AIRBAGS !

A TECHNICAL MANUAL
ABOUT **HIGH LIFT** AND
HIGH PRESSURE AIRBAGS

-HOW THEY WORK-

-DIFFERENT TYPES-

-DO'S AND DON'TS-

-LIFTING TECHNIQUES-

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HOW IT WORKS

1. LIFTING CAPACITY

AN AIRBAG OBTAINS ITS LIFTING CAPACITY BY MULTIPLYING THE FOLLOWING TWO COMPONENTS:

① THE FUNCTIONAL AREA OF THE AIRBAG (THE AREA IN CONTACT WITH THE OBJECT BEING LIFTED).
② THE INTERNAL AIR PRESSURE.

EXAMPLE:

SAY THE FUNCTIONAL AREA OF THE AIRBAG IS 20 SQUARE INCHES (SQ.IN.) AND THE OPERATING PRESSURE IS 100 POUNDS PER SQUARE INCH (PSI).

THE RESULTING LIFTING CAPACITY WOULD BE: **20 SQ.IN. x 100 PSI = 2000 POUNDS** (LBS.)

DOUBLE THE SIZE OF THE AIRBAG THEN THE CAPACITY IS: **40 SQ.IN. x 100 PSI = 4000 LBS.**

CONCLUSIONS:

① THE BIGGER THE BAG THE MORE WEIGHT IT WILL LIFT.
② MORE CONTACT AREA INCREASES THE LIFTING CAPACITY.
③ HIGHER INTERNAL PRESSURE INCREASES THE LIFTING CAPACITY.

2. HOOP STRESS

HOOP STRESS IS THE STRESS IN THE MATERIAL CAUSED BY THE INTERNAL PRESSURE AND IS DIRECTLY RELATED TO THE SIZE OF THE PRESSURE VESSEL (IN THIS CASE YOUR AIRBAG).

EVEN WITH A CONSTANT INTERNAL PRESSURE, THE STRESS IN THE MATERIAL INCREASES WITH THE SIZE (DIAMETER) OF THE AIRBAG.

THIS GREATLY LIMITS THE SIZE OF AIRBAGS, ESPECIALLY HIGH PRESSURE BAGS. THE BIGGEST HIGH PRESSURE AIRBAGS YOU'LL FIND ARE IN THE 65 TO 70 TON RANGE. IF THEY GET ANY BIGGER THE MATERIAL HAS TO BE SO THICK IT IS NO LONGER USEFUL AS AN AIRBAG. FOR THE SAME REASON, ON THE FAR LARGER HIGH LIFT AIRBAGS THE OPERATING PRESSURE IS GREATLY REDUCED TO ACCOMODATE THIS PROBLEM.

3. POWER CURVE

PILLOW SHAPE:

APLICATION: *HIGH PRESSURE AIRBAGS* (FIGURE 1 ON NEXT PAGE)

WHEN FULLY DEFLATED THE TOTAL SIZE OF THE AIRBAG CAN BE UTILIZED FOR MAXIMUM FUNCTIONAL AREA. WHEN THE BAG IS INFLATED AND GAINS HEIGHT, THE FUNCTIONAL AREA DIMINISHES SINCE MORE AND MORE OF THE AIRBAG IS USED FOR HEIGHT AND NOT FOR THE FUNCTIONAL AREA.

KNOWING THAT THE LIFTING CAPACITY IS DIRECTLY RELATED TO THE FUNCTIONAL AREA AND ASSUMING THE INTERNAL PRESSURE TO BE A CONSTANT PRESSURE, THE FOLLOWING APPLIES:

① PILLOW SHAPED AIRBAGS HAVE A DIMINISHING POWER CURVE (LESS AREA > LESS CAPACITY).
② AT MAXIMUM HEIGHT THE BAG WILL THEORATICALY LIFT NO WEIGHT (POINT LOAD AT TOP). THE LIFTING HEIGHT WILL DEPEND ON THE REQUIRED AREA TO LIFT THE LOAD.

CUBICAL OR CYLINDRICAL SHAPE:

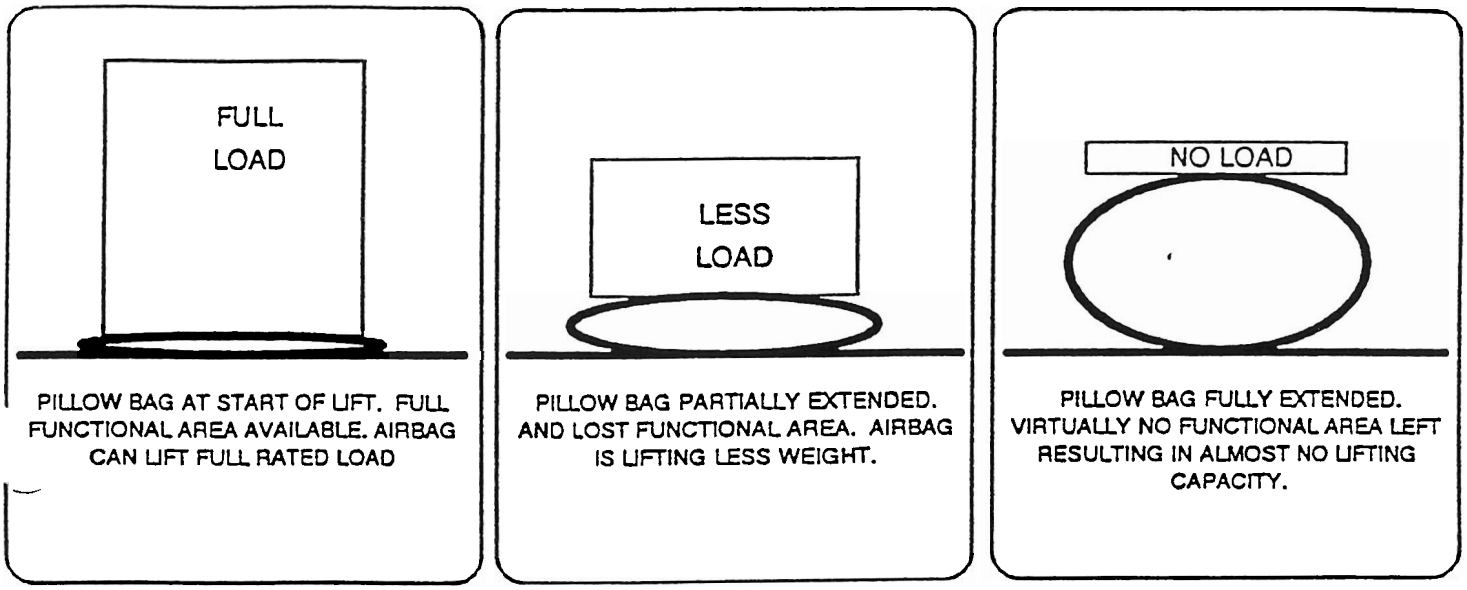
APPLICATION: *HIGH LIFT AIRBAGS* (SEE FIGURE 2 BELOW)

IT IS AS IF A THIRD DIMENSION WAS ADDED TO THE PILLOW SHAPE AIRBAG. THERE IS A SIDEWALL BETWEEN THE TOP AND BOTTOM PLATES OF THE BAG. WITH THIS TYPE OF BAG THE LIFTING PLATFORM OR FUNCTIONAL AREA REMAINS MOSTLY CONSTANT THROUGHOUT THE LIFT AS THE SIDEWALLS EXTEND.

KNOWING THAT THE LIFTING CAPACITY IS DIRECTLY RELATED TO THE FUNCTIONAL AREA AND ASSUMING THE INTERNAL PRESSURE TO BE CONSTANT, THE FOLLOWING APPLIES:

① THE LIFTING PLATFORM OR FUNCTIONAL AREA REMAINS CONSTANT THEREFORE THE LIFTING CAPACITY REMAINS VIRTUALLY CONSTANT THROUGHOUT THE LIFTING RANGE OF THE SIDEWALL.

FIGURE 1: SHOWS LIFTING PROGRESSION USING PILLOW BAGS.

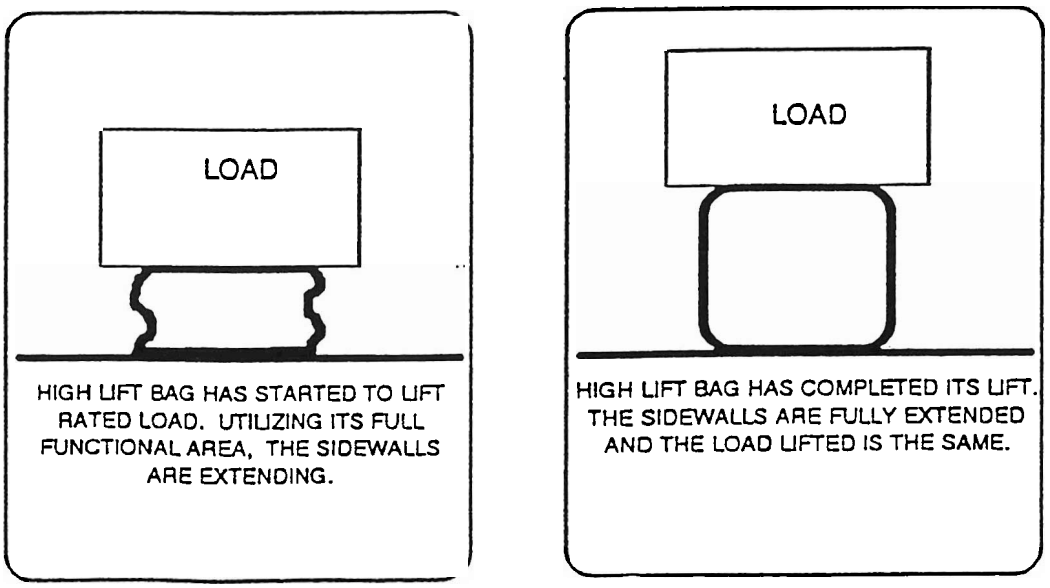


PILLOW BAG AT START OF LIFT. FULL FUNCTIONAL AREA AVAILABLE. AIRBAG CAN LIFT FULL RATED LOAD

PILLOW BAG PARTIALLY EXTENDED. AND LOST FUNCTIONAL AREA. AIRBAG IS LIFTING LESS WEIGHT.

PILLOW BAG FULLY EXTENDED. VIRTUALLY NO FUNCTIONAL AREA LEFT RESULTING IN ALMOST NO LIFTING CAPACITY.

FIGURE 2: SHOWS LIFTING PROGRESSION USING HIGH LIFT BAG.



HIGH LIFT BAG HAS STARTED TO LIFT RATED LOAD. UTILIZING ITS FULL FUNCTIONAL AREA, THE SIDEWALLS ARE EXTENDING.

HIGH LIFT BAG HAS COMPLETED ITS LIFT. THE SIDEWALLS ARE FULLY EXTENDED AND THE LOAD LIFTED IS THE SAME.

