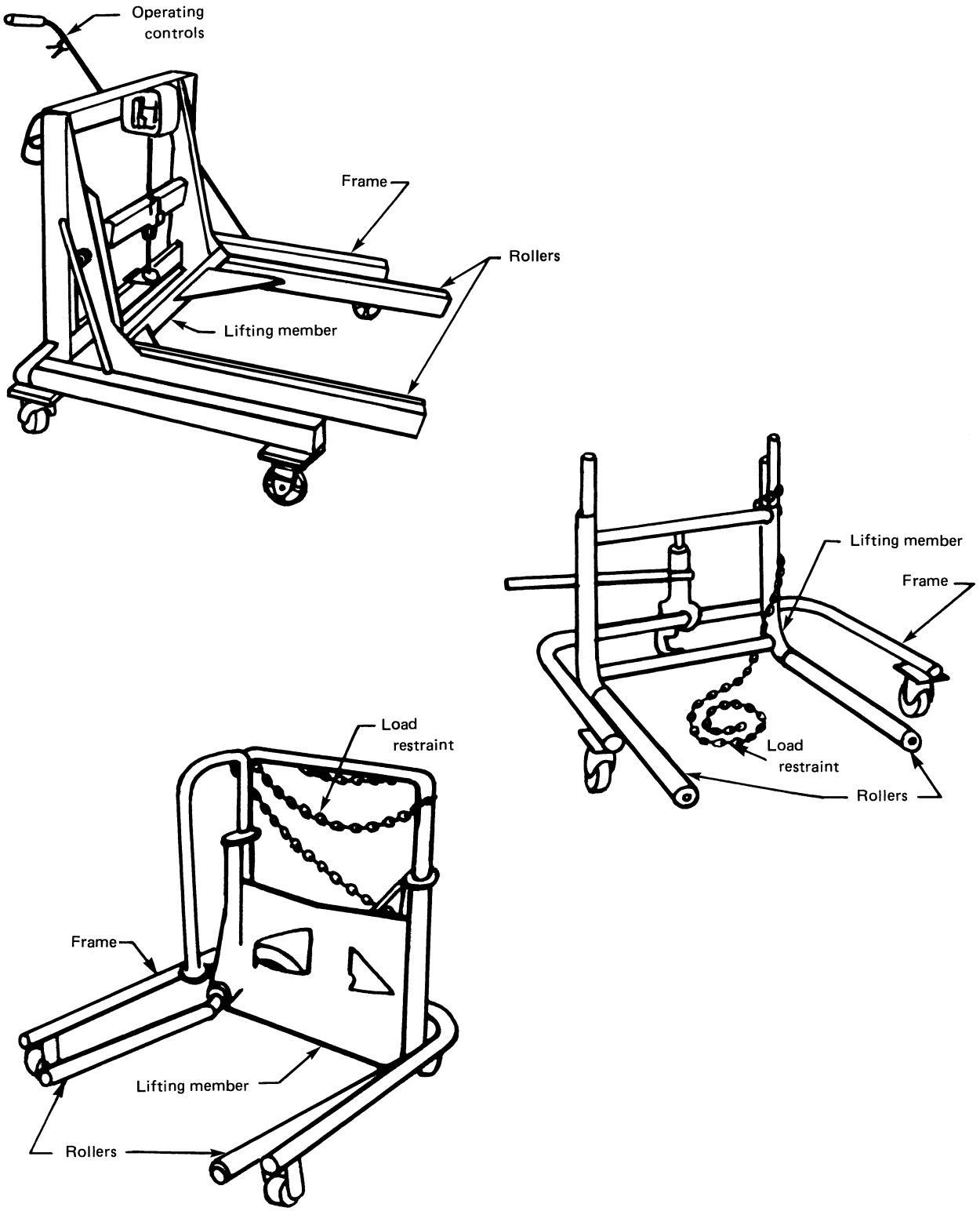
8-3 SAFETY MARKINGS AND MESSAGES (09)

Examples of safety markings and messages are specified in paras. 8-3.1 and 8-3.2.

8-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

Fig. 8-1 Typical Wheel Dollies



(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Before moving, lower the load to the lowest possible point.

(e) Failure to heed these markings may result in personal injury and/or property damage.

8-3.2 Safety Messages

Additional safety messages include the following:

(a) Apply load as close to the vertical portion of the lifting member as possible.

(b) Before moving the load, assure that the load is centered and secured with a load restraint device.

(c) No alterations shall be made to this product.

8-4 DESIGN QUALIFICATION TESTING

8-4.1 Proof Tests

For each design or design change that may affect the wheel dolly's ability to meet this Standard, sample wheel dollies built to design specifications shall be proof tested. To conform with this Standard, the wheel dolly shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

8-4.1.1 Operational Test. A static load, not less than the rated capacity of the wheel dolly, shall be applied centrally between the rollers with the load center of gravity approximately 1.0 ft (305 mm) from the vertical portion of the lifting member. The load center of gravity shall be not less than 27.0 in. (686 mm) from the floor.

(09) **8-4.1.1.1 Load-Sustaining Test.** The load, as defined in para. 8-4.1.1, shall be applied to the lifting member at full height. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

8-4.1.1.2 Release Test. The load, as defined in para. 8-4.1.1, shall be applied to the lifting member at full height. The release mechanism shall be operated to control the rate of descent to no more than 3.0 in./sec (76 mm/s). (09)

8-4.1.1.3 Tilt Mechanism Test (If So Equipped). With the wheel dolly loaded as defined in para. 8-4.1.1 and with the lift member at its maximum height, the tilt mechanism shall be manipulated throughout its entire range of adjustment.

8-4.1.1.4 Mobility Test. The wheel dolly, while loaded as defined in para. 8-4.1.1, shall be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) across a 0.5 in. (12.7 mm) high, 15 deg slope rise in the floor, and a 0.5 in. (12.7 mm) drop to the floor, at an approach angle that will bring only one caster or wheel at a time in contact with the rise and drop. The wheel dolly shall not lose the load or tip over.

8-4.1.1.5 Stability Test. The wheel dolly, while loaded as defined in para. 8-4.1.1, shall be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) against a 2.0 in. (51 mm) high vertical rise 90 deg to the direction of movement at an approach angle that will bring one or two wheels or casters in contact with the rise at the point of greatest instability. The wheel dolly shall not lose the load or tip over.

8-4.1.2 Proof Load Test. A proof load as defined in para. 8-2.4 shall be applied to the lifting member. The load shall be applied centrally between the rollers and located midway between the front and rear of the lifting member. The load shall be lifted throughout the range of travel.

Part 9
Shop Cranes

9-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

9-1.1 Scope

This Part applies to self-contained shop cranes characterized by a pair of laterally spaced legs, an upright mast, pivoting boom with a boom extension and hook, and a power unit to move the boom up and down at a pivot point for the purpose of raising, removing, transporting in the lowered position, and replacing automobile engines/transmissions and other components. This Part applies to shop cranes of 8,000 lbm (3 636 kg) capacity or less.

9-1.2 Classification

Hydraulic and pneumatic/hydraulic are the two classifications for which this Part applies.

9-1.3 Illustration

Figure 9-1 shows typical shop cranes covered by this Part and is not intended to be all-inclusive.

9-1.4 Definitions

base: the structure of a shop crane to which the upright mast and leg extensions are attached.

boom: the pivoting portion of the PALD to which the hydraulic unit is attached to raise and lower loads.

boom extension: that integral portion of the boom that provides adjustment of the effective boom length.

leg extension: that integral portion of the leg that provides adjustment of the effective leg length.

load hook: a device at the end of the boom extension to which the load is applied.

mast, upright: the upright structure mounted to the base to which the boom is attached.

shop crane: a PALD characterized by a pair of laterally spaced legs, an upright mast, pivoting boom with a boom extension, and hook which is used to raise and remove automotive components for service.

shop crane, hydraulic: a shop crane that is actuated by a hydraulic pump.

shop crane, pneumatic/hydraulic: a crane in which the boom is actuated by a mechanism that utilizes a relatively incompressible fluid, such as oil, as the force transmitting means, actuated by a pneumatic power source.

sling: an assembly to be used for lifting when connected to a lifting mechanism at the sling's upper end and when supporting a load at the sling's lower end.

9-2 DESIGN

9-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

9-2.2 Travel Limit

Each shop crane shall be provided with a positive means to prevent the load from being raised or lowered beyond the design limit of travel.

9-2.3 Overload Capacity

All shop cranes shall be designed to meet the requirements of para. 9-2.4 as minimum overload capacity.

9-2.4 Proof Load (09)

All shop cranes shall be capable of performing the proof load test of para. 9-4.1.6 with a proof load of 150% of rated capacity.

9-2.5 Load Hook

The shop crane shall be provided with a load hook and/or chain at the end of the boom extension that is capable of sustaining the proof loads of the unit. The load hook shall be provided with a latching mechanism.

9-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 9-3.1 and 9-3.2.

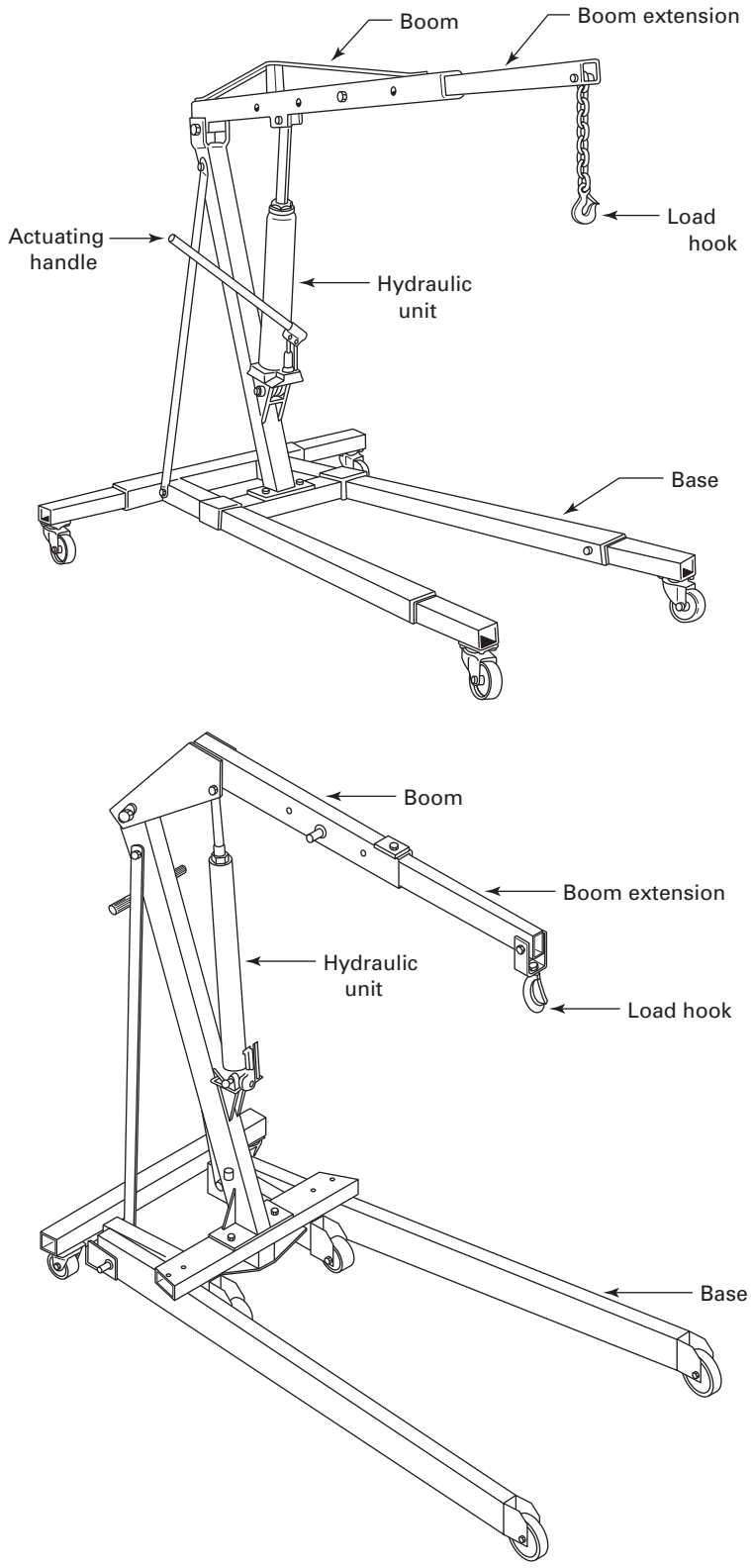
9-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

