LIFTING DEVICE

DEVICE NAME: VACUUM LIFTING FIXTURE

ENGINEERING NOTE NUMBER: 68

DRAWING NUMBER: E831-MC-241224

APPLICABLE STANDARD: ASME B30.20 - 1993

RATED LOAD: ~~[illegible]~~ 80#

TEST LOAD: 6 steel bricks @ ≈ 15 lbs. (80# + 90#) Dang

TEST LOAD PERCENT: 20% +

LAST LOAD TEST DATE: 1/9/95

COLOR: (aluminum)

STRESS CALCULATIONS:

Done by: DON GOLOSKIE / JOHN KRIDER

Date: 11/16/94

Reviewed by: [signature]

Date: 11/16/94

REMARKS:

IDENTIFICATION:

Engineering Note Number & Rated Load Must be Clearly Marked On a Conspicuous Surface.

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
			1

SUBJECT: Vacuum lifting fixture capacity

NAME: J. Krider

DATE: 10-10-94

REVISION DATE:

Rating per pad - 6" outside diameter, 5" effective diameter

Per ASME B30.20-1993, p 23 (Attached)

$$UPC = A(Hg/2)$$

UPC = Ultimate Pad Capacity
A = effective pad area $= \pi r^2 = \pi (2.5\,in)^2$
Hg = System vacuum $\approx$ 25 in Hg typically

$$UPC = \pi (2.5\,in)^2 (25\,in\,Hg/2) = 245\,lb$$

For horizontal surface lifts rated load $\leq 0.5\,UPC = 123\,lb$

For system of 4 pads the total rating is **492 lb**

the actual load will be $\approx 80\,lb$ or 16% of total rating

Tests before certification:

1. Vacuum should not decrease more than 10% in 4 minutes after compressed air supply is disconnected.
2. Load test at 125% of operating load = 1.25x80lb = 100lb

OK D.A. Jaburek 11/1/94

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
			3

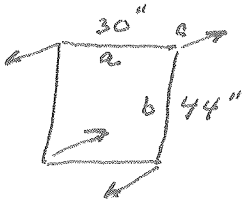
SUBJECT

Stress in Vacuum Lifting fixture

NAME D. Goloskie

DATE 11/16/94 | REVISION DATE

Assume worst case of two diagonal cups not holding



Total Load = 80 lb

At intersection of a & b (Points) the deflection of a = b

For cantilevered beam, fixed ends the deflection is $y = \frac{WL^3}{3EI}$

$$y_a = y_b \qquad \frac{W_a l_a^3}{3EI} = \frac{W_b l_b^3}{3EI}$$

$$W_a = W_b \frac{l_a^3}{l_b^3} = 3.15\, W_b$$

$$W_a + W_b = 40 \text{ lbs}$$

$$3.15 W_b + W_b = 40$$

$$W_b = 9.64 \text{ lb} \qquad W_a = 3.15 W_b = 30.37 \text{ lb}$$

$$\sigma_b = \frac{M_b c}{I} = \frac{9.64(44)}{0.3} = 1.414 \text{ psi}$$

$$\sigma_a = \frac{M_a c}{I} = \frac{30.37(30)}{0.3} = 3.037 \text{ psi}$$

$$I = \frac{bh^3}{12}$$

$$I = \frac{2 \cdot 2^3}{12} - \frac{1.875 \cdot 1.875^3}{12}$$

$$I = 1.33 - 1.03 = 0.3 \text{ in}^4$$

ANSI Standard design stress = 1/3 Yield.

from "Aluminum Standards & Data 1972-73" (95)

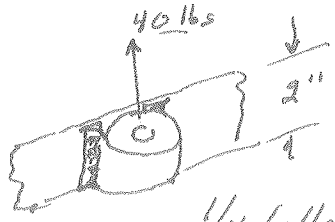
the minimum Yield for 6063-T5 or

6063-T52 is 16,000 psi

design stress = $\sigma_1 = \frac{16,000}{3} = 5,333$ psi

$\sigma_a = 3037 < 5,333$ OK.

Weld Calculation.