TYPES OF AIRBAGS IN GENERAL

1. HIGH PRESSURE PILLOW AIRBAGS

BASICALLY CONSISTS OF TOP PLATE AND BOTTOM PLATE, INFLATES INTO "PILLOW" SHAPE. ALL HIGH PRESSURE AIRBAGS ARE PILLOW SHAPED BAGS. COMMON OPERATING PRESSURE IS 118 TO 145 PSI.

ADVANTAGES:

- RELATIVELY THIN INSERTION SPACE REQUIRED, AS LITTLE AS 1 INCH.
- THICK RUBBER HAS GOOD PUNCTURE RESISTANCE.
- TREMENDOUS LIFTING CAPACITY AT START OF LIFT.
- RELATIVELY STABLE LIFT UP TO HALF ITS MAXIMUM LIFTING HEIGHT.

DISADVANTAGES:

DIMINISHING POWER CURVE. (THEORATICALLY PILLOW BAGS LIFT 0 LBS. AT MAX. HEIGHT)

- LIMITED LIFTING HEIGHT.
- RELATIVELY STIFF AND HEAVY TO HANDLE.
- VERY DIFICULT OR IMPOSSIBLE TO REPAIR.

2. LOW PRESSURE PILLOW AIRBAGS

SAME CONFIGURATION AS HIGH PRESSURE PILLOW BAGS EXCEPT THINNER RUBBER AND SUBSTANTIALLY LOWER OPERATING PRESSURE (15 PSI)

ADANTAGES:

- VERY THIN INSERTION, AS LITTLE AS 1/2 INCH.
- LOW PRESSURE ALLOWS USE AGAINST SHEET METAL AND ON SOFT GROUND.
- FLEXIBLE AND LIGHTWEIGHT.
- EASILY REPAIRABLE.

DISADVANTAGES:

- LOW PRESSURE REDUCES LIFTING CAPACITY.
- DIMINISHING POWER CURVE DUE TO PILLOW SHAPE.
- LESS PUNCTURE RESISTANT.

3. HIGH LIFT AIRBAGS

CONSISTS OF TOP AND BOTTOM PLATE WITH "SIDE WALL" IN BETWEEN. SIDEWALL EXTENDS AS BAG IS INFLATED. AVAILABLE IN CUBICAL OR CYLINDRICAL SHAPE. COMMON OPERATING PRESSURE OF 15 PSI.

ADVANTAGES:

- CONSTANT LIFTING FORCE AS TOTAL TOP PLATE AREA IS USED WHEN SIDEWALLS EXTEND
- TREMENDOUS LIFTING HEIGHT.
- LOW PRESSURE ALLOWS USE AGAINST SHEET METAL AND ON SOFT GROUND.

DISADVANTAGES:

- REQUIRES MORE INSERTION SPACE TYPICALLY 2 INCHES.

  LESS POWERFUL THAN HIGH PRESSURE AIRBAGS.

AIRBAG DESIGNS AND THEIR FUNCTION

SQUARE PILLOW SHAPE:

- ✔ USED MOSTLY FOR HIGH PRESSURE AIRBAGS AND SOME LOW PRESSURE BAGS.
- ✔ THIS SHAPE OFFERS BEST POWER VERSUS LIFTING HEIGHT RATIO.
- ✔ RELATIVELY STABLE AT LOW LIFTING HEIGHTS WITH HEAVY LOADS.
- ✔ UNSTABLE WITH LIGHTER LOADS AND OR GREATER LIFTING HEIGHTS, BAG TAKES SHAPE OF A BALL AND BECOMES VERY UNSTABLE IN ALL DIRECTIONS.

RECTANGULAR PILLOW SHAPE:

- ✔ USED FOR BOTH HIGH PRESSURE AND LOW PRESSURE BAGS.
- ✔ NOT AS GOOD A POWER VERSUS HEIGHT RATIO AS SQUARE BAG.
- ✔ THIS SHAPE HAS A BIG ADVANTAGE IN THAT WHEN IT INFLATES, IT SHAPES LIKE A LOG AND IS THEREFORE STABLE IN ONE DIRECTION AT ANY HEIGHT.

CYLINDRICAL SIDEWALL SHAPE:

- ✔ USED FOR SOME HIGH LIFT BAGS.
- ✔ SHOULD NOT BE CONSIDERED STABLE AT ANY HEIGHT, ESPECIALLY DURING THE LIFTING PROCESS.
- ✔ SOME STABILITY WILL BE OBTAINED AT FULL LIFTING HEIGHT WHEN THE SIDEWALLS ARE FULLY EXTENDED, PROVIDED THE BAG IS NOT HIGHER THAN ITS MAXIMUM DIAMETER.

RECTANGULAR SIDEWALL SHAPE:

- ✔ USED FOR HIGH LIFT BAGS.
- ✔ SHOULD NOT BE CONSIDERED STABLE AT ANY HEIGHT, ESPECIALLY DURING THE LIFTING PROCESS.
- ✔ CONSIDERABLE STABILITY CAN BE OBTAINED WHEN THE SIDEWALLS ARE FULLY EXTENDED. AGAIN, THE FULL HEIGHT OF THE BAG SHOULD NOT EXCEED THE BASE WIDTH OF THE BAG.

INTERNAL TIE DOWNS

HIGH LIFT BAGS WITH INTERNAL TIE DOWN

SOME SIDEWALL BAGS HAVE INTERNAL TIES BETWEEN TOP AND BOTTOM PLATE. THE MAIN REASON FOR THESE TIES IS TO ELIMINATE THE HOOP STRESS ON THE TOP AND BOTTOM PLATE OF THE BAGS (SEE "HOOP STRESS" PAGE 1) ALLOWING THE MANUFACTURER TO USE LESS COSTLY SEAMS.

THIS DESIGN ADDS SOME STABILITY TO THE BAG ONLY WHEN FULL HEIGHT IS REACHED AND THE INTERNAL TIES ARE UNDER TENSION AND ONLY WHEN LIFTING A LIGHT LOAD. IN GENERAL VERTICAL STRANDS DO NOT PROVIDE LATERAL STABILITY (SEE ANY STRUCTURAL BRIDGE OR ROOF SUPPORT DESIGN), SO CAUTION SHOULD STILL BE TAKEN AGAINST LATERAL SHIFTING OF THE LOAD.

HIGH LIFT BAGS WITHOUT INTERNAL TIE DOWNS:

THE MANUFACTURERS HAS PRODUCED A MORE COMPLEX SEAM THAT CAN OVERCOME THE HOOP STRESSES AT THE TOP AND BOTTOM PLATES. LACK OF INTERNAL STRANDS ALLOWS THE BAG UNINTERUPTED CONTACT AREA WITH THE LOAD. HOWEVER, WHEN RAISING LIGHTER LOADS CAUTION SHOULD BE TAKEN NOT TO EXCEED THE HEIGHT OF THE SIDEWALL IN ORDER TO MAINTAIN ITS STABILITY.

MULTIPLE PILLOW SHAPE:

A NEW CONCEPT WHEREBY MULTIPLE LOW PRESSURE AIRBAGS HAVE BEEN VULCANIZED TOGETHER. WHEN MULTIPLE "CELLS" ARE INFLATED CONSIDERABLE LIFTING HEIGHT IS OBTAINED.

NOTE: THIS STYLE BAG HAS A FAR GREATER LIFTING HEIGHT THAN ITS LIFTING PLATFORM AND IS THEREFORE LESS STABLE AT ANY HEIGHT. ALSO, THIS DESIGN IS MORE SUBJECT TO SIDE LOADS EXERTED BY ANGLED LOADS ON THE TOP CELL. GREAT CAUTION SHOULD BE TAKEN AT HIGHER LIFTS.

LIFTING WITH AIRBAGS

BASIC LIFTING RULES:

① WHILE LIFTING AN OBJECT, NO POINT OF THAT OBJECT SHOULD COME DOWN.
② NO LATERAL MOVEMENT OF THE OBJECT IS ALLOWED.
③ ANY HEIGHT GAINED MUST BE SECURED AND MAINTAINED.
④ AIRBAGS SHOULD NOT BE CONSIDERED STABLE.

STABILITY:

AIRBAGS ARE BASICALLY UNSTABLE. BY LIFTING A LOAD AND ASSUMING THE AIRBAG IS NOT STABLE, THE BURDEN OF STABILITY RESTS ON PROPER CRIBBING.

CRIBBING IS ESSENTIAL WHEN USING AIRBAGS. ON THE PREVIOUS PAGE STABILITY WAS EXPLAINED FOR THE DIFFERENT SHAPES AND TYPES OF BAGS. THE STABILITY OBTAINED FROM AN AIRBAG IS HELPFUL BUT SHOULD IN GENERAL NOT BE RELIED ON.

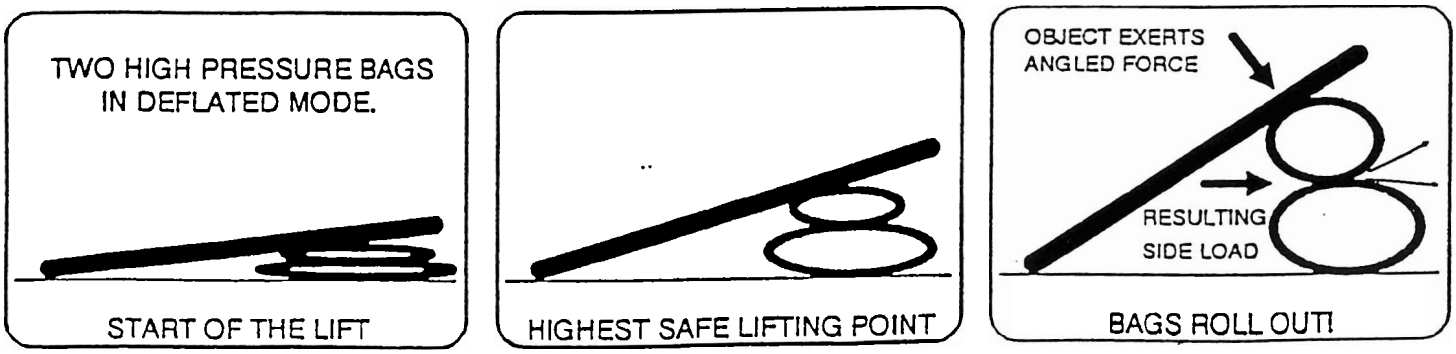
THE NEXT CHAPTER WILL COVER PROPER CRIBBING IN MORE DETAIL.

STACKING AIRBAGS:

① HIGH LIFT AND/OR LOW PRESSURE AIRBAGS SHOULD <u>NEVER</u> BE STACKED.
② HIGH PRESSURE AIRBAGS SHOULD NOT BE STACKED. IN SOME CASES THEY CAN BE STACKED TO A MAXIMUM OF **TWO BAGS ONLY** WHEN:
- ✔ THE OBJECT IS POSITIVELY SECURED AGAINST LATERAL MOVEMENT.
- ✔ THE BAGS ARE NOT INFLATED MORE THAN TWO THIRDS THEIR MAXIMUM HEIGHT.
- ✔ THE OBJECT WILL NOT UNDERGO A SIGNIFICANT ANGLE CHANGE, CAUSING THE AIRBAGS TO LIFT AGAINST AN ANGLED SURFACE.