Fig. 9-1 Typical Shop Cranes



(c) Use only on hard level surface.

(d) Before moving, lower the load to the lowest possible point.

(e) Failure to heed these markings may result in personal injury and/or property damage.

9-3.2 Safety Messages

Additional safety messages include the following:

(a) Use only slings or chains with a rated capacity greater than the weight of the load being lifted.

(b) Do not allow load to swing or drop violently while lowering or moving.

(c) No alterations shall be made to this product.

9-4 DESIGN QUALIFICATION TESTING

9-4.1 Proof Tests

For each design or design change that may affect the shop crane's ability to meet this Standard, sample shop cranes built to design specifications shall be proof tested. To conform with this Standard, the shop crane shall perform to design specification and no functional damage shall occur, nor shall operational characteristics be detrimentally affected. The tests below shall be performed with the boom at the fully extended and fully retracted positions.

9-4.1.1 Load-Sustaining Test. A load not less than the rated capacity shall be applied to the hook with the boom in the horizontal position. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

9-4.1.2 Release Mechanism Test. A load not less than the rated capacity shall be applied to the hook with the boom at its maximum lifting height. The release mechanism shall be operated to control the rate of descent to no more than 3.0 in./sec (76 mm/s).

NOTE: In normal use, a rate of descent greater than 3.0 in./sec (76 mm/s) is expected.

9-4.1.3 Load-Limiting Device Test. Shop cranes equipped with internal load-limiting devices shall be pumped against a measured load with the boom in the horizontal position until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

9-4.1.4 Mobility Test. The shop crane, with rated load center of gravity 2.0 ft (610 mm) off the floor and boom in the horizontal position, shall be moved forward in a direction parallel to the boom at a minimum of 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) across a 0.5 in. (12.7 mm) high, 15 deg slope rise in the floor, and a 0.5 in. (12.7 mm) drop to the floor, at an approach angle that will bring only one caster or wheel at a time in contact with the rise and drop. The shop crane shall traverse the rise and drop without loss of load or tipping over.

9-4.1.5 Stability Test. The shop crane, with rated load center of gravity 2.0 ft (610 mm) below the hook and boom in the fully raised position, shall be moved forward in a direction parallel to the boom at 5.0 in./sec (127 mm/s) to 7.0 in./sec (178 mm/s) against a 2.0 in. (51 mm) high vertical rise 90 deg to the direction of movement that will bring the front wheels or casters in contact with the vertical rise. The shop crane shall not lose the load or tip over. The test shall be repeated with the movement in the opposite direction.

9-4.1.6 Proof Load Test. A proof load as defined in para. 9-2.4 shall be applied to the boom extension. The load shall be lifted throughout the range of travel with the load located on the hook at the end of the boom extension. For this test, any internal load limiting device may be deactivated.

9-5 ATTACHMENT AND ADAPTERS

Slings and/or chains used in conjunction with a shop crane shall have a rated capacity greater than the weight of the object being lifted.

Part 10
Swing-Type Mobile Lifts

10-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

10-1.1 Scope

This Part applies to pneumatic swing-type mobile lifts characterized by a pair of laterally spaced lifting members that raise and lower in unison, and are so arranged as to contact the vehicle at two points across its axis of symmetry on the bumper, bumper supports, axle, or frame members for the purpose of raising the wheels of one end of a vehicle free of the ground.

10-1.2 Classification

Pneumatic is the only classification for which this Part applies.

10-1.3 Illustration

Figure 10-1 shows a typical swing-type mobile lift covered by this Part and is not intended to be all-inclusive.

10-1.4 Definitions

base: the stationary portion of a lift to which lifting members are attached.

dynamic restraint: a device used to prevent the lifting member from extending to its full stroke in an unrestrained manner if the load is suddenly removed from the lift.

lift, pneumatic: a lift that is actuated by a pneumatic power source.

10-2 DESIGN

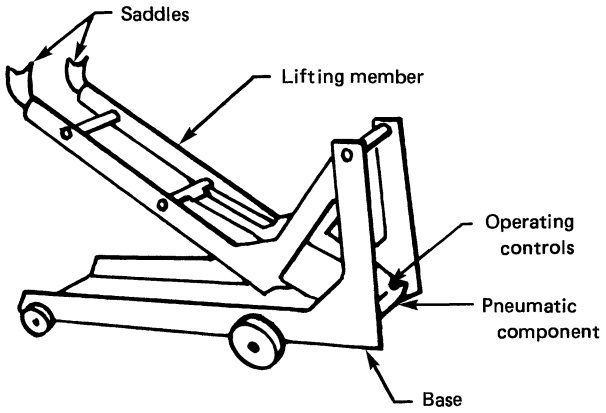
10-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

10-2.2 Travel Limit

Each lift shall be provided with a positive means to prevent the load from being raised or moved beyond the design limit of travel.

Fig. 10-1 Typical Swing-Type Mobile Lift



10-2.3 Overload Capacity

All lifts shall be designed to meet the requirements of para. 10-2.4 as minimum overload capacity.

10-2.4 Proof Load (09)

All swing type mobile lifts shall be capable of performing the proof load test of para. 10-4.1.5 with a proof load of 150% of rated capacity.

10-2.5 Secondary Load Holding Means

Lifts shall be equipped with a device to prevent unrestricted lowering of the load in the event of loss of air pressure.

10-2.6 Saddles

The saddles shall have raised protrusions, such as a tang or rail, on the edges to act as a load restraint.

10-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 10-3.1 and 10-3.2.

10-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Load saddles equally.

(e) Lifting device only. Immediately after lifting, support the vehicle with appropriate means.

(f) Failure to heed these markings may result in personal injury and/or property damage.

10-3.2 Safety Messages

Additional safety messages include the following:

(a) Only attachments and/or adapters supplied by the manufacturer shall be used.

(b) Lift only on areas of the vehicle as specified by the vehicle manufacturer.

(c) No alterations shall be made to this product.

10-4 DESIGN QUALIFICATION TESTING

10-4.1 Proof Tests

For each design or design change that may affect the lift's ability to meet this Standard, sample lifts built to design specifications shall be proof tested. To conform with this Standard, the lifts shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

10-4.1.1 Instantaneous Load Loss Test. Pneumatic lifts shall be loaded to rated capacity and the lifting member raised to a height determined to provide the maximum momentum to the lifting member, should the load be removed. The load shall be removed in such a manner that the vertical height of the lifting member shall not change until the load is completely removed. The lift shall not leave the ground more than 1.0 ft (305 mm). The lifting member, saddles, and attachments shall remain affixed to the lift assembly.

10-4.1.2 Load-Sustaining Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range with the secondary load holding means deactivated. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

10-4.1.3 Secondary Load Holding Means to Test Pneumatic Lifts. Lifts shall be loaded to not less than rated capacity and operated to raise the load. When the internal air pressure is released, the secondary load holding means shall automatically stop the lift and hold the load within a descent of 7.0 in. (178 mm).

10-4.1.4 Release Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range. The release mechanism shall be operated to control the rate of descent to no more than 3.0 in./sec (76 mm/s).

NOTE: In normal use, a rate of descent greater than 3 in./sec (76 mm/s) is expected.

10-4.1.5 Proof Load Test. A proof load as defined in para. 10-2.4 shall be applied to the saddles. The load shall be lifted, sustained, and lowered throughout the range of travel at full extension of all saddles. For this test, any load-limiting device may be deactivated.

Part 11
Scissors-Type Mobile Lifts

11-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

11-1.1 Scope

This Part applies to pneumatic and hydraulic scissors-type mobile lifts characterized by a pair of laterally spaced lifting members that raise and lower in a scissors action and are so arranged as to contact the vehicle at two points across its axis of symmetry on the bumper, bumper supports, or frame members for the purpose of raising the wheels of one end of a vehicle free of the ground.

11-1.2 Classification

Pneumatic and hydraulic are the only classifications for which this Part applies.

11-1.3 Illustration

Figure 11-1 shows a typical scissors-type mobile lift covered by this Part and is not intended to be all-inclusive.

11-1.4 Definitions

base: the stationary portion of a lift to which lifting members are attached.

dynamic restraint: a device used to prevent the lifting member from extending to its full stroke in an unrestrained manner if the load is suddenly removed from the lift.

lift, hydraulic: a lift that is actuated by a hydraulic power source.

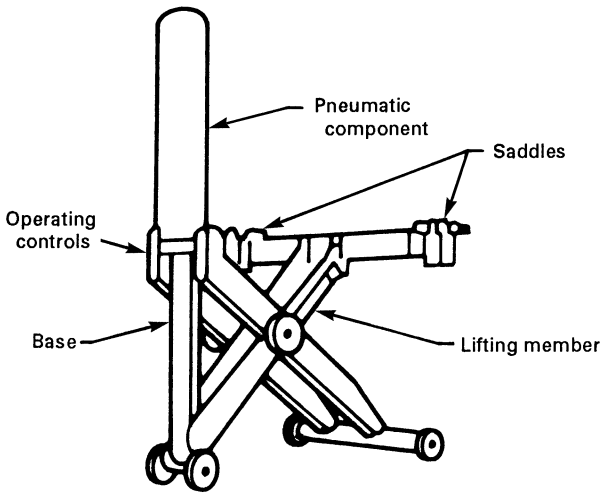
lift, pneumatic: a lift that is actuated by a pneumatic power source.