1/4 fillet weld both sides

From "Welding Kaiser Aluminum 1967" - Pg 6

the lowest strength filler Alloy, #1100 has a weld strength of 2000 lbs per inch for a 1/4 fillet

the bushing is supported by 4" of weld and can support a minimum of 8000 lbs

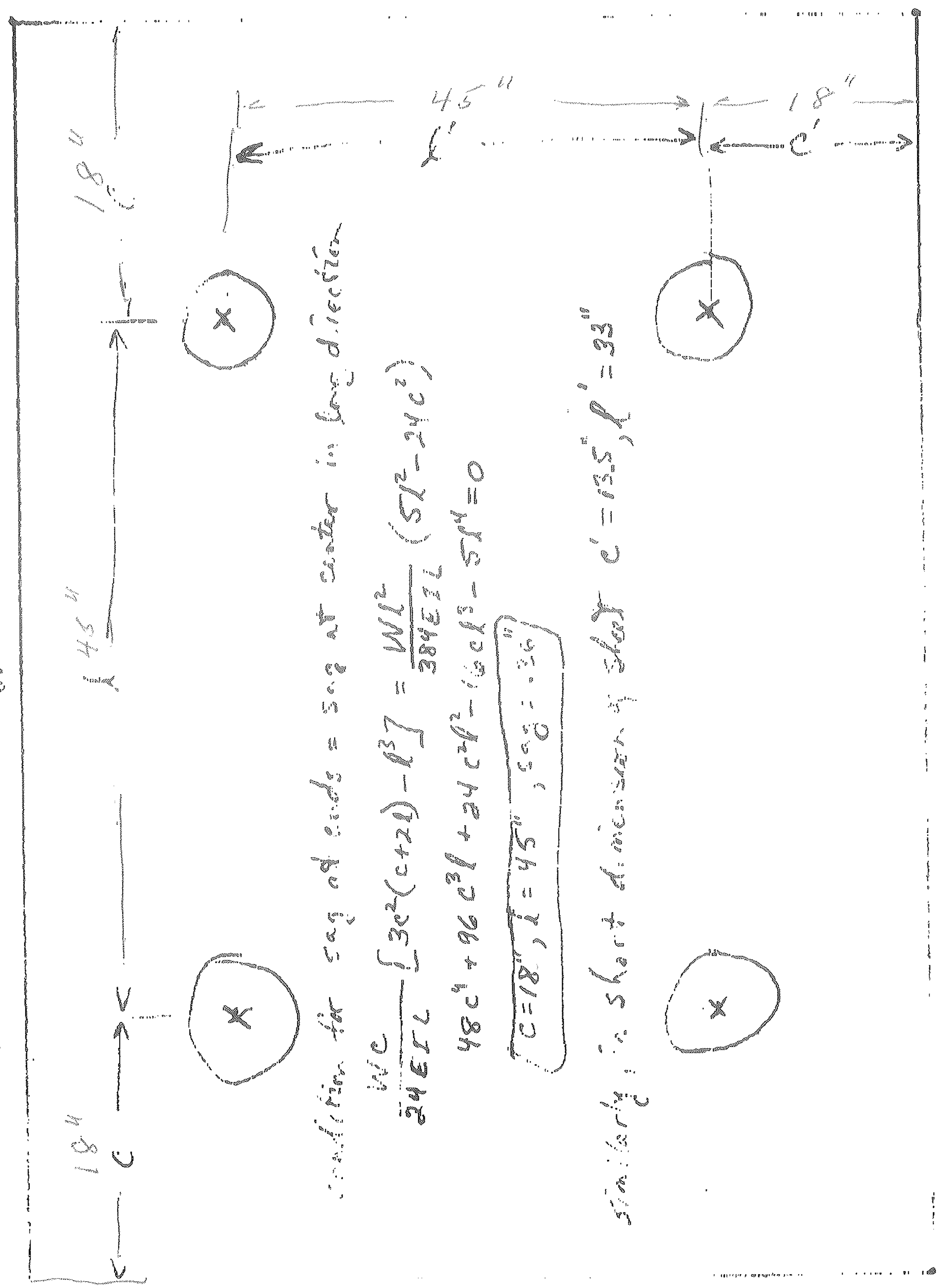
max Load on bushing is 40 lbs

Safety factor on weld = $\frac{8000}{40} = 200$

FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE 4
SUBJECT: Vacuum pad placement on steel sheet		NAME: J. Krider	DATE: 10-10-94	REVISION DATE

15"

Choose pad locations so edges of [illegible]



condition for sag at ends = sag at center in long direction

$$\frac{wc}{24EIL}\left[3c^2(c+2l)-l^3\right] = \frac{wl^2}{384EIL}(5l^2-24c^2)$$

$$48c^4+96c^3l+24c^2l^2-16cl^3-5l^4=0$$

$c=18"$, $l=45"$, $sag_c = .36"$

similarly, in short dimension of sheet $c' = 13.5"$, $l' = 33"$

Aluminum Standards & Data 1972-73 5

The Aluminum Association

TABLE 11.1 Mechanical Property Limits—Extruded Wire, Rod, Bar and Shapes (continued)