SOMETIMES HIGH PRESSURE AIRBAGS ARE STACKED TO GAIN LIFTING HEIGHT. GREAT CAUTION SHOULD BE TAKEN THAT THE ABOVE RULES ARE ADHERED TO. STACKING AIRBAGS SHOULD NOT BE A STANDARD OPERATING PROCEDURE AND SHOULD BE USED AS A LAST RESORT TO GAIN LIFTING HEIGHT.

THE FOLLOWING DIAGRAM SHOWS THE STACKED LIFT PROGRESSION. IT CLEARLY SHOWS HOW THE ANGLED OBJECT EXERTS SIDE FORCES ON THE BAGS CAUSING THEM TO <u>ROLL</u> OUT. THIS IS OBVIOUSLY <u>VERY DANGEROUS</u>. A SPECIFIC AIRBAG SURFACE WILL <u>NOT</u> PREVENT THE BAGS FROM ROLLING.



AIRBAGS AND CRIBBING

TO OBTAIN STABILITY AND SAFETY DURING A LIFTING PROCEDURE, CRIBBING IS ESSENTIAL. IN GENERAL IT'S GOOD PRACTICE TO:

- ✔ CRIB AS YOU GO, OR,
- ✔ LIFT AN INCH THEN CRIB AN INCH.

TO DO EFFECTIVE CRIBBING, A VARIETY OF CRIBBING BLOCKS NEED TO BE ON HAND. USUALLY CONSISTING OF 4X4, 2X4 AND 2X6 LUMBER, AT LEAST 18" LONG, PLUS WEDGES AND STAIR STEPS.

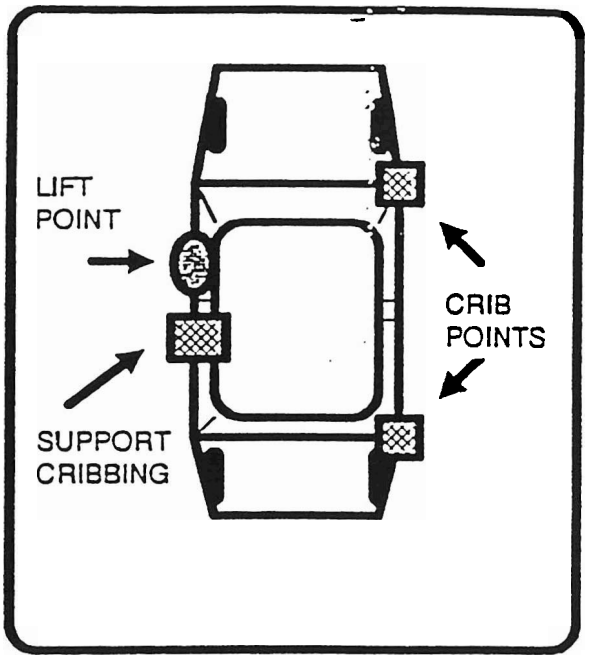
THE FOLLOWING ARE SOME SIMPLE LIFTING SCENARIOS AND BASIC CRIBBING REQUIREMENTS.

BASIC SINGLE POINT VEHICLE LIFT (EXAMPLE: SMALL VEHICLE, CAR, VAN)

① CRIB TWO POINTS ON DOWNSIDE. THIS CRIB NEEDS TO BE LATERALLY STABLE.

② PLACE AIRBAG AT LIFT POINT, USUALLY UNDER DRIVER AREA, LOOK FOR CENTER OF GRAVITY.

③ PLACE SUPPORT CRIB NEXT TO AIRBAG. NOTE: WHEN USING HIGH LIFT BAGS THE SIDEWALLS WILL "BALLOON" OUT AT THE START OF THE LIFT. THE SUPPORT CRIB SHOULD BE AT LEAST 8 INCHES FROM THE AIRBAG PLATFORM.



DURING THE LIFT THE SUPPORT CRIB WILL NEED TO BE RAISED. THIS IS A GOOD SCENERIO TO USE A HIGH LIFT BAG, SINCE IT OVERCOMES THE DISTANCE BETWEEN THE VEHICLE AND THE GROUND WITHOUT THE NEED TO PLACE THE BAG ON TOP A CRIBBED PLATFORM.

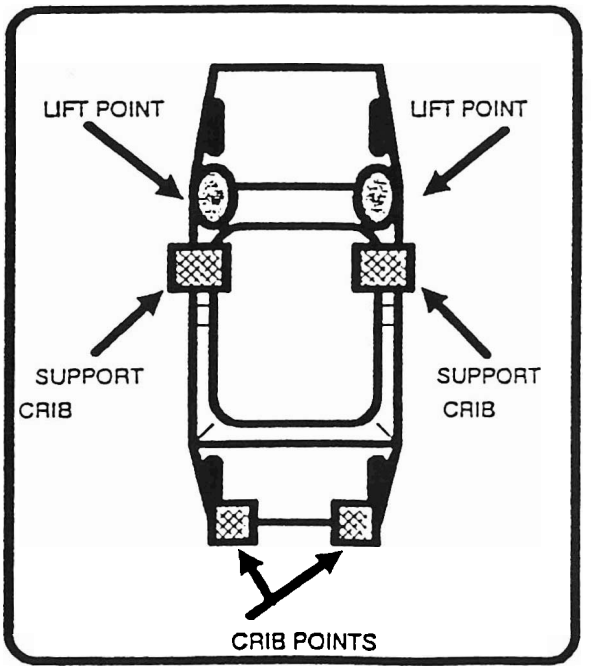
NOTE: A HIGH LIFT BAG WILL NEED TO BE INSERTED AT LEAST TWO THIRDS ITS FUNCTIONAL AREA. BE AWARE THAT HIGH LIFT BAGS ARE FLEXIBLE AND CAN EASILY FOLD AROUND AN OBJECT CAUSING UNWANTED SIDELOADS. PROPER PLACEMENT IS VERY IMPORTANT.

DUAL POINT FRONT OR REAR VEHICLE LIFT.

DUE TO THE LENGTH OF THE VEHICLE, THIS TYPE OF LIFT IS MORE SUBJECT TO LATERAL SHIFTING. THE BAGS SHOULD BE AS CLOSE AS POSSIBLE TO THE CRIB POINTS, HOWEVER, THEY MUST BE CLEARLY TO ONE SIDE OF THE CENTER OF GRAVITY SO AS NOT TO LIFT THE VEHICLE BACKWARDS.

TRY TO PUT THE CRIB POINTS AT THE WIDEST POINT OF THE VEHICLE FOR MAXIMUM SIDE LOAD SUPPORT.

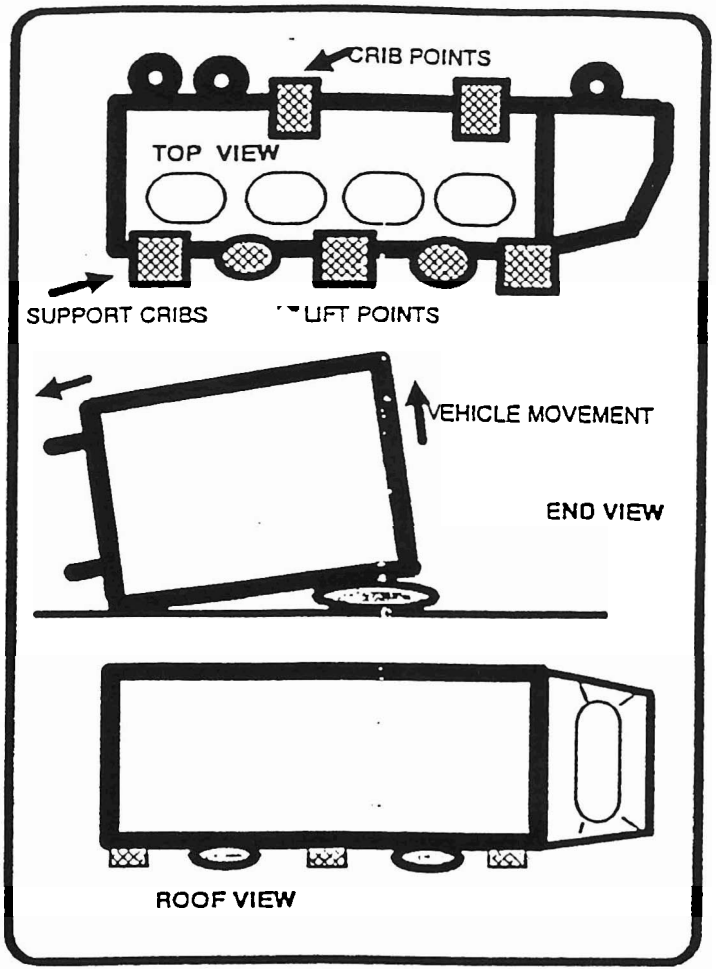
BY PLACING THE SUPPORT OR SAFETY CRIB ON THE DOWNSIDE OF THE AIRBAG, LESS CRIBBING HEIGHT NEEDS TO BE OBTAINED, AGAIN HELPING THE OVERALL STABILITY OF THE LIFT.



OVERTURNED BUS OR TRUCK LIFT.

DUE TO THE LENGTH OF THE VEHICLE, MULTIPLE LIFTING POINTS ARE ADVISED. BUSSES ARE VERY RIGID BUT TRUCKS CAN BEND AND FLEX EASILY, POSSIBLY REQUIRING EVEN MORE LIFTING POINTS.

I E: EACH LIFTING POINT WILL REQUIRE A SAFETY OR SUPPORT CRIB.



OFTEN THE LIFT IS STARTED WITH A PILLOW TYPE HIGH PRESSURE BAG AT THE ROOF RAIL OR CROSS SUPPORT. USUALLY THERE IS LITTLE INSERTION ROOM SO THE PILLOW BAG WILL WORK WELL.

ONCE THE VEHICLE IS LIFTED A FEW INCHES, A HIGH LIFT BAG CAN BE USED TO CONTINUE THE LIFT. THE ADVANTAGE IS THAT THE LIFT CAN USUALLY BE DONE AGAINST THE SHEET METAL SINCE HIGH LIFT BAGS OPERATE ON LOW PRESSURE.

ALLOW THE VEHICLE TO MOVE UP. THE DOWN SIDE SHOULD BE SUPPORTED BUT NOT CRIBBED IN SUCH A WAY TO PROHIBIT MOVEMENT OF THE VEHICLE.

BE CAREFUL NOT TO LIFT THE VEHICLE OFF ITS CRIB POINTS ONTO ITS WHEELS. ALL LATERAL STABILITY WILL BE LOST.