11-2 DESIGN

11-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

Fig. 11-1 Typical Scissors-Type Mobile Lift



11-2.2 Travel Limit

Each lift shall be provided with a positive means to prevent the load from being raised or moved beyond the design limit of travel.

11-2.3 Overload Capacity

All lifts shall be designed to meet the requirements of para. 11-2.4 as minimum overload capacity.

11-2.4 Proof Load (09)

All scissors-type mobile lifts shall be capable of performing the proof load test of para. 11-4.1.6 with a proof load of 150% of rated capacity.

11-2.5 Secondary Load Holding Means

Lifts shall be equipped with a device to prevent unrestricted lowering of the load in the event of loss of air pressure.

11-2.6 Saddles

The saddles shall have raised protrusions, such as a tang or rail, on the edges to act as a load restraint. Means shall be incorporated to limit the outward lateral adjustment of the saddles.

11-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 11-3.1 and 11-3.2.

11-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Load saddles equally.

(e) Lifting device only. Immediately after lifting, support the vehicle with appropriate means.

(f) Failure to heed these markings may result in personal injury and/or property damage.

11-3.2 Safety Messages

Additional safety messages include the following:

(a) Only attachments and/or adapters supplied by the manufacturer shall be used.

(b) Lift only on areas of the vehicle as specified by the vehicle manufacturer.

(c) No alterations shall be made to this product.

11-4 DESIGN QUALIFICATION TESTING

11-4.1 Proof Tests

For each design or design change that may affect the lift's ability to meet this Standard, sample lifts built to design specifications shall be proof tested. To conform with this Standard, the lifts shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

11-4.1.1 Instantaneous Load Loss Test. Pneumatic lifts shall be loaded to rated capacity and the lifting member raised to a height determined to provide the maximum momentum to the lifting member, should the load be removed. The load shall be removed in such a manner that the vertical height of the lifting member shall not change until the load is completely removed. The lift shall not leave the ground more than 1.0 ft (305 mm). The lifting member, saddles, and attachments shall remain affixed to the lift assembly.

11-4.1.2 Load-Limiting Device Test. Lifts equipped with internal load-limiting devices shall be raised against a measured load until the load-limiting device is activated, at which time the jack must have been supporting no less than 100% of its rated capacity and no more than 125% of its rated capacity.

11-4.1.3 Load-Sustaining Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range with the secondary load holding means deactivated. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

11-4.1.4 Secondary Load Holding Means to Test Pneumatic Lifts. Lifts shall be loaded to not less than rated capacity and operated to raise the load. When the internal air pressure is released, the secondary load holding means shall automatically stop the lift and hold the load within a descent of 7.0 in. (178 mm).

11-4.1.5 Release Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range. The release mechanism shall be operated to control the rate of descent to no more than 3.0 in./sec (76 mm/s).

NOTE: In normal use, a rate of descent greater than 3.0 in./sec (76 mm/s) is expected.

11-4.1.6 Proof Load Test. A proof load as defined in para. 11-2.4 shall be applied to the saddles. The load shall be lifted, sustained, and lowered throughout the range of travel at full extension of all saddles. For purposes of this test, any internal load-limiting device may be deactivated.

Part 12
Auxiliary Stands

12-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

12-1.1 Scope

This Part applies to self-contained auxiliary stands designed as a means of partial support for, and the positioning of, vehicle components during their installation/removal, but not for use in stabilizing or supporting vehicles. This Part does not apply to devices classified as vehicle support stands (see Part 4), to units whose rated capacity is more than 1,500 lbm (680 kg), or to devices classified as stabilizing stands.

12-1.2 Classification

Mechanical is the only classification to which this Part applies, excluding units with a tripod, square, or other base design configuration (e.g., stabilizing stands).

12-1.3 Illustration

Figure 12-1 shows typical auxiliary stands and their components that are covered by this Part and is not intended to be all-inclusive.

12-1.4 Definitions

auxiliary stands: self-contained devices designed to be used as a means of partial support for vehicle components during their installation/removal, but not for use in supporting vehicles.

base: that portion of the stand that rests on the ground and holds the adjustable column.

freestanding: when initially positioned vertically, without a load, able to stand in an upright position without the application of external forces.

locking device: the mechanism used to hold the column in the selected height position.

12-2 DESIGN

12-2.1 Base

The base may be of any configuration that provides for a freestanding unit which is capable of being rocked to assist in the positioning of vehicle components. The upper portion of the base shall be designed to house and guide the column.

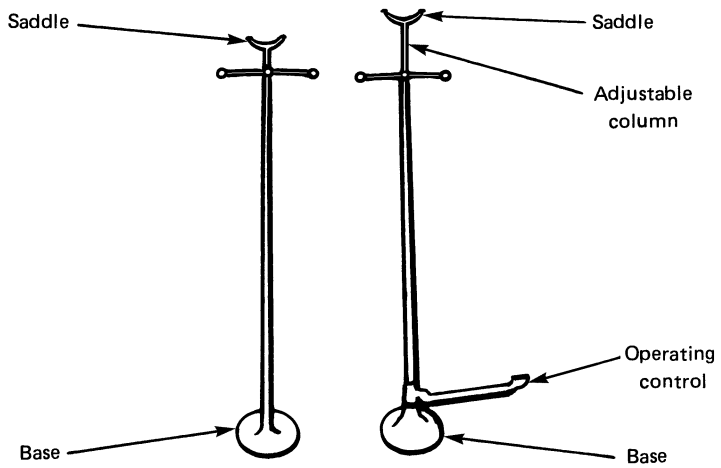
12-2.2 Column

A means shall be provided to prevent the inadvertent separation of the column from the base. In the fully retracted position, the lower end of the column shall not extend below the plane made where the base contacts the ground.

12-2.3 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator

Fig. 12-1 Typical Auxiliary Stands



and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

12-2.4 Saddle

The saddle configuration shall be such as to aid in the proper positioning and supporting of the load.

(09) **12-2.5 Proof Load**

Auxiliary stands shall be capable of performing the proof load test of para. 12-4.1.1 with a load of 110% of rated capacity.

All auxiliary stands shall be capable of performing the proof load test of para. 12-4.1.1 with a proof load of 200% of rated capacity.

12-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 12-3.1 and 12-3.2.

12-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Adequately support the vehicle before starting repairs.

(e) Do not use to support or stabilize vehicle.

(f) Center load on saddle.

(g) Failure to heed these markings may result in personal injury and/or property damage.

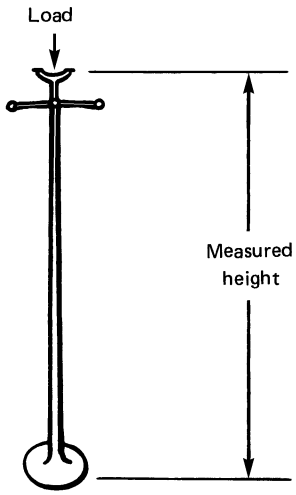
12-3.2 Safety Messages

Additional safety messages include the following:

(a) This stand is intended to provide partial support of vehicle components during removal and installation.

(b) No alterations shall be made to this product.

Fig. 12-2 Application of Load for Proof Load Test



12-4 DESIGN QUALIFICATION TESTING

12-4.1 Proof Tests

For each design or design change that may affect the stand's ability to meet this Standard, sample stands built to design specifications shall be tested. To conform with this Standard, the stands shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

(09) **12-4.1.1 Proof Load Test.** A horizontally constrained vertical load of 200% of rated capacity shall be applied centrally to the saddle, with the column in both the fully extended and the fully retracted positions, with the base resting on a hard level surface. The load shall be applied as shown in Fig. 12-2 for at least 10 min. A permanent reduction in height, measured after the removal of the load, at the point of load contact shall not exceed 0.125 in. (3.18 mm). A preload of no more than 100% of rated capacity may be applied to establish initial overall height.

Part 13
Automotive Ramps

13-1 SCOPE, CLASSIFICATION, AND ILLUSTRATIONS

13-1.1 Scope

This Part applies to automotive ramps to be used in matched pairs to support one end (front or rear) of a vehicle. They are not to be used to simultaneously support both ends or one side of a vehicle.

13-1.2 Classification

This Part applies to load sustaining devices, used in matched pairs, upon which two front or rear wheels of a vehicle are driven to elevate either end of the vehicle.

13-1.3 Illustrations

Figures 13-1, 13-2, and 13-3 show typical automotive ramps that are covered by this Part and are not intended to be all-inclusive.

13-1.4 Definitions

matched pair: similar height, length, and capacity.

platform: the top section of the ramp that locates and supports the vehicle tire.

ramp height: the maximum vertical distance between the platform and the base.

ramp stability: a measure of resistance to tipping and lateral movement while driving on the ramps, driving off the ramps, and while supporting the load.

13-2 DESIGN

13-2.1 Base

The base may be of any configuration that provides ramp stability under proof load and that resists parallel and lateral movement while a vehicle is being driven onto and off the ramps.

13-2.2 Stability

The ramps shall be designed such that the width of the base is equal to or greater than the height of the ramp platform. The projected edges of the incline and platform shall align with or be within the area of the base.

13-2.3 Surfacing

The top surface of the inclined portion of the ramps shall be constructed to provide slip resistance.

13-2.4 Locating Devices

The platform of the ramp shall be equipped with a device or configuration so that the vehicle operator or the observer will be able to ascertain that the wheel of the vehicle is in the correct location.

13-2.5 Resistance to Roll-Off

Each ramp shall have an inherent means of resisting roll-off of a vehicle from the ramp.

13-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 13-3.1 and 13-3.2.

13-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Center load between the sides of the ramp.

(e) Use as a matched pair to support one end of a vehicle.

(f) Failure to heed these markings may result in personal injury and/or property damage.

13-3.2 Safety Messages

Additional safety messages include the following:

(a) Ramps are not to be used to simultaneously support both ends or one side of a vehicle.

(b) Maximum allowable tire width is (manufacturer to specify for each set of ramps).

(c) Do not use other lifting equipment in conjunction with the ramps.

(d) Do not disconnect brakes, engine, transmission components, drive train, drive shaft, universal joints, or wheels while the vehicle is on the ramps.

(e) Be sure the wheels to be driven on the ramps are positioned straight forward in alignment with the ramps, and center the two ramps against the tires.

(f) Another person, standing clear from vehicle path, should observe and guide the vehicle operator when ascending and descending the ramps.