ALLOY AND TEMPER	DIAMETER OR THICKNESS① in.	AREA sq in.	TENSILE STRENGTH—ksi (MPa)				ELONGATION② percent min in 2 in. or 4D③
			ULTIMATE		YIELD		
			min	max	min	max	
2219							
2219-0	All	All	..	32.0 (221)	..	18.0 (124)	12
2219-T31, T3510⑤⑦ and T3511⑤⑦	Up thru 0.499 0.500-2.999	Up thru 25 Up thru 25	42.0 (290) 45.0 (310)	..	26.0 (179) 27.0 (186)	..	14 14
2219-T62④⑧	Up thru 0.999 1.000 and over	Up thru 25 Up thru 32	54.0 (372) 54.0 (372)	..	36.0 (248) 36.0 (248)	.. ..	6 6
2219-T81, T8510⑤ and T8511⑤	Up thru 2.999	Up thru 25	58.0 (400)	..	42.0 (290)	..	6
3003							
3003-0 3003-H112	All All	All All	14.0 (97) 14.0 (97)	19.0 (131) ..	5.0 (34)⑥ 5.0 (34)⑥	.. ..	25 ..
5083							
5083-0 5083-H111 5083-H112	Up thru 5.000 Up thru 5.000 Up thru 5.000	Up thru 32 Up thru 32 Up thru 32	39.0 (269) 40.0 (276) 39.0 (269)	51.0 (352)	16.0 (110) 24.0 (165) 16.0 (110)	.. .. ..	14 12 12
5086							
5086-0 5086-H111 5086-H112	Up thru 5.000 Up thru 5.000 Up thru 5.000	Up thru 32 Up thru 32 Up thru 32	35.0 (241) 36.0 (248) 35.0 (241)	46.0 (317)	14.0 (97) 21.0 (145) 14.0 (97)	.. .. ..	14 12 12
5154							
5154-0 5154-H112	All All	All All	30.0 (207) 30.0 (207)	41.0 (283) ..	11.0 (76) 11.0 (76)	.. ..	.. ..
5454							
5454-0 5454-H111 5454-H112	Up thru 5.000 Up thru 5.000 Up thru 5.000	Up thru 32 Up thru 32 Up thru 32	31.0 (214) 33.0 (228) 31.0 (214)	41.0 (283)	12.0 (83) 19.0 (131) 12.0 (83)	.. .. ..	14 12 12
5456							
5456-0 5456-H111 5456-H112	Up thru 5.000 Up thru 5.000 Up thru 5.000	Up thru 32 Up thru 32 Up thru 32	41.0 (283) 42.0 (290) 41.0 (283)	53.0 (365)	19.0 (131) 26.0 (179) 19.0 (131)	.. .. ..	14 12 12
6061							
6061-0	All	All	..	22.0 (152)	..	16.0 (110)	16
6061-T4, T4510⑤⑦ and T4511⑤⑦	All	All	26.0 (179)	..	16.0 (110)	..	16
6061-T42④⑧	All	All	26.0 (179)	..	12.0 (83)	..	16
6061-T6, T62④⑧, T6510⑤ and T6511⑤	Up thru 0.249 0.250 and over	All All	38.0 (262) 38.0 (262)	..	35.0 (241) 35.0 (241)	.. ..	8 10
6063							
6063-0	All	All	..	19.0 (131)	..	..	18
6063-T1	Up thru 0.500 0.501-1.000	All All	17.0 (117) 16.0 (110)	..	9.0 (62) 8.0 (55)	.. ..	12 12
6063-T4 and T42④⑧	Up thru 0.500 0.501-1.000	All All	19.0 (131) 18.0 (124)	..	10.0 (69) 9.0 (62)	.. ..	14 14
6063-T5	Up thru 0.500 0.501-1.000	All All	22.0 (152) 21.0 (145)	..	16.0 (110) 15.0 (103)	.. ..	8 8
6063-T52	Up thru 1.000	All	22.0 (152)	30.0 (207)	16.0 (110)	25.0 (172)	8
6063-T6 and T62④⑧	Up thru 0.124 0.125-1.000	All All	30.0 (207) 30.0 (207)	..	25.0 (172) 25.0 (172)	.. ..	8 10

For all numbered footnotes, see page 142.