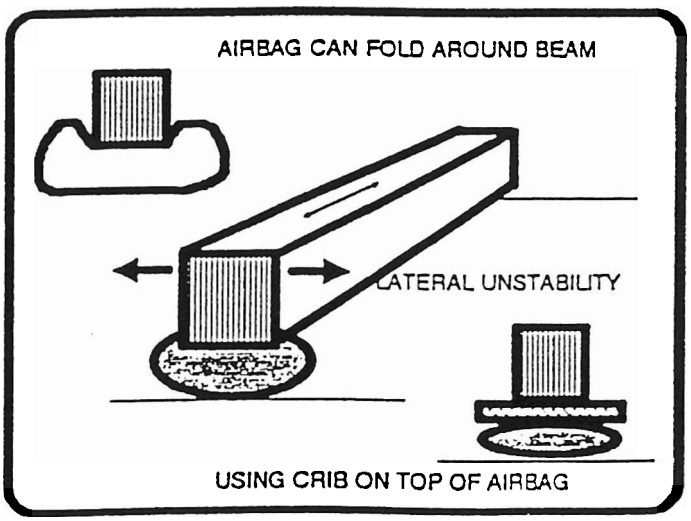
ROTATING THE TIRES WILL ALLOW EXTRA LIFTING HEIGHT. NOTICE THAT THE LIFT POINTS ARE 1/4 OF THE TOTAL DISTANCE OF THE VEHICLE FROM EACH END, SO THE WEIGHT IS EVENLY DISRTIBUTED ONTO THE AIRBAGS.

BEAM LIFT

LIFTING BEAMS IN A BUILDING COLLAPSE SCENERIO OFFERS A UNIQUE CHALLENGE TO THE AIRBAGS, AND THE OPERATOR. LATERAL UNSTABILITY IS A PARTICULAR PROBLEM.

USUALLY THE BEAM IS MUCH NARROWER THAN THE AIRBAG, CAUSING THE BAG TO FOLD AROUND THE BEAM.

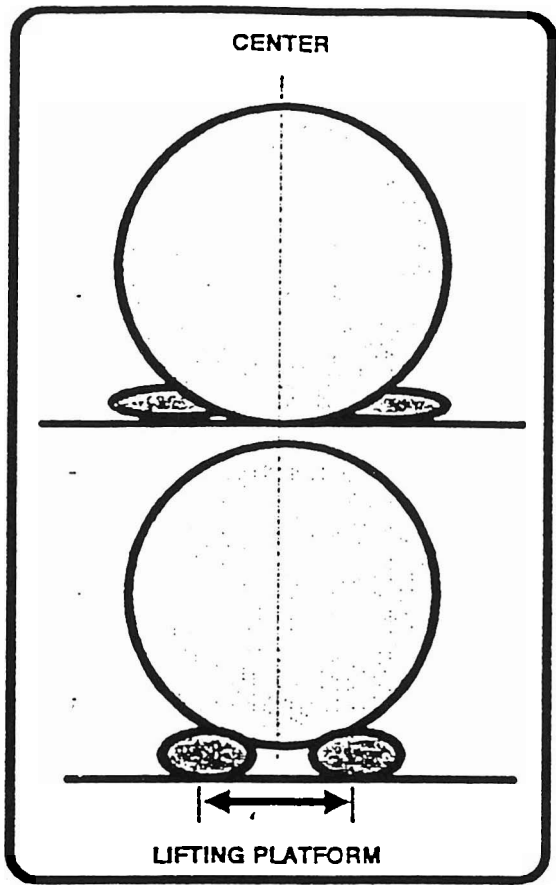
THE FUNCTIONAL LIFTING AREA IS ONLY THE CONTACT AREA OF THE BEAM ON THE AIRBAG. THIS IS OFTEN NOT ENOUGH, SO THE USE OF CRIBBING ON TOP OF THE BAG IS NECESSARY TO DISTRIBUTE THE LOAD AND GAIN FUNCTIONAL AREA.



THIS SCENERIO LENDS ITSELF WELL FOR THE USE OF RECTANGULAR SHAPED AIRBAGS. WHEN USED SIDEWAYS WITH THE BEAM A RECTANGULAR BAG OFFERS GOOD LATERAL STABILITY.

USUALLY THE BEAM WILL BE ANCHORED ON ONE END CAUSING IT TO BE STABLE IN THE LENGTH DIRECTION. THE BEAM IS LIGHTER WHEN LIFTED CLOSER TO THE END.

ROUND OBJECT LIFT



ROUND OBJECTS CAN ONLY BE LIFTED FROM THE GROUND BY USING PILLOW TYPE BAGS.

① PLACE THE PILLOW BAGS ON BOTH SIDES OF THE OBJECT. NOTE: BAGS MAY **NOT** BE STACKED FOR THIS SCENERIO.

② INFLATE THEM SIMULTANEOUSLY TO CREATE AN EVEN LIFT.

IF MORE LIFTING HEIGHT IS REQUIRED YOU CAN:

① PLACE LARGER PILLOW BAGS NEXT TO THE EXISTING BAGS. DO **NOT** USE HIGH LIFT BAGS. NOTE: BE SURE TO KEEP THE BAGS SUFFICIENT DISTANCE FROM THE CENTER TO MAINTAIN GOOD PLATFORM WIDTH.

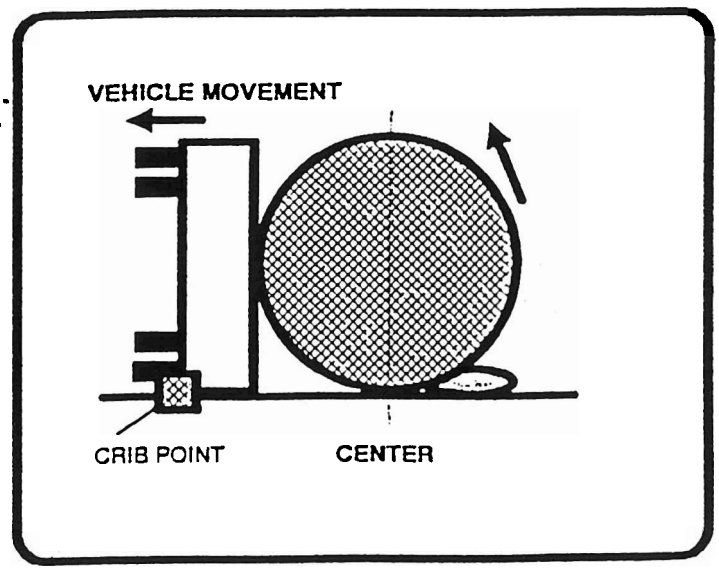
② BOTH BAGS MAY BE PLACED ON A SINGLE PLATFORM CRIB AT LEAST THE SAME WIDTH AS THE LIFTING PLATFORM DISTANCE. NOTE: DUE TO THE ANGLED FORCES, INDIVIDUAL CRIBS BENEATH THE AIRBAG COULD PUSH OUT AND SHOULD THEREFORE BE AVOIDED.

SINCE THE BAGS WILL BE WORKING AT SEVERE ANGLES, GREAT CAUTION SHOULD BE TAKEN TO AVOID SLIPPING. UNFORTUNATELY, PRACTICE SHOWS, THAT SPECIAL SURFACE DESIGNS DO VERY LITTLE AGAINST SLIPPING SINCE THE BAGS ARE OF A SOFTER MATERIAL THAN THE USUAL STEEL OR CONCRETE SURFACE ABOUT TO BE LIFTED.

- ✔ BE SURE THAT THE BAGS ARE CLEAN FOR BEST GRIP.
- ✔ DO **NOT** USE CRIBBING ON TOP OF THE BAG.
- ✔ IN GENERAL IT IS BETTER TO **NOT** COVER THE BAG. (CONSULT MANUFACTURER RECOMMENDATIONS)
- ✔ WHEN POSSIBLE BAGS SHOULD BE TIED TO PREVENT ANY TRAVEL DISTANCE SHOULD THEY SLIP. NOTE: ALWAYS ALLOW SLACK SO THE BAG CAN MOVE UP AND DOWN UNRESTRICTED.

TANKER TRUCK LIFT

EVEN THOUGH TANKER TRUCKS ARE ROUND, THEY ARE CONSIDERABLY EASIER TO LIFT THAN THE PREVIOUS SCENERIO. THE ADVANTAGE IS THAT ONLY ONE SIDE OF THE ROUND SURFACE IS LIFTED WHEREAS THE OTHER SIDE IS ANCHORED TO THE TRUCK FRAME.



① USE A HIGH PRESSURE PILLOW BAG TO START THE LIFT. LOOK FOR REINFORCEMENT RIBS TO PLACE THE AIRBAGS. PLACE AS IN "BUS SCENERIO".

② CRIB AS YOU GO. REFER TO "BUS SCENERIO" FOR POSITIONING.

③ HIGH LIFT BAGS MAY BE PLACED UNDER THE CENTER OF THE TANK IF MORE HEIGHT IS REQUIRED. (CONSIDER WEIGHT)

④ ALLOW VEHICLE TO ROTATE WHEN LIFT OCCURS. NOTE: DO NOT LIFT ONTO ITS WHEELS.

HOW TO CRIB AN AIRBAG

FOR LIFTING HEIGHT

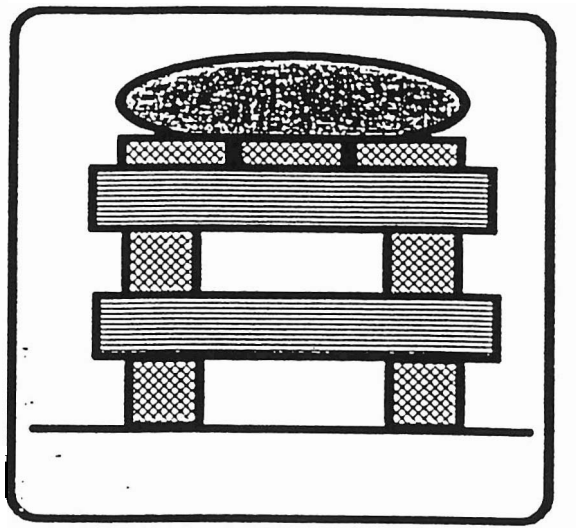
GAIN LIFTING HEIGHT, CRIBBING SHOULD **ONLY** BE DONE BENEATH THE AIRBAG.

USE A BOX STYLE CRIB FOR HEIGHT AND MAKE THE TOP LAYER A SOLID PLATFORM OF 2X4'S FOR HIGH LIFT BAGS OR LIGHTER LOADS. USE 4X4'S FOR HIGH PRESSURE BAGS DURING A HEAVY LOAD SCENERIO.

THE BOX CRIB SHOULD NOT BE HIGHER THAN THE SIZE OF ITS FOOTPRINT.

WHEN USING HIGH LIFT BAGS, THE TOP PLATE SHOULD EXCEED THE WIDTH AND LENGTH OF THE AIRBAG TO HOLD THE SIDEWALLS THAT MAY FOLD OVER THE EDGE WHEN THE LIFT IS STARTED.

DO NOT USE THIS TYPE OF CRIB WHEN SEVERE ANGLES ARE PRESENT.