(g) Never accelerate or apply brakes suddenly. Proceed slowly and cautiously. Once the vehicle reaches

Fig. 13-1 Typical Automotive Ramps

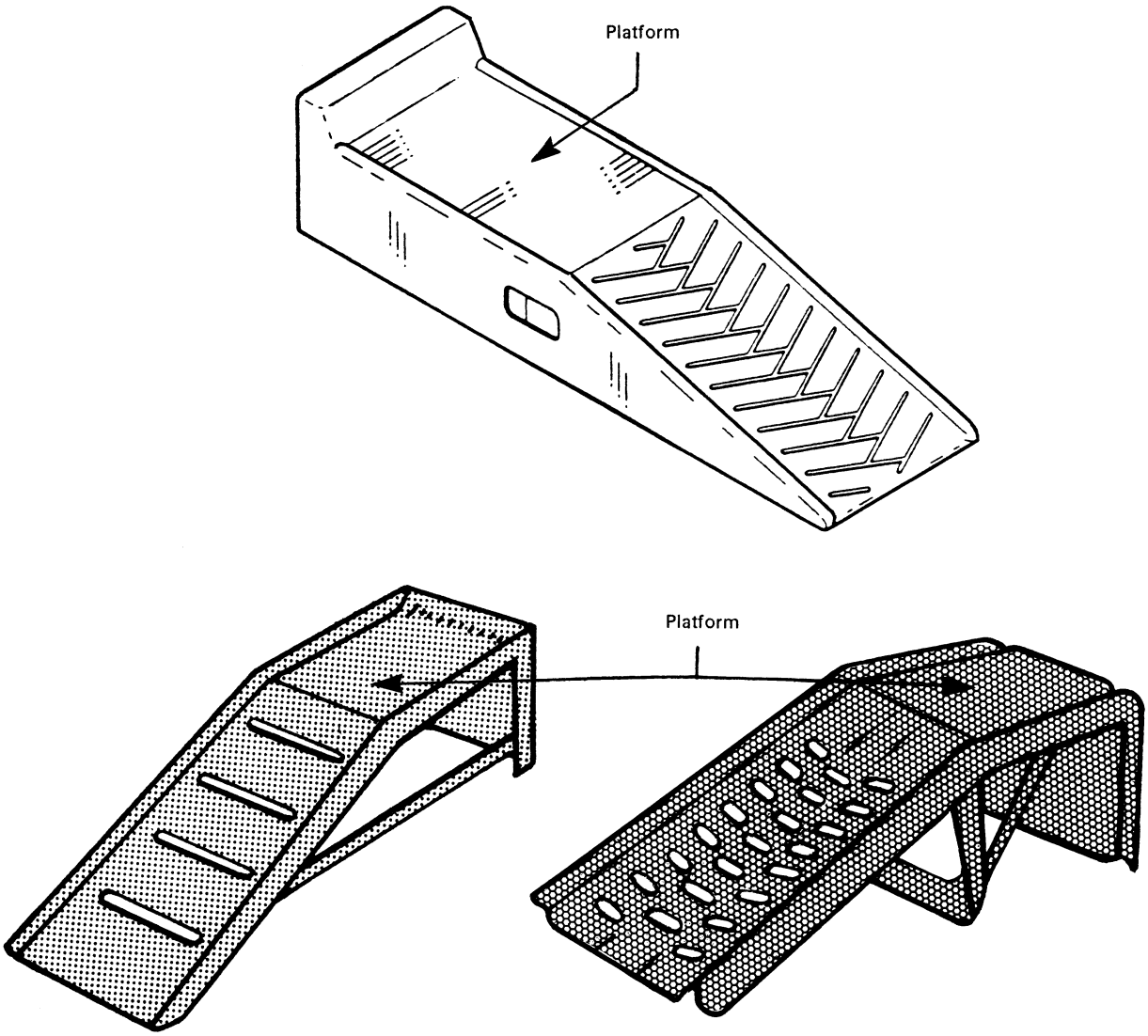


Fig. 13-2 Typical Test Area for Off-Center Load Test

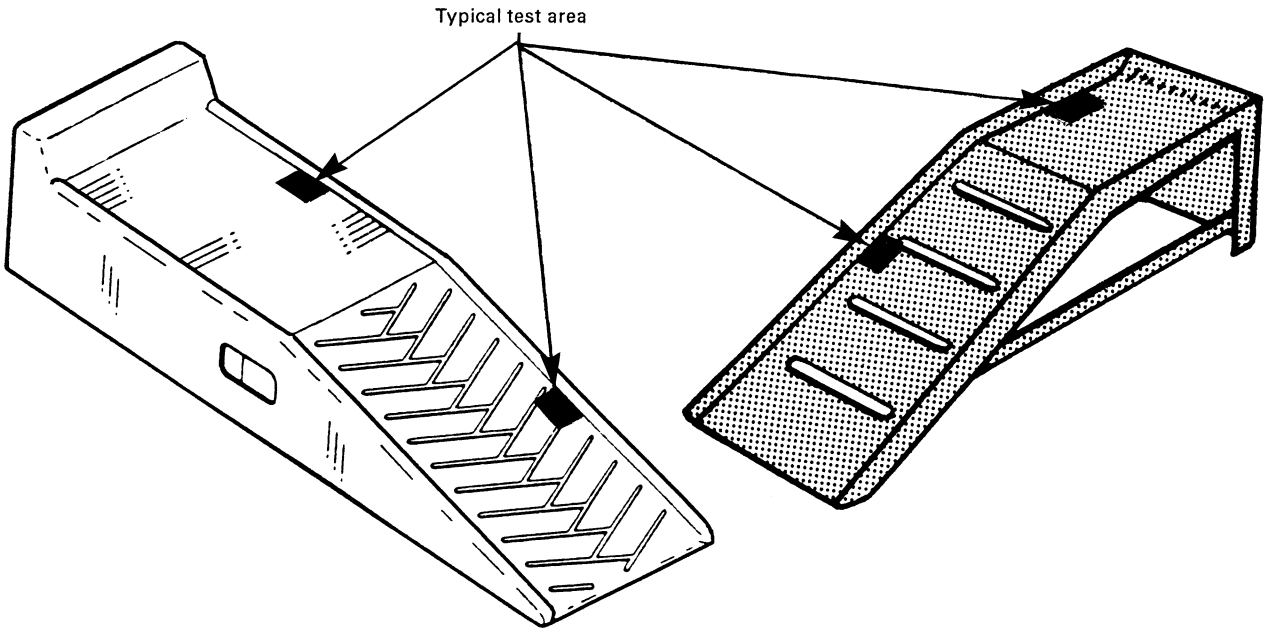
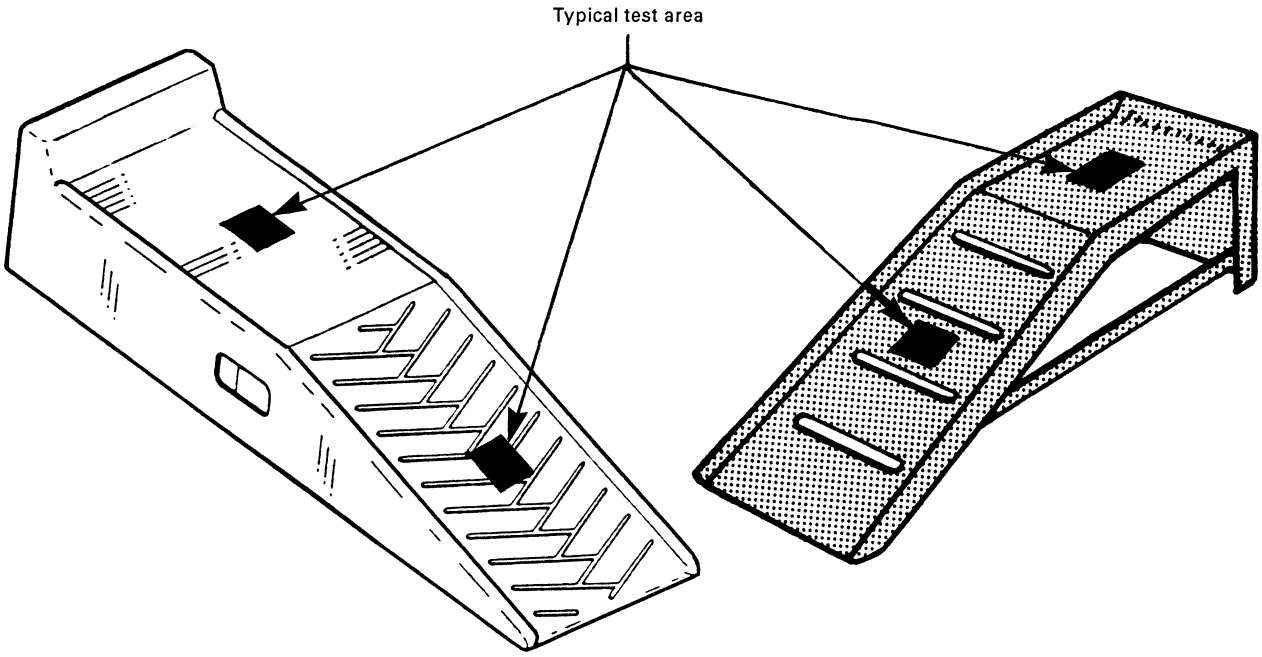


Fig. 13-3 Typical Test Area for Proof Load Test



the top of the ramps, apply brakes only to prevent overtravel.

(h) Place the vehicle in neutral. Release brakes; vehicle should not move. Set emergency brake. Place vehicle in park (or in reverse gear for manual transmission). Chock wheels on the ground.

(i) Be sure that both tires are properly positioned on the ramp's support platform. Using caution in positioning your body clear of danger, shake vehicle sideways and endways to be sure that vehicle and ramps are stable. Check that ramps have not become damaged or bent during loading.

(j) Supplier may provide information to assist the user in the selection of appropriately rated ramps for different gross vehicle weights.

(k) If assembly is required, follow the assembly instructions provided.

(l) No alterations shall be made to this product.

13-4 DESIGN QUALIFICATION TESTING

13-4.1 Proof Tests

For each design or design change that may affect the ramp's ability to meet this Part, sample ramps built to design specifications shall be proof tested. To conform with this Part, the ramps shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected. A nominally 4.0 in. (102 mm) long by 6.0 in. (152 mm) wide platen shall be used in conjunction with the following tests.

NOTE: Material may be added to the platen to simulate a tire surface and prevent slippage of the platen.

13-4.1.1 Off-Center Load Test. A horizontally constrained vertical load equal to rated capacity shall be applied using the platen, first to the outside edge of the platform (one at a time) and second to the outside edges of the inclined portion of the ramp (one at a time), as shown in Fig. 13-2, for a period of 10 min with the base resting on a hard level surface.

13-4.1.2 Proof Load Test. A horizontally constrained vertical load of 200% of rated capacity shall be applied for at least 10 min at the midpoint of the ramp incline using the platen. The load shall then be applied for at least 10 min to the portion of the platform designed to receive the tire footprint. See Fig. 13-3. (09)

Part 14
High-Reach Supplementary Stands

14-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

14-1.1 Scope

This Part applies to self-contained high-reach supplementary stands designed to help prevent the tipping/rocking of a vehicle while the vehicle is engaged on an automotive lift. This Part does not apply to devices classified as vehicle support stands (see Part 4) or devices classified as auxiliary stands (see Part 12).