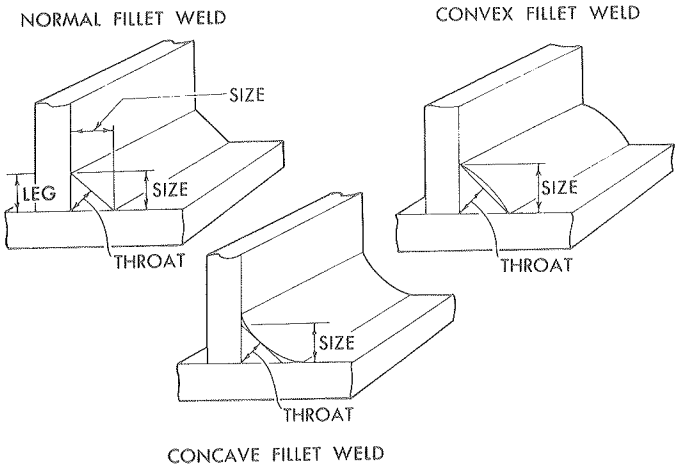


Fig. 62—Fillet weld size is specified as the minimum leg length, in inches, measured by the throat dimension which is in shear.

Size of Fillet Welds

Reference has been made to selecting proper *lengths* of fillet welds where several welds divide a load between them, page 3-17. The material that follows discusses some of the many other factors that affect the selection of proper fillet-weld size.

Fillet welds are considered to be triangular in cross section, the triangle being the largest right triangle which can be inscribed within the weld cross section, Fig. 62. For unequal-leg fillet welds, where an isosceles triangle could also be inscribed within the weld cross section, the size and throat dimensions for design purposes, are always based on the largest inscribed right triangle.

The size of a fillet weld is specified as the minimum leg length, in inches. A fillet weld is designed, however, upon the throat dimension which is in shear. No allowance is made for fusion beyond the theoretical root of the joint, as such fusion is a variable depending upon welding procedure.

Fillet Welds in Longitudinal Shear

Fillet welds can be loaded in longitudinal shear if the applied load is parallel to the axis of the weld. In fillet welds subjected to longitudinal shear, the shear plane having maximum stress logically appears to be through the minimum

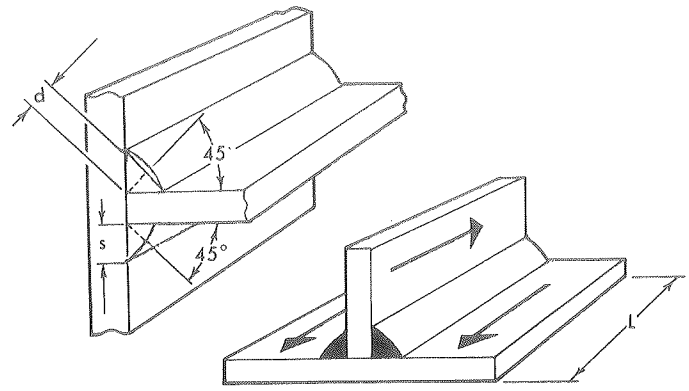
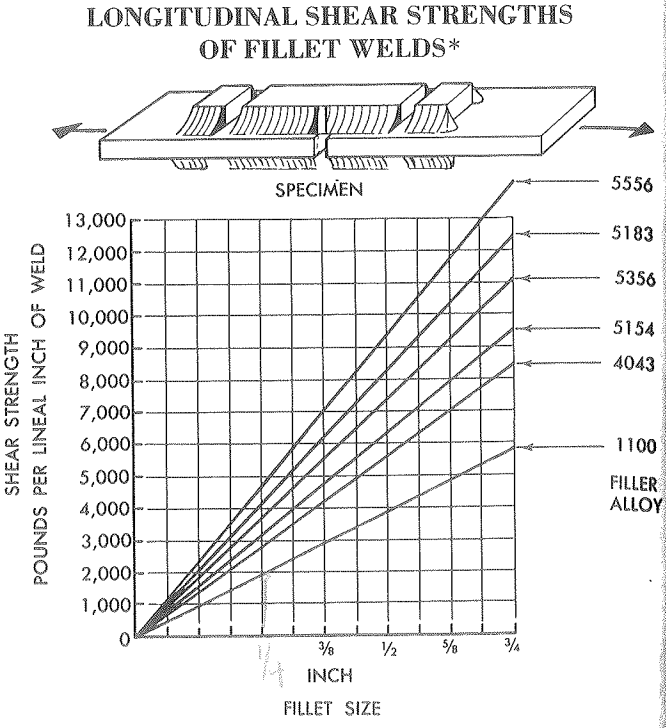


Fig. 63—Fillet welds can be loaded in longitudinal shear when the applied load is parallel to the axis of the weld.