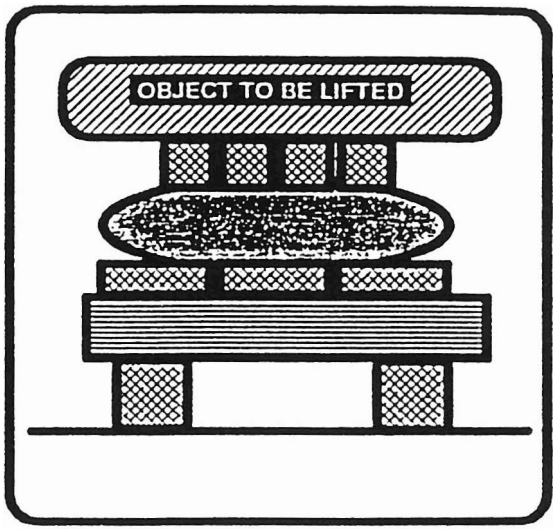
FOR LOAD DISTRIBUTION

AIRBAGS MAY CRIBBED ON TOP OF THE BAG IN ORDER TO DISTRIBUTE A LOAD OVER THE FULL FUNCTIONAL AREA OF THE BAG.

S CRIB SHOULD BE LIMITED TO ONE LAYER.

USE 4X4'S FOR HEAVY LOADS WHEN USING HIGH PRESSURE AIRBAGS AND 2X4'S OR 2X6'S (BETTER) FOR LIGHTER DUTY OPERATIONS AND WHEN USING HIGH LIFT BAGS.

WHEN CRIBBING ON TOP OF HIGH LIFT BAGS THE CRIB SHOULD BE AT LEAST 20% LONGER THAN THE WIDTH OF THE BAG.



DO'S AND DON'TS

DO

- ✔ ALWAYS USE A SAFETY CRIB.
- ✔ STABILIZE VEHICLE ON DOWN SIDE AGAINST LATERAL AND DOWNWARD MOVEMENT.
- ✔ USE FULL FUNCTIONAL AREA OF THE AIRBAG WHENEVER POSSIBLE.

DO NOT

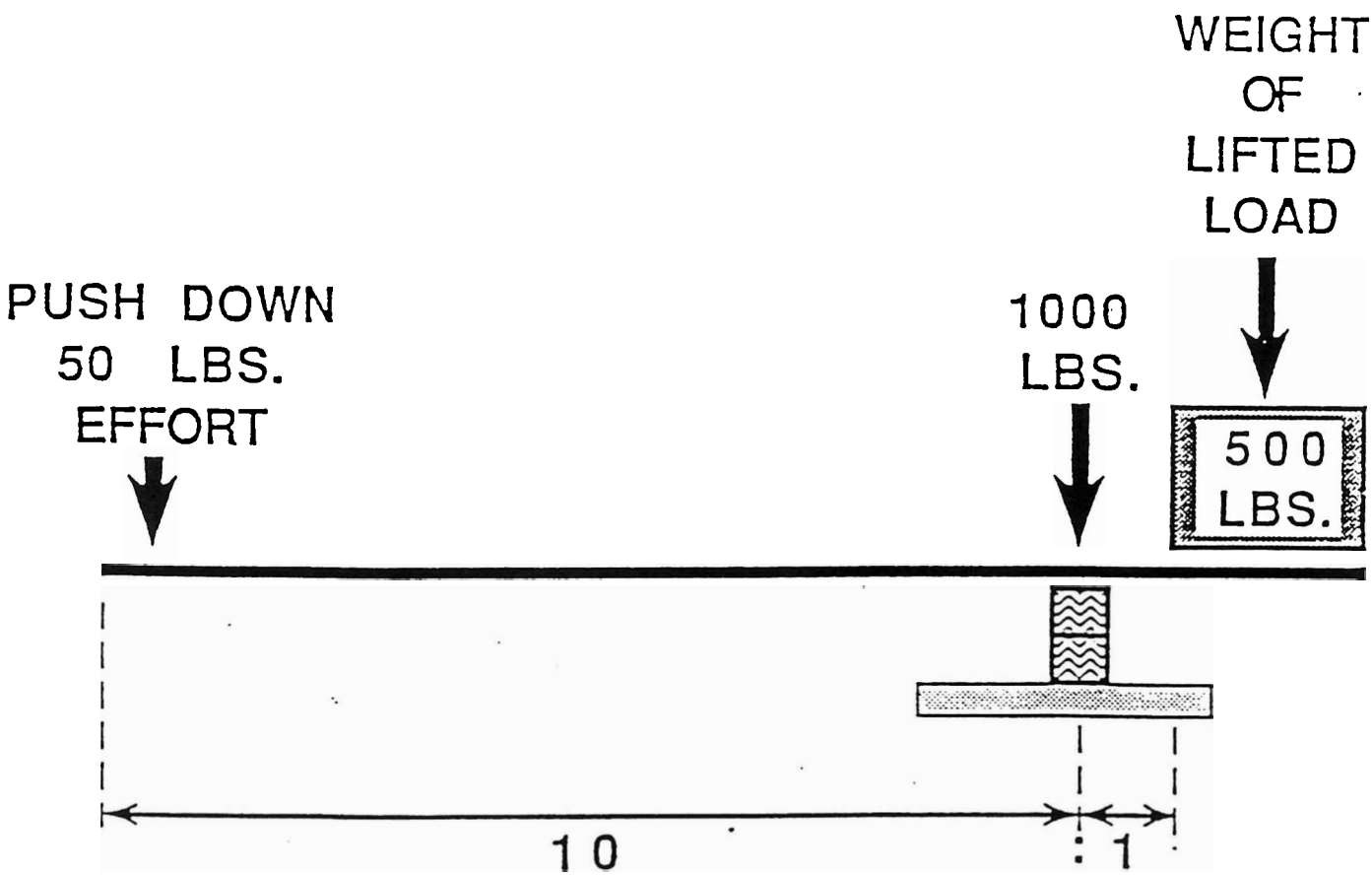
- ✔ STACK HIGH LIFT BAGS AND OR LOW PRESSURE BAGS.
- ✔ STACK HIGH PRESSURE BAGS MORE THAN TWO AND ONLY IN ACCORDANCE WITH SAFETY RULES.
  CHANGE OR ALTER MANUFACTURERS EQUIPMENT IN ANY WAY.
- ✔ LIFT VEHICLES TO SEVERE ANGLES.
- ✔ TURN VEHICLES OVER (THATS FOR RECOVERY BAGS, NOT RESCUE BAGS).
- ✔ LIFT AGAINST SHARP OBJECTS.

TO SUMMARIZE

AS YOU CAN SEE THERE ARE A FEW THINGS TO KEEP IN MIND WHEN LIFTING A LOAD. LIFTING WITH AIRBAGS IS A COMBINATION OF ANTICIPATING ANGLES AND COMMON SENSE. NONE OF IT IS DIFFICULT BUT ALL OF IT IS DANGEROUS. EXPERIENCE IS YOUR BEST TOOL TO DO AN EFFECTIVE AND SAFE LIFT. SPEND SOME TIME WITH CRIBBING AND AIRBAGS AT ONE OF YOUR FUTURE TRAINING CLASSES.

SHOULD YOU HAVE ANY QUESTIONS OR IF YOU WOULD LIKE TO SEE CERTAIN SCENERIOS EXPLAINED, PLEASE CALL WIN VANBASTEN AT 215/657-7825.

SINGLE POINT LOADING



50 LB. EFFORT X 10:1 (M.A.) = 500 LBS.

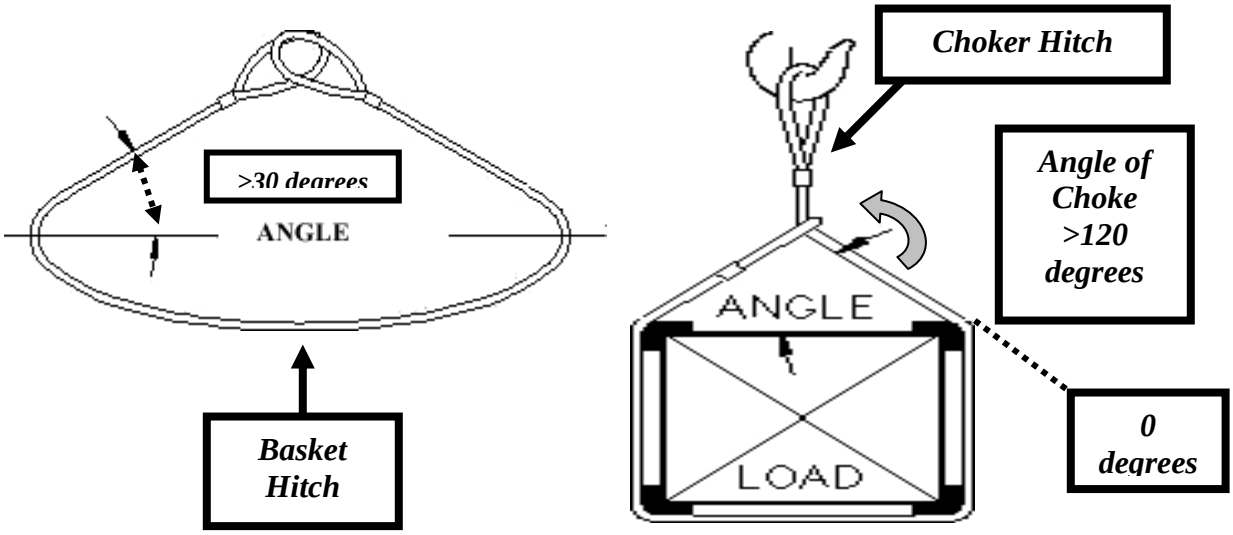
\+ WEIGHT OF LIFTED LOAD = 500 LBS.

SINGLE POINT LOAD = 1000 LBS.

SYNTHETIC SLINGS

Slings may be constructed of synthetic fibers such as nylon, polyester, or other high performance fibers. They may be flat or round. The two most common types using in rescue/recovery are the Single Leg Sling, and the Spliced Endless Sling. The Single Leg Sling may be constructed in the Eye and Eye, Twisted Eye, or Folded Eye form. Generally synthetic slings are lighter in weight, more flexible, stronger, and less expensive than chain slings. These slings have the advantage of spreading the load out over a greater area as opposed to chain slings. Some slings have inspection devices built into them, such as colored fibers or fiber optic cables.

Disadvantages of synthetic slings includes stretch, tearing or cutting of the material, degradation caused by exposure to sun, heat, cold, or chemicals.



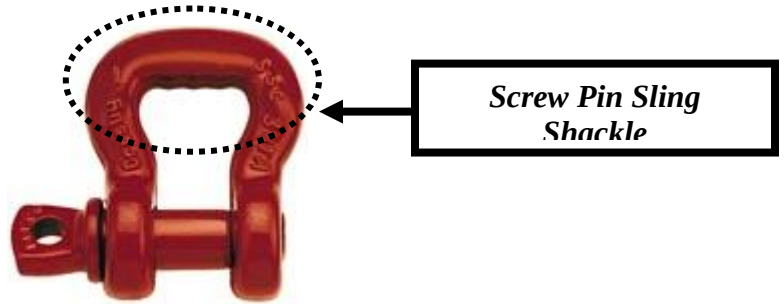
HITCHES-

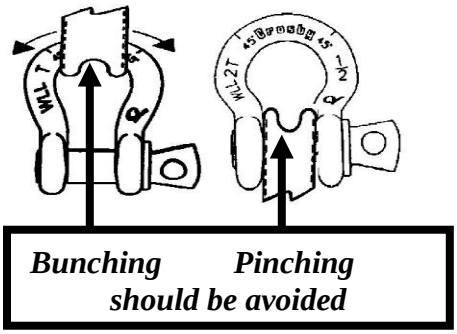
Basically three types of hitches are formed with synthetic slings. They are: Vertical Hitch, Basket Hitch, and Choker Hitch. Vertical and basket hitches are commonly used for flat stock materials that can be stacked. The Vertical Hitch supports the entire load on a single leg. The Basket Hitch has twice the capacity of a single leg if the legs are vertical. Choker hitches are used primarily for round stock, where gripping the load is important for load control. The capacity of a Choker Hitch is based on the hitch being formed properly. For full Choker Hitch capacity, the Angle of Choke for all types of slings should be a minimum of 120 degrees. According to the Web Sling & Tie Down Association, synthetic slings have a reduction of up to 25% at an Angle of Choke greater than or equal to 120 degrees (75% of WLL for a single leg hitch). If the Angle of Choke is less than 120 degrees the sling capacity will decrease even more.