14-1.2 Classification

High-reach supplementary stands with an adjustable column is the classification for which this Part applies, excluding products with a convex base configuration (e.g., auxiliary stands).

14-1.3 Illustration

Figure 14-1 shows typical high-reach supplementary stands and their components that are covered by this Standard and is not intended to be all-inclusive.

14-1.4 Definitions

base: that portion of the stand that rests on the ground and holds the adjustable column.

column: that portion of the stand that can be extended or retracted to vary the overall height.

freestanding: when initially positioned vertically, without a load, able to stand in an upright position without the application of external forces.

high-reach supplementary stands: self-contained devices to be used to add to the stability of a vehicle on an automotive lift by helping to prevent the tipping/rocking of the vehicle upon which work is being performed, but not to be used to support vehicles.

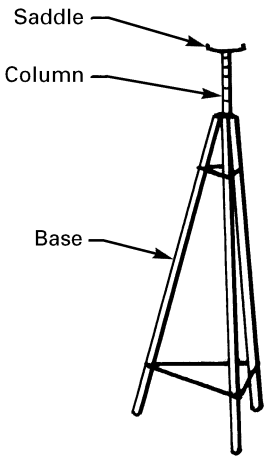
locking device: the mechanism used to hold the column in the selected height position.

14-2 DESIGN

14-2.1 Base

The base may be of any configuration that provides the equivalent of three or more points of contact with the ground. A circular, triangular, or polygonal base shape (in plan view) is considered equivalent to the above. The upper portion of the base shall be designed to house and guide the column.

Fig. 14-1 Typical High-Reach Supplementary Stands



14-2.2 Column

A means shall be provided to prevent the inadvertent separation of the column from the base. In the fully retracted position, the lower end of the column shall not extend below the plane made where the base contacts the ground.

14-2.3 Locking Device

The locking device shall prevent adjustment of the column height after the load has been applied. If the column is supported by means of a locking pin, the pin must be secured to the stand to prevent its loss.

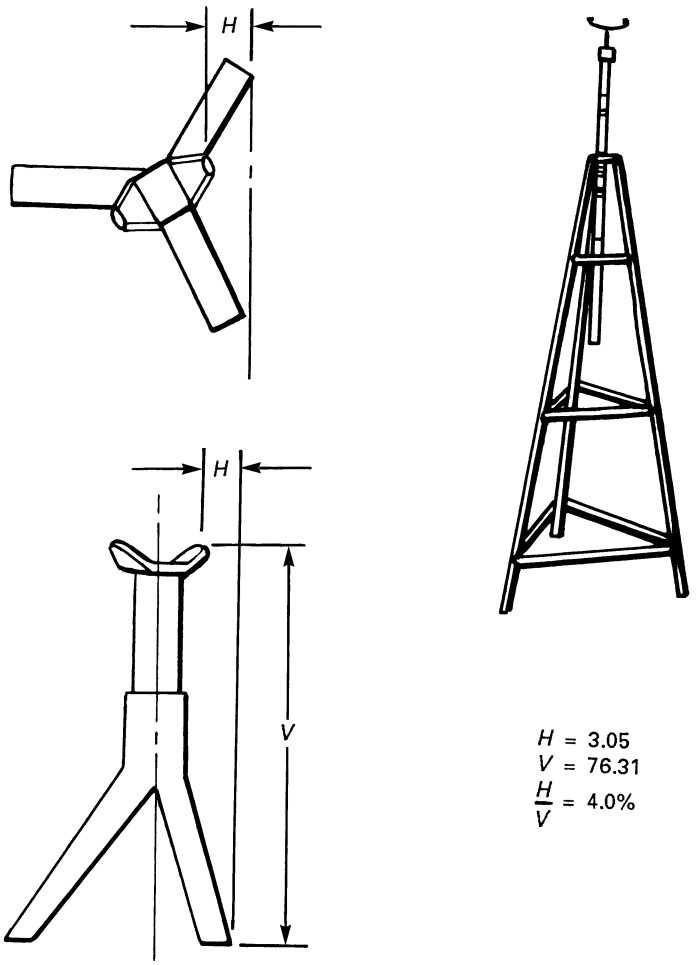
14-2.4 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require positive action by the operator for release to prevent accidental lowering.

14-2.5 Saddle

The saddle configuration shall be such as to aid in the proper centering, positioning, and stabilization of the load.

Fig. 14-2 Stability



14-2.6 Stability

The stands shall be designed so that the minimum horizontal distance from the projected edge of the saddle to the nearest edge of the base shall be at least 4% of the maximum extended vertical height. See Fig. 14-2, in which the horizontal dimension is shown as *H* and the vertical height as *V*.

(09) **14-2.7 Proof Load**

All high-reach supplemental stands shall be capable of performing the proof load test of para. 14-4.1.1 with a load of 200% of rated capacity.

(09) 14-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 14-3.1 and 14-3.2.

14-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Do not use the stand to support a vehicle.

(e) Center load on saddle.

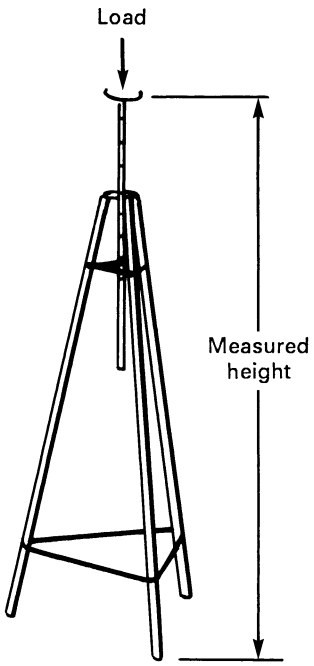
(f) Use stands in pairs to stabilize the vehicle before starting repairs.

(g) Failure to heed these markings may result in personal injury and/or property damage.

14-3.2 Safety Messages

Additional safety messages include the following: NO ALTERATIONS SHALL BE MADE TO THIS PRODUCT.

Fig. 14-3 Proof Load Test



14-4 DESIGN QUALIFICATION TESTING

14-4.1 Proof Tests

For each design or design change that may affect the stand's ability to meet this Standard, sample stands built to design specifications shall be proof tested. To conform with this Standard, the stands shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

14-4.1.1 Proof Load Test. A static vertical load of 200% of rated capacity shall be applied centrally to the saddle, with the column in both the fully extended and the fully retracted positions, with the base resting on a hard level surface. The load shall be applied as shown in Fig. 14-3 for at least 10 min. A permanent reduction in height, measured after the removal of the load, at the point of load contact shall not exceed 0.125 in. (3.18 mm). A preload of no more than 100% of rated capacity may be applied to establish initial overall height. (09)

Part 15
Forklift Jacks

15-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

15-1.1 Scope

This Part applies to hydraulic walking-beam-type jacks characterized by a lifting members that raises and lowers in a scissors action and is so arranged as to contact vehicles with low road clearance, on frame members for the purpose of raising the wheels of one end or one side of a vehicle free of the ground. Some jack designs may incorporate an auxiliary saddle not located on the lift member.

15-1.2 Classification

Hydraulic is the only classification for which this Part applies.

15-1.3 Illustration

Figure 15-1 shows typical forklift jacks covered by this Part and is not intended to be all-inclusive.

15-1.4 Definitions

base: the stationary portion of a jack to which lifting members are attached.

integrated lift point: notch or other means integrated into the lift member intended as a lift point.

jack, forklift: a self-contained device designed for lifting, but not sustaining, a partial vehicular load, consisting of a frame with wheels supporting a mechanism that actuates a pivoting lift arm equipped with a saddle that follows a path (arc) similar to that of the path (arc) of the vehicle being lifted.

primary saddle: saddle located on the lifting member.

secondary saddle: saddle not located on the lifting member.

15-2 DESIGN (09)

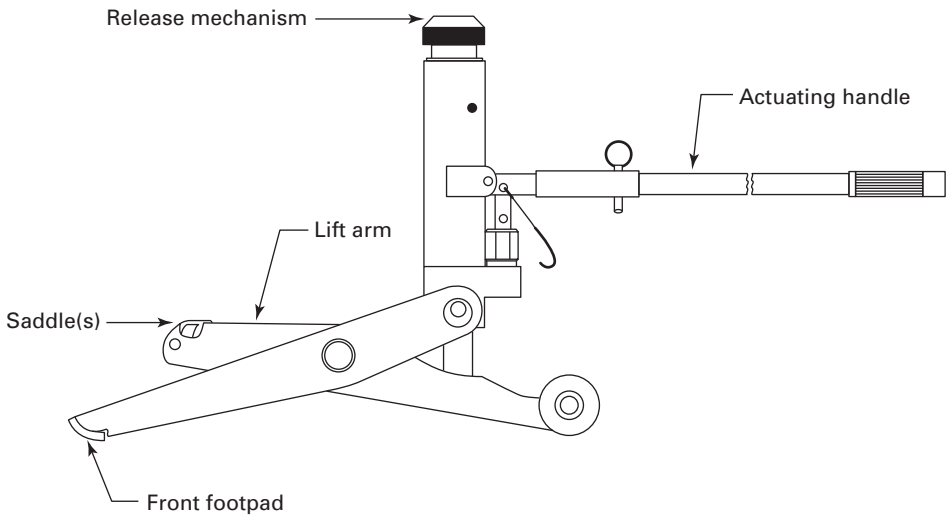
15-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator for release to prevent accidental lowering.

15-2.2 Travel Limit

Each jack shall be provided with a positive means to prevent the load from being raised or moved beyond the design limit of travel.

Fig. 15-1 Typical Forklift Jack



15-2.3 Proof Load

All forklift jacks shall be capable of performing the proof load test of para. 15-4.1.4 with a proof load of 150% of rated capacity.

15-2.4 Saddles

Primary saddles shall have raised protrusions, such as a tang, on the surface to act as a load restraint, and/or incorporate means intended to engage an edge on the load to be lifted. Auxiliary saddles may be separately rated, if so equipped.

15-3 SAFETY MARKINGS AND MESSAGES

Examples of safety markings and messages are specified in paras. 15-3.1 and 15-3.2.

15-3.1 Safety Markings

If so equipped, secondary saddles shall be separately identified. Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surfaces.

(d) Lifting device only. Immediately after lifting, support the vehicle with appropriate means.

(e) Position this jack perpendicular to the vehicle such that the load is balanced by the remaining two wheels in contact with surface.

(f) Failure to heed these markings may result in personal injury and/or property damage.

(09) 15-3.2 Safety Messages

Additional safety messages include the following:

(a) Ensure cylinder does not contact vehicle *during lifting*.

(b) Only attachments and/or adapters supplied by the manufacturer shall be used.

(c) Lift only on areas of the vehicle as specified by the vehicle manufacturer.

(d) No alterations shall be made to this product.