*Plotted from typical values. Failure in fillet is assumed and is largely a function of filler metal alloy.

Fig. 64—Longitudinal shear strengths of fillet welds made with six different filler alloys.

throat depth, d, at a 45° angle to either leg of the fillet, as shown in Fig. 63. The *length* of the shear plane (the plane that is perpendicular to the axis of the weld) is $d = s \cos 45°$, where s is the fillet size or, the length of the fillet leg. The stress from the loading in Fig. 63 is:

$$f = \frac{P}{0.707\ s} \times \frac{1}{L} \times \frac{1}{2} = \frac{P}{1.414\ s\ L}$$

in which f = Longitudinal stress on shear plane, psi
P = Total longitudinal force acting on weld, lb.
s = Fillet size (length of fillet leg), in.
L = Length of weld, in.

Actual longitudinal shear strengths of fillet welds made with six different filler alloys are given in Fig. 64. Substantiating tests were conducted in accordance with AWS requirements.

Fillet Welds in Transverse Shear

Fillet welds are said to be loaded in transverse shear if the load is applied perpendicular to the axis of the weld, Fig. 65.

In transverse fillet loading, the plane of maximum strength is not at the minimum throat depth but theoretically is at an angle of 22½° with the fillet leg for the maximum shear stress and at an angle of 67½° for the maximum tensile stress.* It should be noted that the actual numerical values for these maximum shear and tensile stresses are equal. Therefore, fillet welds will always fail in shear since the shear stress can never equal the tensile stress. These theoretical planes are depicted in Fig. 66.

*See detailed note starting under Fig. 66, opposite page.

Chapter 20-2
Group II — Vacuum Lifting Devices

Section 20-2.1 — Scope

(93) The provisions of Group II shall apply to the marking, construction, installation, inspection, testing, maintenance, and operation of vacuum below-the-hook lifting devices. The provisions apply to all power operated and mechanically operated vacuum lifting and manipulating devices, except those vacuum lifting devices handling porous materials that require special design construction.

Section 20-2.2 — Marking, Construction, and Installation

20-2.2.1 Marking

(a) Rated Load. The rated load, maximum width, maximum length, and minimum thickness of the load shall be legibly marked on the main structure. If the vacuum lifting device has shutoff valves on individual pads or groups of pads, the rated load of each pad shall also be marked.

(b) Identification. The vacuum lifting device shall be marked with identification information as follows:

(1) manufacturer's name
(2) model number
(3) serial number
(4) lifter weight
(5) electrical power (when applicable)
(6) pressure and volume of compressed air (when applicable)
(7) rated load

(c) Warnings

(1) All vacuum lifting devices shall have affixed to them in a readable position a label or labels displaying the following information concerning operating procedures as follows:

(a) The word "WARNING" or other legend designed to bring the label to the attention of the operator;

(b) cautionary language against:

(1) exceeding the rated load, or lifting loads not specified in the instruction manual;

(2) operating a damaged or malfunctioning unit, or a unit with missing parts;

(3) operating when the vacuum indicator or indicators show inadequate vacuum;

(4) operating when the vacuum pads are not spaced for equal loading;

(5) incorrect positioning of lifter on load;

(6) lifting people;

(7) lifting loads over people;

(8) removing or obscuring warning labels;

(9) operating without having read and understood the operating manual;

(10) operating lifter when rated load lifter weight or safety markings are missing;

(11) lifting loads higher than necessary and leaving suspended loads unattended;

(12) making alterations or modifications to lifter.

(c) Where size or shape of unit prohibits the inclusion of all or any such markings, a label shall be affixed referring user to consult manufacturer's instruction manual.

(d) If the vacuum lifting device has manual shutoff valves on individual pads or groups of pads, the valves shall be marked to show operating position. Should this marking be some type of coding, then a label or tag shall be attached at or near the valve which explains such markings.

20-2.2.2 Construction

(a) Vacuum Pad Rating. The ultimate pad capacity (UPC) shall be determined by the following formula:

(1) Inch-Pound Method

$$UPC = A(Hg/2)$$

where

A = effective area of the vacuum pad expressed in square inches enclosed between the pad and the material when the pad is fully compressed against the material surface to be lifted

Hg = system vacuum expressed in inches of mercury. Reductions for altitude, efficiency, consistency, and wear of vacuum source shall be considered.