The angle of the sling leg to the load, known as the Horizontal Sling Angle must not be less than 30 degrees. Tension (load) increases as the angle between the sling leg and load decreases. Generally the longest sling practical should be used within overhead lifting clearance. Rigging close to the load with a choker hitch increases sling leg tension.

BASKET RIGGING HITCHES
For
Wire Rope, Synthetic Slings, and Chain

Horizontal Angle	*Strength Relative to Single Leg Hitch*
90 degrees to load	2X (200%)
60 degrees to load	1.7X (170%)
45 degrees to load	1.4X (140%)
30 degrees to load	1X (100%)





SLING INSPECTION-

1. All slings must be inspected according to all applicable Federal and State OSHA rules and regulations, and any other applicable rules and regulations. All inspections must be documented.
2. Visually check for signs of deterioration, wear, physical, thermal and chemical damage.
3. Closely check for any broken threads or strands, and replace according to manufacturers recommendations.
4. Ensure that the certification tag or label is present, clean, and legible.
5. Only the manufacturer must make repairs. After repair, slings must be proof tested and a certification label attached to the sling.
6. Closely check each sling for signs of ultra-violet degradation. These signs are: bleaching of color, increased stiffness of material, and surface abrasion in areas not normally in contact with the load.
7. Closely check the entire sling for embedded particles or snags.
8. Replace any sling failing inspection.

SLING USE-

1. Avoid dynamic loading any sling.
2. Always pad contact points of the sling and load. Protect the sling from sharp and abrasive edges, or hot surfaces.
3. Don't expose slings to excessive heat or cold temperatures.
4. Don't leave slings lying in the sun.
5. **NEVER exceed the WLL of a sling or any attachment**.
6. Make hitches correctly to prevent slipping.
7. Don't knot two slings to extend them, or tie a knot in a sling.
8. Avoid kinking or twisting of slings when in use or storage.
9. Store slings in a cool, dry, dark area.
10. Avoid pinching or bunching of a sling in an attachment.
11. A sling eye of either synthetics or wire rope must not be placed over an object (usually a hook or other collector) that is greater in width than 1/3 of the eye length.
12. When using multiple leg slings, the rated load for the single leg sling shall not be exceeded in any leg of the multiple leg slings.
13. When using slings with non-symmetrical loads, calculations should be performed to prevent overloading any leg. When the COG is not equally spaced between the pick points the slings will not carry an equal share of the load. The sling connected closet to the COG in the same horizontal plane will carry a greater share of the load.
14. No one should stand under a freely suspended load, nor should they stand in-line or next to a sling that is under tension. Do not place any body part between the sling and the load, or between the sling and hook.
15. Slings should not be pulled from under a load when the load is resting on the sling. Do not drag a sling over a surface.
16. Loads should be rigged to the Center of Gravity (COG). A load properly rigged will lift level, otherwise the load will shift.

17. For more contact with the load use a double wrap basket hitch. Make certain the double wrap basket doesn't overlap at the bottom of the load. Adjust the double wrap basket hitch to equalize the load in each side of the basket.
18. A double wrap choker hitch must not be used with less than a 60 degree horizontal sling angle. Smaller angles will cause the slings to slide inward.
19. The maximum included angle when slings are collected in a hook is 90 degrees. When slings are collected in a shackle bow the maximum included angle is 120 degrees.
20. The minimum horizontal sling angle is 45 degrees if slings are placed into a hook. The minimum horizontal sling angle is 60 degrees if using a choker or basket hitch. The fittings at the load connection see the same load as the sling itself.
21. Do not use a sling that appears damaged.

REMOVAL OF SLINGS FROM SERVICE

A synthetic sling shall be removed from service if any of the following are present:

1. Holes, tears, cuts, embedded particles, or abrasive wear that exposes core fibers.
2. If the rated sling capacity tag is missing or not readable.
3. If the sling has been tied into a knot.
4. Melting, charring, or weld spatter is visible on any part of the sling.
5. Chemical burns or degradation is seen on any part of the sling.
6. Broken or worn stitching on the cover that exposes the core fiber.
7. Distortion, excessive pitting, corrosion, rusting, or other damage to a fitting attached to the sling.
8. Any condition that creates doubt as to the integrity or strength of the sling.

INSPECTION OF SLINGS

Initial Inspection-

Before any new or repaired sling is placed into service, it shall be inspected by a designated person to ensure the correct sling is being used, as well to determine the sling meets applicable specs and has not been previously damaged.

Frequent Inspection-

The inspection made by the user handling the sling each time it is used.

Periodic Inspection-

This inspection shall be conducted by a designated person. The specific frequency of inspection should be based upon:

1. Frequency of sling use
2. Severity of service conditions
3. Experience gained on the service life of slings used in similar applications
4. Periodic inspections should be conducted no less than annually

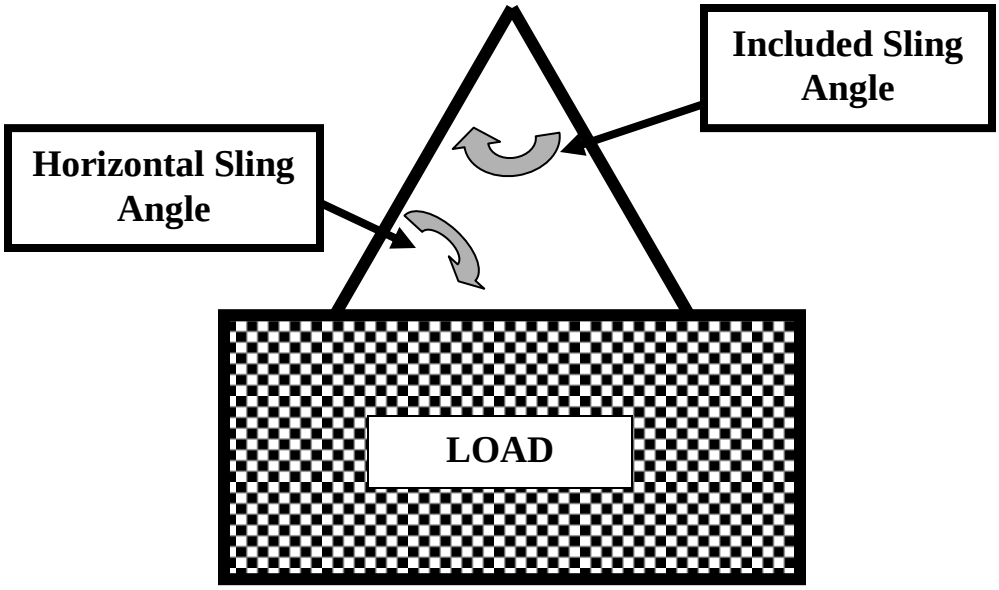
BASKET RIGGING HITCHES
For
Wire Rope, Synthetic Slings, and Chain

Horizontal Angle	*Strength Relative to Single Leg Hitch*	*Factor*
90 degrees to load	2X (200%)	1.00
60 degrees to load	1.7X (170%)	.866
45 degrees to load	1.4X (140%)	.707
30 degrees to load	1X (100%)	.500

Recommended Minimum
Connecting Hardware Diameter

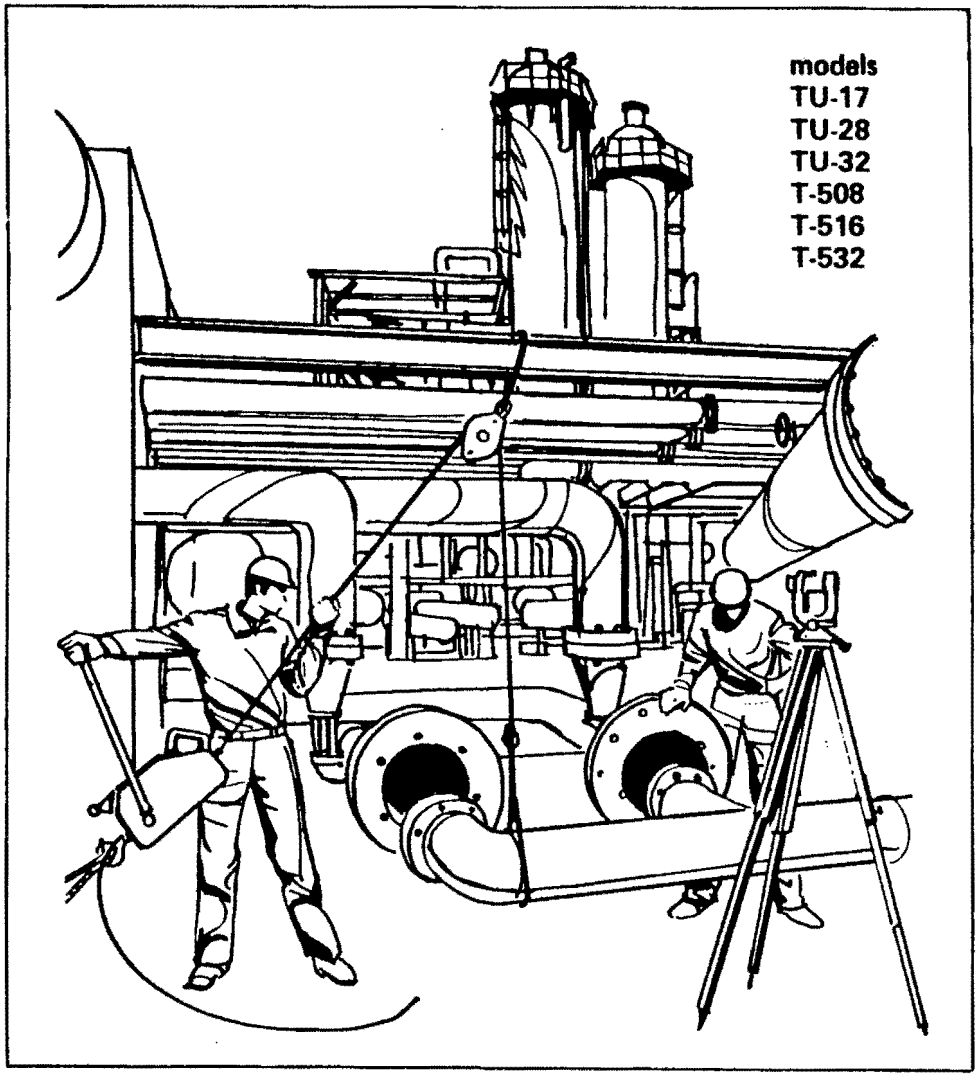
Sling Size- Vertical Capacity	*Vertical (single leg) Hitch*	*Basket Hitch*
2,600	.50	.62
5,300	.62	.88
8,400	.75	1.00
10,600	.88	1.25
13,200	1.00	1.38
16,800	1.12	1.62
21,200	1.25	1.75
25,000	1.25	1.88
31,000	1.50	2.00
40,000	1.62	2.38
53,000	1.88	2.75

THE RIGGING TRIANGLE



griphoist®

manual hoists
use and maintenance

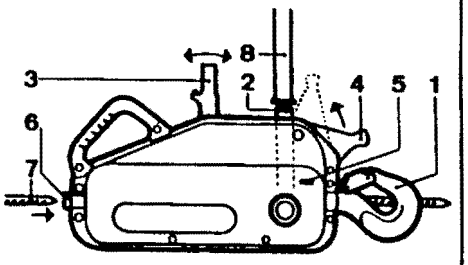


models
TU-17
TU-28
TU-32
T-508
T-516
T-532

Griphoist Inc.