15-4 DESIGN QUALIFICATION TESTING

15-4.1 Proof Tests

Primary, integrated lift points and auxiliary saddles (if so equipped) shall be tested separately. For each design or design change that may affect the jack's ability to meet this Standard, sample jacks built to design specifications shall be proof tested. To conform with this Standard, the jacks shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

15-4.1.1 Load-Limiting Device Test. Jacks equipped with internal load-limiting devices shall be raised against a measured load until the load-limiting device is activated. The measured load shall be no less than 100% of rated capacity nor more than 125% of rated capacity.

15-4.1.2 Load-Sustaining Test. A load not less than the rated capacity shall be applied to the lifting member at approximately 100% of its lifting range. The load shall not lower more than 0.125 in. (3.18 mm) in the first minute, nor a total of 0.1875 in. (4.76 mm) in 10 min.

15-4.1.3 Release Test. A load not less than the jack's rated capacity shall be applied centrally to the saddle and the test performed at three points:

(a) lift arm horizontal[1]

(b) full extension

(c) a position measured midway between points (a) and (b).

NOTE: In normal use, a rate of descent greater than 1.0 in./sec (25.4 mm/s) is expected.

15-4.1.4 Proof Load Test. A proof load test as (09) defined in para. 15-2.3 shall be applied to the saddle. The load shall be lifted, sustained, and lowered throughout the range of travel. For purposes of this test, any internal load limiting device may be deactivated.

15-4.1.5 Off-Center Load Test. A vertical load equal (09) to the rated capacity shall be applied and sustained by means of a 1 in. (25.4 mm) wide rectangular block through the entire lifting range and maintained for 10 min. on each outermost edge at full extension prior to lowering.

15-5 ATTACHMENTS AND ADAPTERS

Only the attachments or adapters supplied by the manufacturer or supplier for this equipment shall be used.

[1] For jacks with arched or curved lifting arms, the measurement for determining when the lift arm is in the horizontal position shall be taken at the highest point of the lifting arm's arch.

Part 16
High-Reach Fixed Stands

16-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

16-1.1 Scope

This Part applies to self-contained high-reach fixed stands designed to support a vehicle after the vehicle has been raised by an automotive lift and the automotive lift has been removed. This Part does not apply to devices classified as vehicle support stands (see Part 4), devices classified as auxiliary stands (see Part 12), or devices classified as high-reach supplementary stands (see Part 14).

16-1.2 Classification

High-reach fixed stands with or without an adjustable column or columns is the classification for which this Part applies, excluding products with a convex base configuration (e.g., auxiliary stands) and products that are designed to be adjustable under load (e.g., high-reach supplementary stands).

16-1.3 Illustration

Figures 16-1 and 16-2 shows typical high-reach fixed stands and their components that are covered by this Standard and is not intended to be all-inclusive.

16-1.4 Definitions

base: that portion of the stand that rests on the ground and holds the adjustable column.

column: that portion of the stand that can be either fixed or extended/retracted to vary the overall height.

freestanding: when initially positioned vertically, without a load, able to stand in an upright position without the application of external forces.

high-reach fixed stands: self-contained devices to be used to support a vehicle after the vehicle has been raised by an automotive lift and the automotive lift has been removed.

locking device: the mechanism used to hold the column in the selected height position.

16-2 DESIGN

16-2.1 Base

The base may be of any configuration that provides the equivalent of three or more points of contact with the ground. A circular, triangular, or polygonal base shape (see Fig. 16-2) is considered equivalent to the above. The upper portion of the base shall be designed to house and guide the column.

16-2.2 Column

A means shall be provided to prevent the inadvertent separation of the column from the base. In the fully retracted position, the lower end of the column shall not extend below the plane made where the base contacts the ground. The column and the base juncture shall be configured to eliminate potential for a pinch point between the base and the column when fully retracted.

16-2.3 Locking Device

The locking device shall prevent adjustment of the column height after the load has been applied. If the column is supported by means of a locking pin, the pin must be secured to the stand to prevent its loss.

16-2.4 Wheels

If wheels are provided on the base to facilitate relocation of the stand, then the wheels shall not be subject to load when the stand is loaded.

16-2.5 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require positive action by the operator for release to prevent accidental lowering.

16-2.6 Saddle

The saddle configuration shall be such as to aid in the proper centering, positioning, and stabilization of the load.

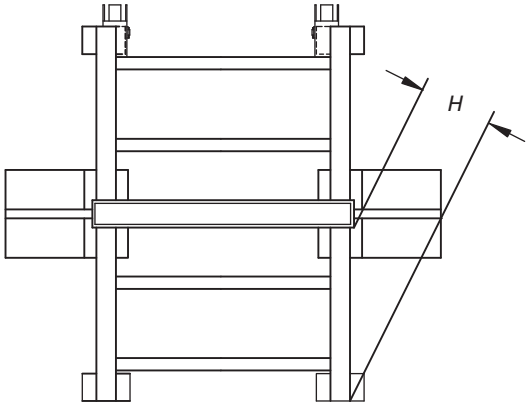
16-2.7 Stability

The stands shall be designed so that the minimum horizontal distance from the projected edge of the saddle to the nearest edge of the base shall be at least 8% of the maximum extended vertical height when the column is moved by hand to remove all slack in the direction of the vertical measurement. See Fig. 16-2, in which the horizontal dimension is shown as H and the vertical height is shown as V.

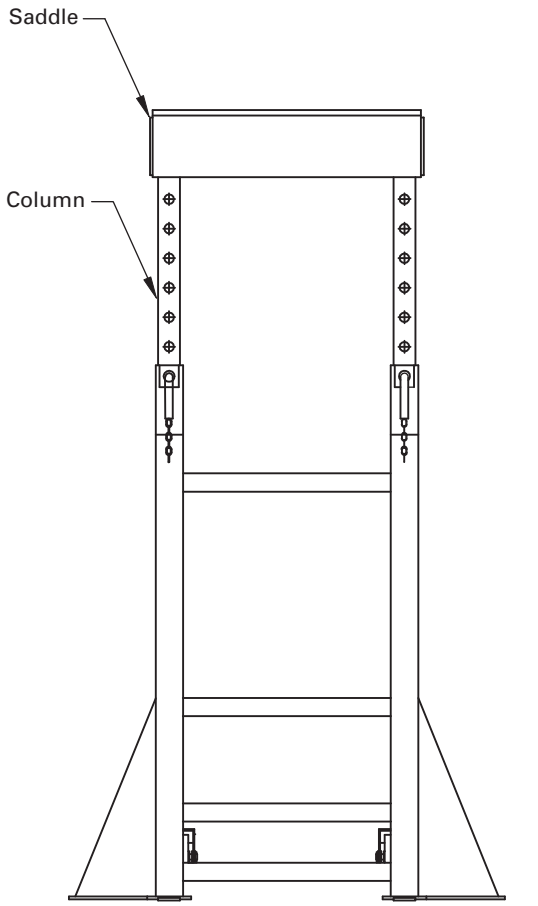
16-2.8 Proof Load (09)

All high-reach fixed stands shall be capable of performing the proof load test of para. 16-4.1.2 with a load of 200% of rated capacity.

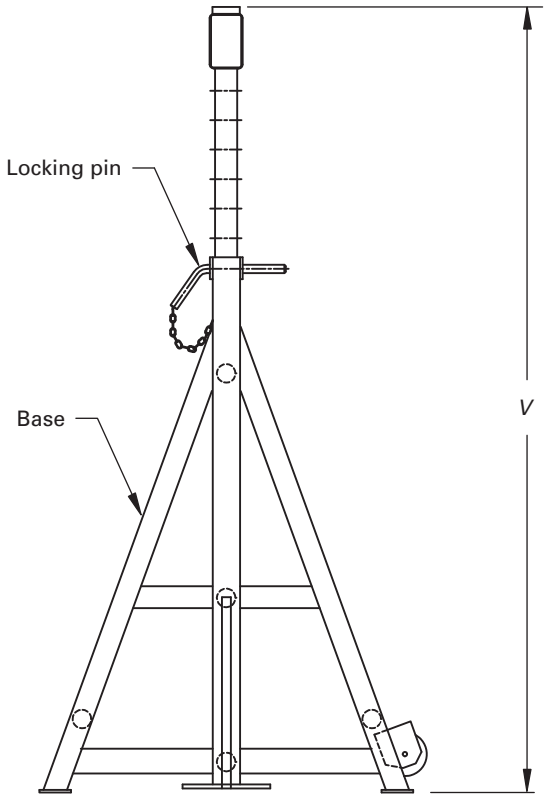
Fig. 16-1 Typical High-Reach Fixed Stand Saw Horse Type



Top View

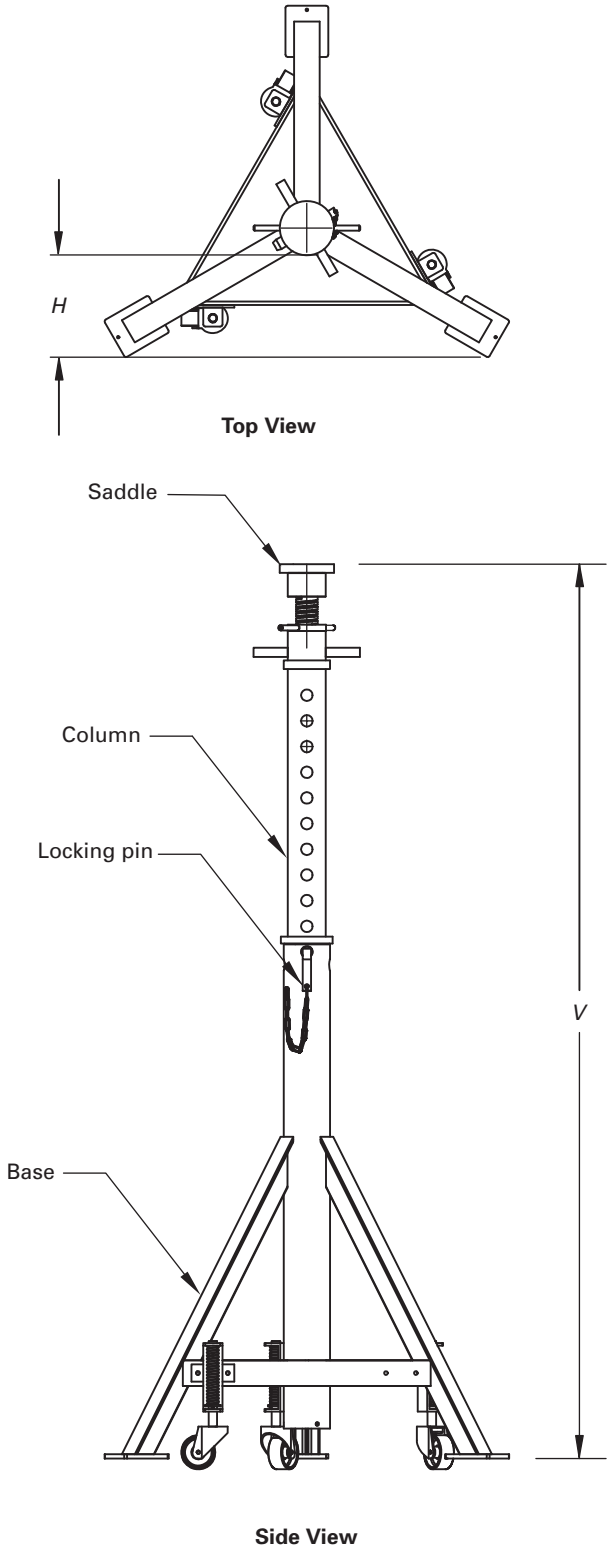


Side View



End View

Fig. 16-2 Typical High-Reach Fixed Stand Tripod Type



16-3 SAFETY MARKINGS AND MESSAGES

Examples of required safety markings and messages are specified in paras. 16-3.1 and 16-3.2. They need not be verbatim but shall convey the following.