2 = division constant for inch-pound method

EXAMPLE:
Effective pad area = 100 sq in.
System vacuum = 24 in. *Hg*
UPC = 100 sq in. (24/2)
UPC = 1200 lb

(2) Metric Method.

$$UPC = (A \times Hg)/73.6)$$

where

A = effective area of the vacuum pad expressed in square centimeters between the pad and the material when the pad is fully compressed against the material surface to be lifted

Hg = system vacuum expressed in centimeters of mercury. Reductions for altitude, efficiency, consistency, and wear of vacuum source shall be considered.

73.6 = division constant for metric method

EXAMPLE:
Effective pad area = 100 sq cm
System vacuum = 10 cm *Hg*
UPC = 100 sq cm (10/73.6)
UPC = 13.6 kg

(93) *(b) Horizontal Surface Lifts.* The rated load shall not be greater than 50% of the UPC for horizontal surface lifts.

(93) *(c) Vertical Surface Lifts.* The rated load shall not be greater than 25% of the UPC for vertical surface lifts.

(d) Load Type. These factors are for clean, flat, dry, nonporous loads, and shall be increased as required by the surface conditions of materials to be lifted.

(e) Vacuum Reserve System. The vacuum lifting device shall incorporate a vacuum reservoir of sufficient size to prevent the vacuum level under the pads from decreasing more than 10% in 4 min with power off on a clean, dry, and nonporous load. The vacuum lifting device shall be designed so that when in operation, all available vacuum reservoirs of the machine shall be channeled to the vacuum pads in use during a "vacuum power-off" condition.

(f) Vacuum Lifter Structural Design. Vacuum lifter load-bearing structural components shall be designed to withstand the forces imposed by their rated load with a minimum design factor of 3 based on the yield strength of the material.

(93) *(g)* All welded construction shall be in accordance with ANSI/AWS D1.1.

20-2.2.3 Installation

(a) The vacuum lifting device shall be assembled and installed in accordance with the manufacturer's instructions.

(b) The user shall ensure that the power supply is the same as that shown on the nameplate.

(c) The electrical power supply to the vacuum lifter shall be connected to the line side of the crane disconnect or to an independent circuit.

(d) The user shall check for correct rotation of all pumps.

(e) Prior to initial use, the operational and rated load test shall be performed by a qualified person to ensure compliance with para. 20-2.3.4.

(f) Operating instructions, maintenance, and parts information shall be furnished by the manufacturer.

Section 20-2.3 — Inspection, Testing, and Maintenance

20-2.3.1 Inspection Classification (93)

(a) Initial Inspection. Prior to initial use, all new, reinstalled, altered, modified, or repaired vacuum lifting devices shall be inspected by or under the direction of a qualified person to verify compliance with provisions of this volume.

(b) Inspection Intervals. Inspection procedure for vacuum lifting devices in regular service is divided into three general classifications based upon the intervals at which inspection should be performed. The intervals in turn are dependent upon the nature of the critical components of the vacuum lifting device and the degree of their exposure to wear, deterioration, or malfunction. The three general classifications are designated as every lift, frequent and periodic, with respective intervals between inspections as defined below:

(1) Every Lift Inspection. The following items are to be inspected by the operator before and/or during every lift with records not required.

(a) surface of the load for debris

(b) seal of the vacuum pad for debris

(c) condition and operation of the controls

(d) condition and operation of the indicators, meters, and pumps where applicable

(2) Frequent Inspection. Visual examinations by the operator or other designated persons with records not required.

(a) normal service — monthly

(b) heavy service — weekly to monthly

(c) severe service — daily to weekly

(d) special or infrequent service — as recommended by a qualified person before and after each occurrence

(3) Periodic Inspection. Visual inspection by a qualified person who makes records of apparent external conditions to provide the basis for a continuing evaluation. An external coded mark on the vacuum lifting device is an acceptable identification in lieu of records.

(a) normal service — equipment in place — yearly

(b) heavy service — as in (a) above, unless external conditions indicate that disassembly should be done to permit detailed inspection — semiannually

(c) severe service — as in (b) above — quarterly

(d) special or infrequent service — as recommended by a qualified person before the first occurrence and as directed by the qualified person for any subsequent occurrences

20-2.3.2 Frequent Inspection. Items such as the following shall be inspected at intervals as defined in para. 20-2.3.1(b)(1). In addition, visual observations should be conducted during regular service for any damage or evidence of malfunction which appears between regular inspections. Any deficiencies such as those listed below shall be carefully examined, and determination made as to whether they constitute a hazard. Examine:

(a) all load carrying portions of the machine for deformation, cracks, and excessive wear;

(b) the vacuum generator for output;

(c) all vacuum pad seal rings for cuts, tears, excessive wear, and presence of foreign particles;

(d) all vacuum lines and vacuum line connections for leakage, cuts, kinks, and collapsed areas of hoses;

(e) the vacuum reservoir for leaks and visual damage;

(f) the entire vacuum system, including indicator lights, gages, horns, bells, pointers or other warning devices, and vacuum level indicators, by attaching a nonporous, clean surface to the vacuum pad or pads and then stopping the vacuum source. The vacuum level in the system shall not decrease by more than the manufacturer's specified rate.