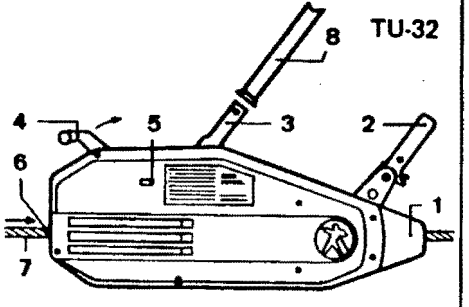
Fig. 1

TU-8
TU-16



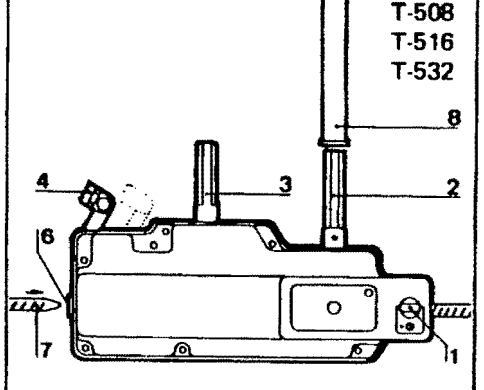
Front Rear

TU-32



1. Anchor hook / pin
2. Power stroke lever
3. Reversing lever
4. Rope release lever
5. Lock botton
6. Wire rope entry
7. Wire rope
8. Telescopic operating handle

T-508
T-516
T-532



1. INTRODUCTION

This operating and maintenance booklet informs you about the functioning of the manual GRIPHOIST machines. A spare parts nomenclature for the specified model is also contained. Nomenclatures for the other models can be sent on request.

2. DESCRIPTION

2.1. Working principle

The principle of the GRIPHOIST units is based on a unique arrangement of two pairs of self-energizing grip jaws. Instead of the wire rope being reeled on a drum as it is in a conventional hoist, it is pulled through the GRIPHOIST in a straight line. The grip jaws are machined to a radius suitable for the wire rope. The surfaces of the jaws are smooth and grip the wire rope without damaging it.

The 2 jaw blocks are enclosed in a casing. They alternately grip the wire rope to pull it during lifting or retain it during lowering.

In operation the action of the grip jaws can be compared to two hands which alternately seize the wire rope and draw it. The two sets of jaws are locked by the pull of the wire rope. **The heavier the load — the stronger the grip.**

2.2. Principal operating components

(see opposite folder)

2.3. Technical specifications

Model		T-508	TU-17*	T-516	TU-28*	T-532	TU-32*
Material lifting capacity**	lbs	2,000	2,000	4,000	4,000	8,000	8,000
Manriding capacity**	lbs	—	1,500	—	3,000	—	6,000
Approx. speed per minute	fpm	7 - 9	7 - 9	6	7 - 8	6	5
Weight:							
hoist	lbs	14.25	18.5	30	41	51	59.5
operating handle	lbs	2.5	2.2	5	5.3	5	5.3
Overall dimensions	in.	16-1/2 x9-7/8 x3-7/8	20-3/4 x9-3/4 x4-1/2	20-7/8 x12-7/16 x5	26x13 x5-3/4	24-7/16 x14 x5-1/8	27x13 x6-1/8
Length of operating handle	in.	22/28	22/28	25-5/8 45-1/4	31-1/2 47-1/2	25-5/8 45-1/4	31-1/2 47-1/2
GRIPHOIST wire rope:							
standard length***	ft	30	30	60	60	30	30
diameter	in.	5/16	5/16	7/16	7/16	5/8	5/8
	mm	8.4	8.4	11.6	11.6	16.3	16.3
	ref.	C8	C8	C12	C12	C16	C16
breaking strength	lbs	10,000	10,000	20,000	20,000	40,000	40,000

* U.L. classified

** capacity calculated for materials hoisting. For manriding, conform to all safety regulations;

*** any odd lengths supplied on request. Unless specified otherwise, wire rope is fitted with its standard eye hook with latch at one end and welded point the other end.
A light weight metal reel, supplied with the wire rope, facilitates carrying and stowing.
As a rule GRIPHOIST units are not sold without their wire rope.

3. OPERATING INSTRUCTIONS

Remark: the drawings of the following parts can be found on the folder page 2.

3.1. Equipment required

For lifting, pulling or tightening a load with a GRIPHOIST machine, we recommend the following standard equipment:

a. the appropriate GRIPHOIST unit with its telescopic lever,

b. the GRIPHOIST wire rope with appropriate length,

c. corresponding wire rope or chain slings for the anchoring of the hoist and to fix the load to the traction wire rope,

d. pulley blocks when increasing the wire rope capacity by means of sheaves,

e. oil to lubricate the inner mechanism and the wire rope when working.

3.2. Anchoring

Anchor the GRIPHOIST by its hook or anchor pin (1) with a sling or chain to any resistant fixed point. Make sure the sling, chain and anchorage are capable of supporting all imposed loads.
As GRIPHOIST machines work equally well in any position **horizontally, vertically or diagonally** — the operator may choose the most convenient anchoring point.

There are several ways of anchoring the machine:

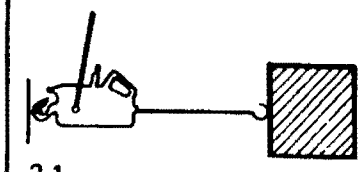
PULLING (Fig. 2.1.)
For pulling operations the machine is generally anchored to a fixed point to where the load is to be taken to.

LIFTING (Fig. 2.2.)
When a reversing sheave is used, the machine can be anchored to any fixed point away from the load, this is the most commonly used method.

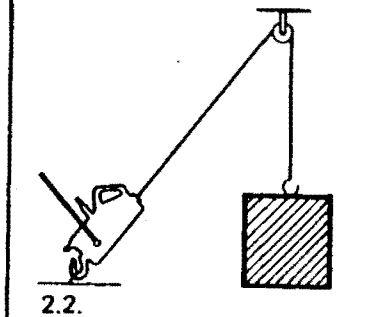
LIFTING (Fig. 2.3.)
Machine anchored above the load to be lifted.

LIFTING (Fig. 2.4.)
GRIPHOIST anchored directly to the load. In this case the wire rope remains static and the machine and load climb the wire rope.

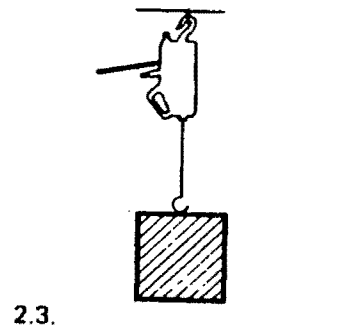
Fig. 2



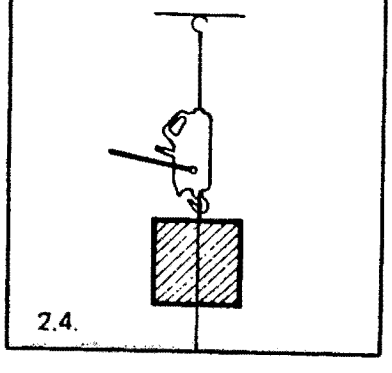
2.1.



2.2.



2.3.



2.4.

When preparing the machine observe following recommendations:

- make sure that the load on the machine will not exceed the rated capacity of the hoist;
- anchor with an independent sling so that the unit is in line with the load in the most advantageous working position;
- ensure that there is nothing to obstruct the free movement of the power stroke lever (2), the reversing lever (3) and the rope release lever (4);
- ensure that the rope exit is clear of obstruction or the wire rope will be forced back into the machine;
- to provide the extra "safety" – in addition to the safety factor inherent in our GRIPHOIST machines – we recommend the use of our BLOCSTOP safety device for all works imperilling human lives and where additional safety measures are required by the ruling safety regulations. It is the duty of the hoist owner and operator to obtain all pertinent Federal, State and local regulations and to use the equipment in compliance with them.

⚠ **Warning!** The hooks for the machine (on TU-17 & TU-28 models, Fig. 3) and the wire rope hooks (Fig. 4) are fitted with a safety latch to retain loose slings or devices under slack conditions. This latch is not intended to be anti-fouling device, so caution should be used to prevent it from supporting any of the load. Periodic inspection of the latch must be made to make sure it is not defective or missing. If it is replace it prior to use.

DO NOT OPERATE MACHINE IF IT IS FUNCTIONING IMPROPERLY.

Fig. 3

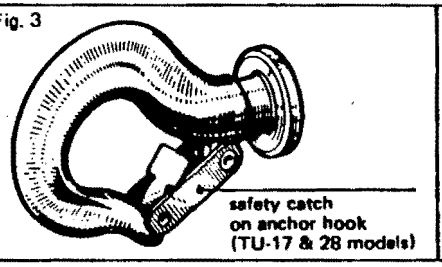
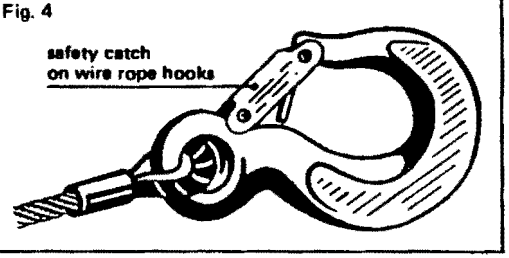


Fig. 4



3.3. Inserting the wire rope

- uncoil the wire rope in a straight line;
- open both jaws by operating the rope release lever (4); see instruction plate fixed to the machine;
- insert wire rope at rope entry (6), push until it comes out at the opposite side and pull all slack wire rope through machine by hand;
- to close jaws on wire rope, let rope release lever (4) return to its initial position (see instruction plate).