16-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard level surface.

(d) Locate saddle at vehicle manufacturer designated support points.

(e) Center load on saddle.

(f) Use a minimum of four stands to support and stabilize a vehicle, and a minimum of two additional stands for each additional axle assembly, before starting repairs.

(g) Do not apply horizontal forces or large torque loads to the vehicle while supported by stands.

(h) Do not start engine while supported on stands.

(i) Ensure stands are stable and vehicle is balanced before lowering onto stands.

(j) Carefully lower vehicle onto all stands simultaneously.

(k) Failure to heed these markings may result in personal injury and/or property damage.

16-3.2 Safety Messages

Additional safety messages include the following:

(a) Only attachments, restraints or adapters supplied by the manufacturer shall be used.

(b) No alterations shall be made to this product.

16-4 DESIGN QUALIFICATION TESTING

16-4.1 Proof Tests

For each design or design change that may affect the stand's ability to meet this Standard, sample stands built to design specifications shall be proof tested. To conform with this Standard, the stands shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

16-4.1.1 Off-Center Load Test. A horizontally unconstrained vertical load equal to rated capacity shall be applied, with the column in the fully extended position and fully retracted position for at least 10 min on the lug or edge of the saddle as shown in Fig. 16-3. The saddle's ability to retain the load shall not be adversely affected by this test. A permanent reduction in height,

Fig. 16-3 Application of Load for Off-Center Load Test

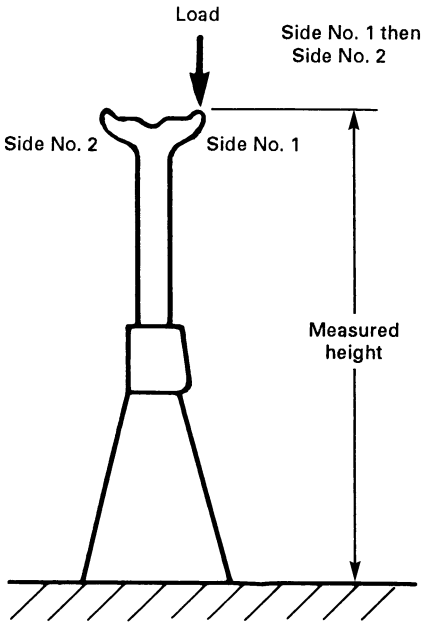
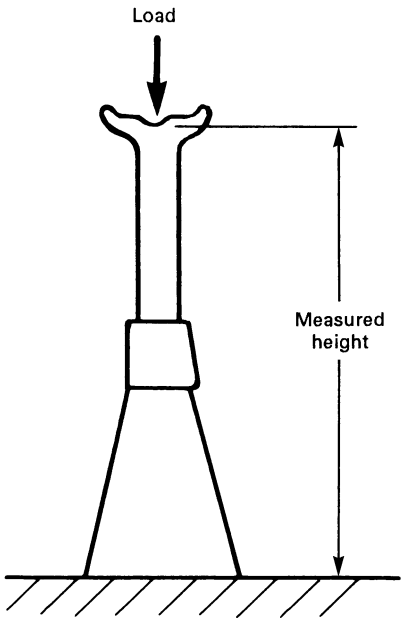


Fig. 16-4 Application of Load for Centered Load Test



measured after the removal of the load, at the point of load contact as shown in Fig. 16-3 shall not exceed 0.125 in. (3.18 mm). The test shall be repeated on all lugs and edges. A preload of not more than 100% of rated capacity may be applied to establish initial overall height.

(09) **16-4.1.2 Proof Load Test.** A static vertical load of 200% of rated capacity shall be applied centrally to the saddle, with the column in both the fully extended and the fully retracted positions, with the base resting on a hard level surface. The load shall be applied as shown in Fig. 16-4 for at least 10 min. A permanent reduction in height, measured after the removal of the load, at the point of load contact shall not exceed 0.125 in. (3.18 mm). A preload of not more than 100% of rated capacity may be applied to establish initial overall height.

Part 17
Vehicle Transport Lifts

17-1 SCOPE, CLASSIFICATION, AND ILLUSTRATIONS

17-1.1 Scope

This Part applies to vehicle transport lifts that are used for lifting, transporting, servicing, and storing of automotive vehicles. It includes only those lifts that raise the automotive vehicle clear off the floor. It does not include those devices which are designed to lift one end or side of a vehicle, nor does it include stationary automotive lifts or automotive lifts that become stationary when loaded.

17-1.2 Classification

Hydraulic, pneumatic, and mechanical are the classifications for which this Part applies. When a combination of these force transmitting means is used, each system shall be tested to conform with this Part.

(09) **17-1.3 Illustration**

Figure 17-1 shows typical vehicle transport lifts covered by this Part and is not intended to be all-inclusive.

17-1.4 Definitions

lift, hydraulic: a movable device that utilizes a hydraulic pump as the force transmitting means to raise and lower an automotive vehicle.

lift, mechanical: a movable device that utilizes mechanical lifting means, such as cables, gears, screws, chains or the like as the force transmitting means to raise and lower an automotive vehicle.

lift platform: the portion of the lift that contacts the automotive vehicle, including any bracket(s), or adapter(s), provided.

lift, pneumatic: a movable device that utilizes compressed air as the force transmitting means to raise and lower an automotive vehicle.

lifting member: that portion of the lift that activates the lift platform.

load restraint: a device supplied by the manufacturer to restrain the load on the lift pad assembly.

mechanical load holding means: mechanical means of securing the lift platform in a raised position.

vehicle transport lift: a lift that is equipped with wheels, rollers, or slides, which render it capable of being moved while the load is in the raised position.

17-2 DESIGN (09)

17-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The release system shall require intentional positive action by the operator to prevent accidental lowering.

17-2.2 Lift Platform

A load restraint means shall be provided. The lift platform shall be designed to minimize slipping or sliding of the load along the platform's horizontal surface. The lift platform shall be designed in such a manner as to be capable of sustaining a proof load placed across its intended load contact member(s).

17-2.3 Mechanical Load Holding Means

The lift shall be provided with a self-acting mechanical means of preventing inadvertent lowering of the load in the event of failure of the force transmitting means. Such means shall prevent inadvertent lowering of more than 3 in. after raising to any position at or above the lowest designated storage position. Such means shall automatically reset upon full descent.

17-2.4 Travel Limit

Each lift shall be provided with a positive means to prevent the load from being raised or lowered beyond the design limit of travel.

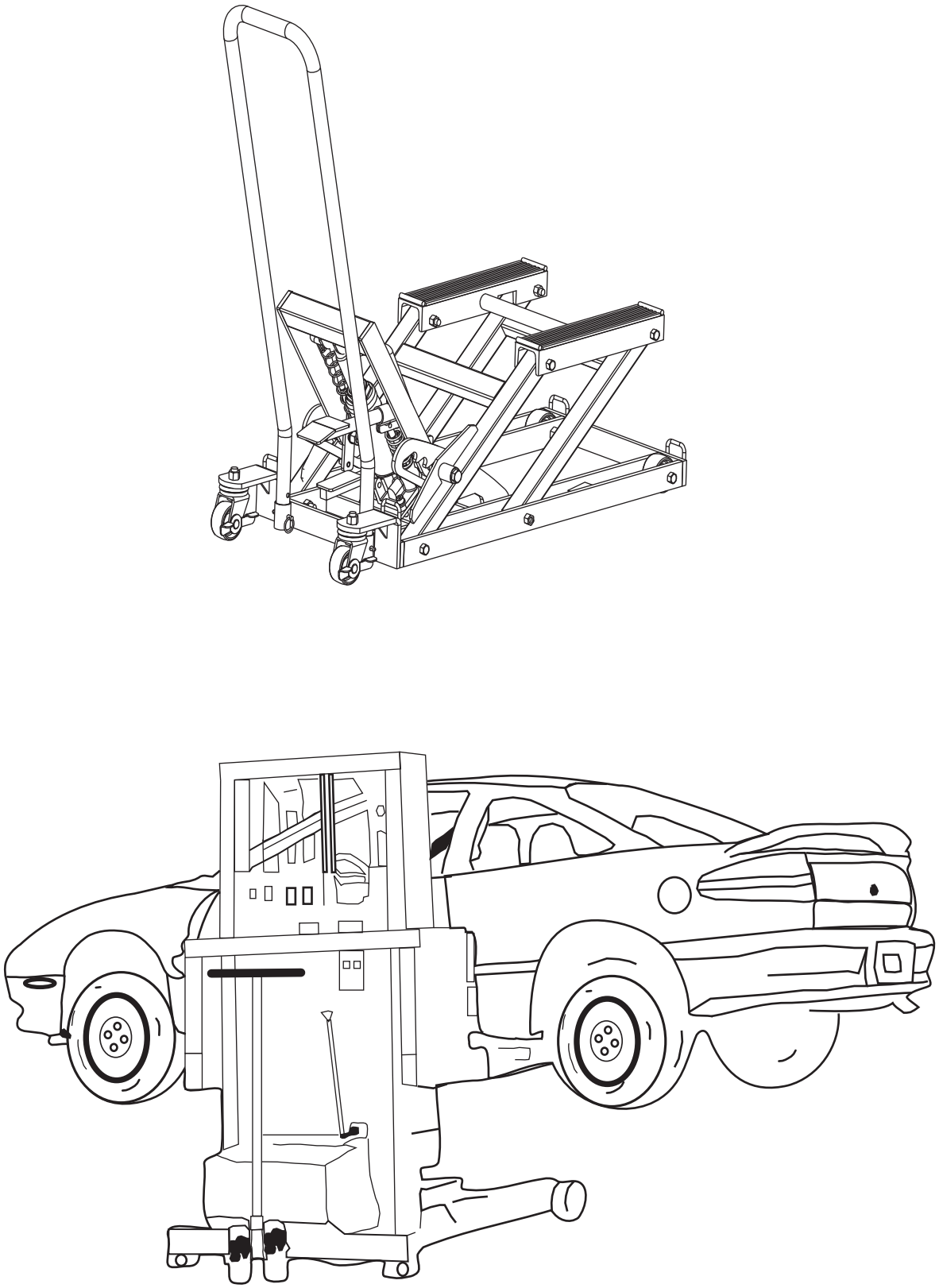
17-2.5 Proof Load

All vehicle transport lifts shall be capable of performing the proof load test of para. 17-4.1.3 with a proof load of 200% of rated capacity.