20-2.3.3 Periodic Inspection. Complete inspections of the vacuum lifting device shall be performed at intervals as defined in para. 20-2.3.1(b)(2). Any deficiencies such as those listed below shall be examined and determination made as to whether they constitute a hazard. These inspections shall include the requirements of para. 20-2.3.2, and in addition, items such as the following:

(93) (a) external evidence of:

(1) looseness

(2) wear

(3) deformation

(4) cracking

(5) corrosion

(93) (b) external evidence of damage to:

(1) supporting structure

(2) motors

(3) controls

(4) other auxiliary components

(c) warning label required by para. 20-2.2.1(c)

20-2.3.4 Testing

(a) *Operational Tests.* Prior to initial use, all new, reinstalled, altered, repaired, or modified vacuum lifting devices shall be tested to ensure compliance with this Standard, including the following.

(1) All testing shall be performed by or under the direction of an appointed person and dated reports of all operational tests shall be filed.

(2) The seals and connections shall be tested for leaks by attaching a nonporous clean surface to the vacuum pad or pads and then stopping the vacuum source. Vacuum level in the system shall not decrease by more than manufacturer's specified rate.

(3) All indicator lights, gages, horns, bells, pointers, or other warning devices and vacuum level indicators shall be tested by the same method as (b) below.

(b) *Rated Load Test*

(1) Prior to initial use, all new, repaired, and altered vacuum lifting devices shall be tested and inspected by, or under the direction of, a qualified person and a written report be furnished by such person, confirming the load rating of the vacuum lifting device. The load rating should not be more than 80% of the maximum load sustained during the test. Test loads shall not be more than 125% of the rated load, unless otherwise recommended by the manufacturer. Subsequent load tests may be used to rerate the equipment at a higher rated load, but not more than the original rating. Test reports should be available.

(2) The rated load test shall consist of the following steps.

(a) Attach pads to the designated test load.

(b) Raise the test load a minimum distance to assure that the load is supported by the vacuum lifting device.

(c) Hold load for 2 min.

(d) Lower the load for release.

(3) After the test, the vacuum lifting device shall be visually inspected. Any defect shall be corrected before the lifting device is placed in service.

20-2.3.5 Maintenance

(a) *Preventive Maintenance.* A preventive maintenance program should be established and be based on recommendations made by the vacuum lifting device manufacturer or a qualified person.

(1) All vacuum pads, sealing rings, mufflers and filters should be cleaned per the manufacturer's recommendations.

(2) The vacuum generator should be maintained according to the manufacturer's recommendations.

(3) Replacement parts shall be at least equal to the original manufacturer's specifications.

(b) Maintenance Procedure

(1) Before adjustments and repairs are started on a vacuum lifting device, the following precautions should be taken.

(a) Locate the vacuum lifting device where it will cause the least interference with other operations in the area.

(b) Place all controls in the "off" condition.

(c) Pull the vacuum lifting device's main power disconnect switch and lock it in the de-energized position. This switch may or may not be located on the vacuum lifting device.

(d) Provisions should be made for qualified persons to work on energized equipment when adjustments and tests are required.

(2) After adjustments and repairs have been made, the vacuum lifting device shall not be restored to service until all guards have been reinstalled, safety devices reactivated, and maintenance equipment removed from the vacuum lifting device.

(c) Adjustments and Repairs. Any hazardous conditions disclosed by the inspection requirements of para. 20-2.3.1 shall be corrected before normal operation of the vacuum lifting device is resumed.

(1) Adjustments and repairs shall be done only by qualified personnel.

(2) Adjustments shall be maintained to assure correct functioning of components.

(3) Repairs or replacements shall be made as needed.

(4) Replacement parts shall be at least equal to the original manufacturer's specifications.

(5) If repairs of load sustaining members are made by welding, identification of materials shall be made and appropriate welding procedure shall be followed.

(d) Lubrication. All moving parts of the vacuum lifting device for which lubrication is specified should be regularly lubricated. Care should be taken to follow manufacturer's recommendations as to points and frequency of lubrication, maintenance of lubrication levels, and types of lubricant to be used.