17-2.6 Adapters, Restraints

All adapters and restraints manufactured specifically for a lift shall be capable of performing their intended function with that lift. All adapters and restraints shall

Fig. 17-1 Typical Vehicle Transport Lifts



be capable of supporting a proof load of 150% of the load they are designed to support.

17-3 SAFETY MARKINGS AND MESSAGES

Examples of required safety markings and messages are specified in paras. 17-3.1 and 17-3.2.

17-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Use only on hard, level surfaces.

(d) Center load on lift platform.

(e) Lift only those areas of the automotive vehicle specified by its manufacturer.

(f) Immediately after lifting load, ensure lift mechanical load holding means is engaged.

(g) Before moving, lower the load to the lowest possible point.

(h) Secure load with appropriate restraint device.

(i) Failure to heed these markings may result in personal injury and/or property damage.

17-3.2 Safety Messages

Additional safety messages include the following:

(a) Use of this product is limited to lifting, lowering, transporting, and storing in the lowered position, loads consisting of a single motor vehicle whose lift points are compatible with the lift platform. Incompatibility is evident when the loaded vehicle wobbles, appears unstable, and/or does not securely engage the lift platform.

(b) Restraining an incompatible load will not make the load secure and may cause unexpected loss of load.

(c) Never work on, around or under a load that is not secured and stable.

(d) Keep operator's and bystander's head, hands and feet away from lift arms when raising and lowering.

(e) No alterations shall be made to this product.

(f) Only attachments, restraints, or adapters supplied by the manufacturer shall be used.

17-4 DESIGN QUALIFICATION TESTING

17-4.1 Proof Tests

For each design or design change that may affect the lift's ability to meet this Standard, sample lifts built to design specifications shall be proof tested. To conform with this Standard, the lift shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

17-4.1.1 Loaded Operational Test. A deadweight load equal to the rated capacity of the lift and configured such that the entire load is upon and above the lift platform shall be centrally located and restrained and the following operational tests shall be conducted. The mechanical load holding means may be deactivated to facilitate testing.

17-4.1.1.1 Release Mechanism Test. With the lift fully extended, the release mechanism shall be operated to control the initial rate of descent to no more than 1.0 in./sec (25.4 mm/s). With the release mechanism fully open, the average rate of descent shall not exceed 4 in./sec (100 mm/s).

17-4.1.1.2 Mobility Test. The lift, with the lift platform at the highest locked height, shall be moved by means of the handle provided, in any direction over a smooth, level floor surface. The lift, while loaded as above, shall be moved at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) across a 0.5 in. (12.7 mm) high, 15 deg slope rise in the floor, and a 0.5 in. (12.7 mm) drop to the floor, at an approach angle that will bring each caster or wheel individually into contact with the rise and drop. The lift shall traverse the rise and drop without loss of load or tipping over.

17-4.1.1.3 Stability Test. The lift, with the lift platform at the highest locked height, shall be moved by means of the handle provided, while loaded as above at 1.5 ft/sec (457 mm/s) to 2.0 ft/sec (610 mm/s) against a 2.0 in. (51 mm) high vertical rise 90 deg to the direction of movement at an approach angle that will bring two wheels or casters in simultaneous contact (or the lift base frame in contact) with the rise in the direction of greatest instability. The lift shall not lose the load or tip over.

17-4.1.1.4 Horizontal Force Test. With lift raised to its highest locked height, a force of 100 lbf (444 N) shall be applied centrally in the lateral and longitudinal direction both forward and rearward to the load for 10 sec. The lift shall not tip over. The lift wheels may be restrained for this test.

17-4.1.1.5 Load-Sustaining Test. With the lift platform at its maximum height, and the mechanical load holding means disengaged, the lift shall sustain the load and shall not lower more than 0.125 in. (3.18 mm) in the first minute nor a total of 0.1875 in. (4.76 mm) in 10 min.

17-4.1.1.6 Mechanical Load Holding Means Test. The lift platform shall be raised with the mechanical load holding means positioned to allow maximum disengaged distance from the nearest downward engagement. The release valve shall be fully opened to allow the maximum rate of descent of the lift. The lift shall be allowed to free-fall to the nearest engagement. The lift shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

17-4.1.2 Load-Limiting Device Test

(a) Hydraulic lifts with a single stage hydraulic cylinder equipped with internal load-limiting devices shall be pumped against a measured load with the lift platform within 1.0 in. (25.4 mm) above its low height until the load-limiting device is activated and the measured load shall be no less than rated capacity and no more than 125% of its rated capacity.

(b) Hydraulic lifts with multiple stage hydraulics equipped with internal load-limiting devices shall be pumped against a measured load with final stage extended 1.0 in. (25.4 mm) to 2.0 in. (51 mm) above its low height until the load-limiting device is activated and the measured load shall be no less than rated capacity and no more than 125% of its rated capacity.

17-4.1.3 Proof Load Test. A proof load, as defined in para. 17-2.5, shall be applied centrally across the lift platform. The load shall be lifted and lowered throughout the lifting range. For purposes of this test, any internal load-limiting device may be deactivated. **(09)**

Part 18
Attachments, Adapters, and Accessories

18-1 SCOPE, CLASSIFICATION, AND ILLUSTRATION

18-1.1 Scope

This Part applies to attachments, adapters, and accessories (including below-the-hook devices) that are intended to be used in conjunction with one or more of the PALDs described herein for the purpose of conformance of the PALD to the load to be lifted, manipulated or supported. This Part does not apply to those attachments, adapters or accessories described elsewhere in this Standard that are specific to host PALDs.

Representative devices covered by this Part include, but are not limited to: end lift attachments; transmission jack attachments, adapters, or accessories; shop crane attachments, adapters, or accessories: drum lift attachments, adapters or accessories; and load-positioning devices.

18-1.2 Classification

Attachments, adapters, and accessories with or without operating controls or adjustment capability are the classifications covered by this Part.

18-1.3 Definitions

accessory: a device that, when used with a PALD, provides an alternative or supplementary function for the PALD.

adapter: a device that, when connected to a load, facilitates lifting by a PALD.

attachment: a device that, when connected to a PALD, facilitates the intended purpose of the host PALD.

below-the-hook device: an accessory that is used to connect a load to shop crane.

18-2 DESIGN

18-2.1 Operating Controls

Operating controls shall be designed in such a manner that they are readily visible and accessible to the operator and so that the operator will not be subjected to pinch points, sharp edges, or snagging hazards. The operation of controls should be clear to the operator either by position, function, labeling, or combination thereof. The handle (if employed), or other operating device, shall be capable of being operated to the rated capacity of the attachment, adapter, or accessory without sustaining functional damage. To prevent accidental operation, the handle (if employed), or other operating device, shall require intentional positive action by the operator to move, or reposition the load.

18-2.2 Design Requirement

Attachments, adapters, or accessories shall not increase the rated capacity of the host PALD. The attachment, adapter, or accessory shall be capable of holding, moving, or repositioning its rated capacity throughout its range of travel. It is the responsibility of the manufacturer of the attachment, adapter, or accessory that the device does not compromise the design integrity of the host PALD. The manufacturer of the attachment, adapter, or accessory shall also designate the intended use by stating the applicable make and model of the host PALD.

18-2.3 Travel Limit

Each attachment, adapter, or accessory shall be provided with a positive means to prevent the load from being moved or repositioned beyond the design limit of travel in all possible directions.

18-2.4 Proof Load

Attachments, adapters, or accessories shall be capable of performing the proof load test of para. 18-4.1.3 with a proof load of 150% of rated capacity.

18-2.5 Stability

An attachments, adapters, or accessories shall not have loading positions that extend beyond the peripheral limits of the host device. The host PALD with the attachment, adapter, or accessory loaded to its rated capacity, shall meet the stability requirements of the host PALD.

18-2.6 Lubrication

If needed, the attachment, adapter, or accessory shall be lubricated by the manufacturer.

18-3 SAFETY MARKINGS AND MESSAGES

Examples of required safety markings and messages are specified in paras. 18-3.1 and 18-3.2.

18-3.1 Safety Markings

Safety markings shall conform to the ANSI Z535 series of standards.

(a) Study, understand, and follow all instructions before operating this device.

(b) Do not exceed rated capacity.

(c) Assure load is secured to the device.

(d) To be used only with the following PALD (list).

(e) Failure to heed these markings may result in personal injury and/or property damage.

18-3.2 Safety Messages

Additional safety messages include the following:

(a) Release load locking devices (if employed) slowly and carefully.

(b) No alterations shall be made to this product.

18-4 DESIGN QUALIFICATION TESTING

18-4.1 Proof Tests

For each design or design change that may affect the attachment's, adapter's, or accessory's ability to meet this Standard, sample attachments, adapters, or accessories built to design specifications shall be proof tested on the host PALD. To conform with this Standard, the attachment, adapter, or accessory shall perform to design specifications and no functional damage shall occur, nor shall operational characteristics be detrimentally affected.

18-4.1.1 Operating Test. The attachment, adapter, or accessory shall be operated in the most adverse positions, throughout the full range of travel with a connected load equal to the rated capacity.

18-4.1.2 Travel Limit Test. The attachment, adapter, or accessory shall be operated to the full extent of travel in all possible directions with a connected load equal to the rated capacity.

18-4.1.3 Proof Load Test. A proof load, as defined in para. 18-2.4, shall be connected to the attachment, adapter, or accessory. The attachment, adapter, or accessory shall be capable of holding, moving, and repositioning the load throughout the range of travel. Should the original operating handle (if supplied) not be capable of operating the attachment, adapter, or accessory, a substitute handle may be used for the performance of this test.

MANDATORY APPENDIX I
REFERENCES

The following are safety standards and codes (unless otherwise noted) referenced within this Standard. It is the intent of this Standard to refer to the standards and codes listed below in their latest editions when they are referenced within the Standard.

ANSI Z535.1-1991, Safety Color Code
ANSI Z535.2-1991, Environmental and Facility Safety Signs
ANSI Z535.3-1991, Criteria for Safety Symbols
ANSI Z535.4-1991, Product Safety Signs and Labels
ANSI Z535.5-1991, Accident Prevention Tags
Publisher: American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036 (www.ansi.org)

ASTM B 117-95, Standard Practice for Operating Salt Spray (Fog) Apparatus (not a safety standard)
Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

NONMANDATORY APPENDIX A
METRIC UNITS CONVERSIONS

1 in. = 25.4 mm
1 lbm = 0.45 kg
1 lbf = 4.448 N

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