Section 20-2.4 — Operation

20-2.4.1 Operators. Below-the-hook lifting devices shall be operated only by trained, appointed personnel.

20-2.4.2 Qualifications. Qualifications for operators of below-the-hook lifting devices are as follows.

(a) The operator shall be instructed in the use of the device by a designated person. Instructions should include, but not be limited to, the following:

(1) application of the lifter to the load and adjustments of the lifts, if any, that adapt it to various sizes or kinds of loads;

(2) instructions in any special operations or precautions;

(3) condition of the load itself required for operation of the lifter such as balance, or degree of order of stacked loads, or surface cleanliness, bending, load thickness, etc.;

(4) storage of lifter to protect it from damage;

(5) that the rated load of the lifting device not be exceeded nor the capacity of the hoisting equipment be exceeded by the combined weight of the load, the lifting device, and rigging;

(6) charging of the battery (if required);

(7) the purpose of indicators, meters, or alarms on the vacuum lifter;

(8) the proper attachment of adaptors to vacuum lifters for special load handling.

(b) The operator shall demonstrate the ability to operate the lifter as instructed before assuming responsibility for using the lifter.

20-2.4.3 Conduct of Lifting Device Operators

(a) The operator shall give attention to the operation of the lifts during a lifting sequence.

(b) When physically or otherwise unfit, an operator shall not engage in the operation of the equipment.

(c) The operator shall be responsible for those operations under his/her direct control. Whenever there is any doubt as to safety, the operator shall consult with a designated person before handling the load. (93)

(d) The operator shall respond only to instructions from designated persons. However, the operator shall obey a stop order at all times, no matter who gives it.

(e) The operation of the lifter shall be observed before using and during a shift. A defect observed shall be carefully examined by an appointed person. If the defect constitutes a hazard, the lifter shall be removed from service.

(f) The operator shall be familiar with standard hand signals when applicable.

(g) The operator shall land any attached load and store the lifter before leaving the lifting device.

(h) All controls shall be tested by the operator before using during a shift. If any controls do not operate properly, they should be adjusted or repaired before operations are begun.

(i) The operator shall not ride or allow others to ride loads.

20-2.4.4 Lifting Device Operating Practices

(a) Lifting devices shall be operated only by the following qualified personnel:

(1) designated persons;

(2) trainees under the direct supervision of a designated person;

(3) maintenance and test personnel, when it is necessary in the performance of their duties;

(4) inspectors (lifting devices).

(b) The lifting device shall not be loaded in excess of its rated load or handle any load for which it is not designed.

(93) (c) The lifter shall be applied to the load in accordance with the instruction manual.

(d) Before lifting, the operator shall make sure that lifter ropes or chains are not kinked, and that multiple part lines are not twisted about each other.

(e) Care should be taken to make certain the load is correctly distributed for the lifter being used.

(f) The temperature of the load should not exceed the maximum allowable limits of the lifter.

(g) The lifter shall be brought over the load in such a manner as to minimize swinging.

(h) Care shall be taken that there is not sudden acceleration or deceleration of the load.

(i) Do not allow load or lifter to come into contact with any obstruction.

(j) The operator shall avoid carrying the load over people.

(k) The lifter shall not be used for side pulls or sliding the load unless specifically authorized by a qualified person.

(l) If power goes off while making a lift, the operator shall immediately warn all persons in the vicinity of the lifter and land the load if at all possible to do so.

(m) The vacuum lines shall be free from kinks and twists, and shall not be wrapped around or looped over portions of the lifter that will move during the lift.

(n) The pad contact surface shall be clean and free of loose particles.

(o) Before starting to lift, verify that the vacuum level indicator has reached the required level. (93)

(p) Before starting to lift, raise the load a few inches to establish that the vacuum lifting device has been correctly applied and that a stable vacuum level exists. (93)

(q) The operator shall not leave suspended loads unattended. (93)

20-2.4.5 Miscellaneous Operating Practices

(a) An operator shall not use a lifting device which is tagged "Out of Service" or otherwise designated as nonfunctioning.

(b) "Out of Service" tags on lifting devices shall not be removed without the approval of the person placing them or an authorized person.

(c) The lifter, when not in use, should be stored at an assigned location.

(d) Caution should be taken that operating markings or tags shall not be removed or defaced. Those removed or defaced shall be replaced.

Section 20-2.5 — Manuals

Operating instructions and maintenance and parts information shall be furnished by the manufacturer.