3.4. Working with the machine

Place the telescopic operating handle (8) on lever (2) for lifting or pulling, or on lever (3) for slacken or lower. Lock it into position by twisting, so that the handle will not fall off. Moving the handle to-and-fro will cause the wire rope to be moved towards the machine. The handle can be used fully opened or closed depending on the operator and load.

When it is left in any position, it will remain stationary.

If the pulling is very hard, the work should be stopped and the wire rope reeved through a snatch block (see page 6).

Never use another object to replace the telescopic operating handle.

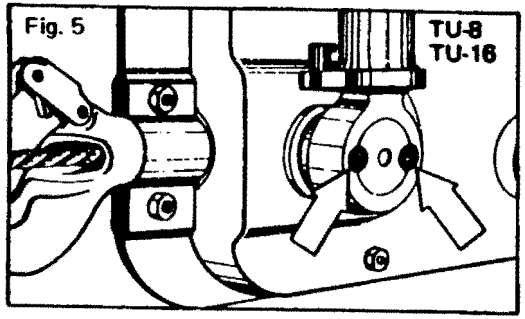
Never operate power stroke lever (2) and reversing lever (3) at the same time.

NEVER ATTEMPT TO MOTORIZE OR MECHANICALLY OPERATE A HOIST DESIGNED FOR MANUAL OPERATION.

3.5. Removing the wire rope

As the jaws are locked by the tension of the wire rope, the load must first be removed. Slacken the rope completely by lever (3). Open the jaws by opening rope release lever (4) – see instruction plate – and remove wire rope by hand.

Fig. 5



3.6. Overload Protection Device

On all GRIPHOIST machines the power stroke lever (2) is connected to the crankskaft by means of one or – depending from model – more shear pin(s) (Fig. 5, 6 & 7).

The diameter and the composition of these shear pins have been predetermined to shear in case of overload, which can be of 50 to 100 %, depending on working conditions.

This protects the machine from more serious and costly damage. Although sheared pins prevent further pulling or lifting, reverse action is still possible using reversing lever (3) to remove the load.

Spare shear pins will be found in the hollow of the power stroke lever (models TU-17 & TU-28), resp. of the rope release lever (models TU-32, T-508, T-516 & T-532). Just remove cap of the lever.

Broken shear pins can be replaced in a few minutes. Stop or lower the load, leave machine under light tension to facilitate the operation.

Fig. 6

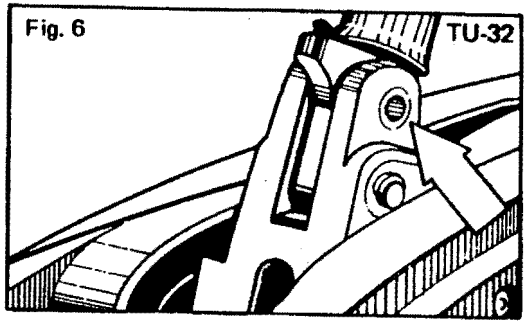
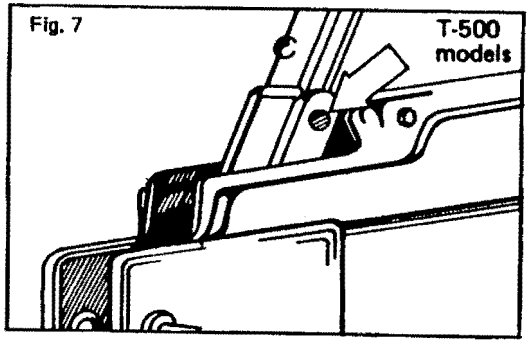


Fig. 7



3.6.1. Replacement of shear pin(s):

- GRIPHOIST TU-32 and all T-500 models:
  remove shear pin by means of a pin extractor. Align the power stroke lever (2) and drive in the new shear pin.
- GRIPHOIST TU-17 and TU-28:
  Use a gear puller to remove power stroke lever from crankshaft. When no gear available, it may be possible to remove the lever while machine is under tension, by using the telescopic operation handle – work back and forth to pull off power stroke lever.
  Remove broken pins, clear off the burr produced by shearing. Duly grease end of crankshaft, replace power stroke lever on crankshaft, and fix it by means of the new shear pins. Drive them in smoothly with a hammer, take care not to damage crankshaft.

The machine is again ready for use. Considering that the pin sheared because of overloading it is necessary to use one or several sheave blocks to increase the capacity of the machine (see 3.7., page 6), or reduce the load to finish work without further incident.

DO NOT USE THE SHEAR PIN(S) TO MEASURE THE MAXIMUM LOAD TO BE LIFTED. IT IS AN OVERLOAD PROTECTIVE DEVICE ONLY.

3.7. To increase the capacity of the GRIPHOIST

GRIPHOIST machines used in conjunction with **sheave blocks** will efficiently solve most of your pulling and lifting problems.

By using sheave blocks on the hauling rope, the nominal capacity of GRIPHOIST machines can be multiplied 2, 3 and even 4 times as shown in fig. 8.

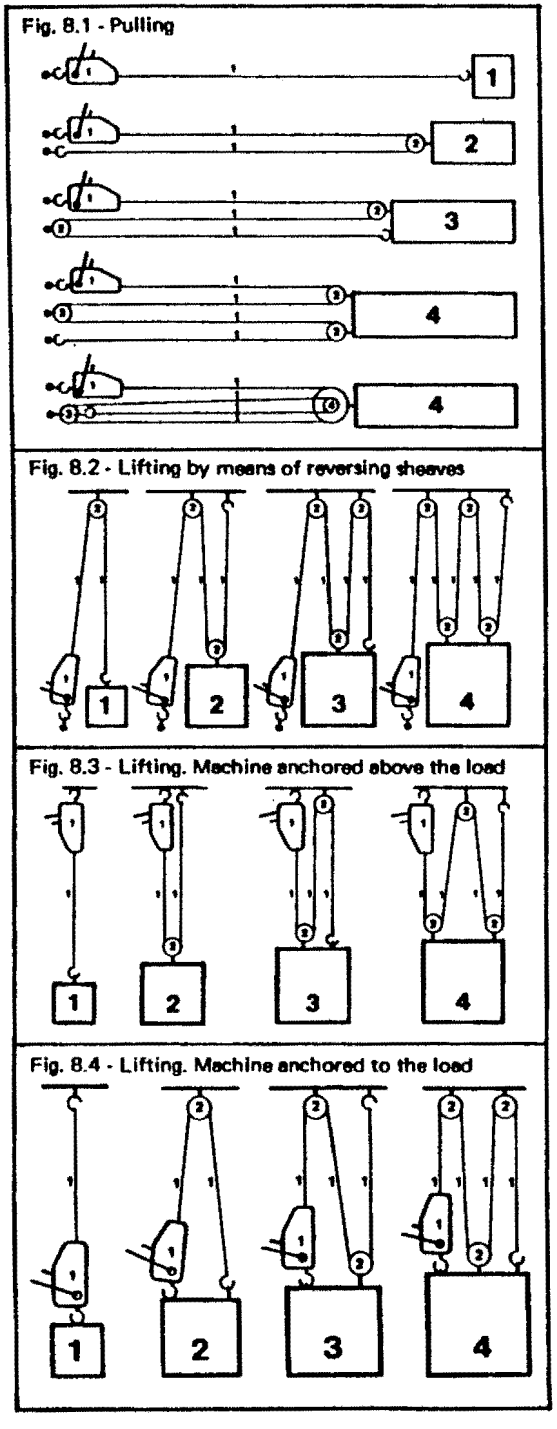
As a rule it is not difficult to figure the number of line parts to be used for a given load. It is however important, especially when there is a greater number of line parts, to take into consideration the friction in the sheaves, which can increase on the hoist and the top anchoring hook of the block.

For a specific lifting or pulling problem tables below allow one to rapidly determine the sheave block combination, which is the most appropriate to solve it.

3.7.1. Sheave block combinations

	TU-17 T-508	TU-28 T-516	TU-32 T-532
2,000	1	1	1
4,000	2	1	1
6,000	3	2	1
8,000	4	2	1
12,000	–	3	2
16,000	–	4	2
24,000	–	–	3
max. load lbs	sheave block combination no. (see fig. 8)		

Fig. 8 - Sheave block combinations



3.8. GRIPHOIST Wire Rope

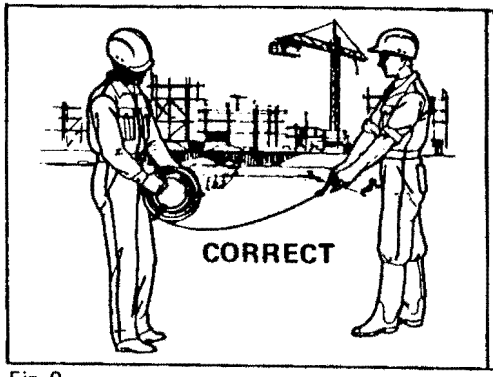


Fig. 9

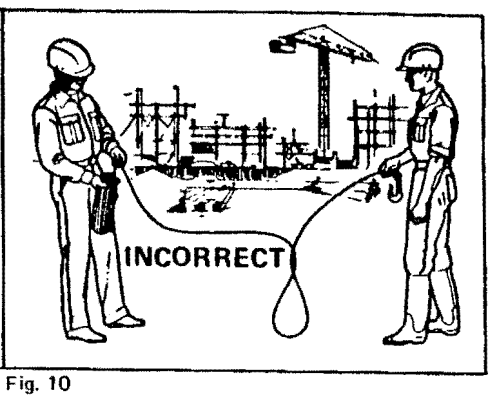
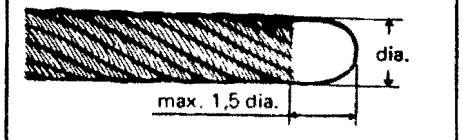


Fig. 10

The different GRIPHOIST wire ropes have been developed specially to meet the requirements of the machine. The rope tips should be welded round (Fig. 11).

Other wire ropes deform under pressure of the jaws, causing malfunction of the machines.

Fig. 11



For this reason use only the GRIPHOIST wire rope, which can alone ensure proper working of your machine.

- the wire rope should be reeled and unreeled in a straight line (Fig. 9) to prevent loops and kinks (Fig. 10). Kinked wire rope will not work in the GRIPHOIST machine. For this reason never use the rope as a sling; always use a separate wire rope or chain sling;
- be sure that the wire rope is wiped clean before inserting it into the machine. For longer life and better performance the wire rope should be oiled well from time to time;
- the wire rope outlet of the machine should not be obstructed. The rope must be able to pass freely to prevent it being forced back into the unit;
- never kink the wire rope by bending over sharp edges;
- never use wire rope that has been subject to damage such as fire, corrosive chemicals or atmosphere or exposed to electric current, etc. . .
- to avoid unlaying the strands, never allow a loaded rope to rotate.

CAUTION:

THE MANUFACTURER DECLINES ALL RESPONSIBILITY FOR MACHINES USED WITH A WIRE ROPE OTHER THAN GRIPHOIST WIRE ROPE.

I. MAINTENANCE AND LUBRICATION

I.1. GRIPHOIST Machine

Maintenance and lubrication are the best guarantees for the good working of GRIPHOIST machines. Conduct periodic visual inspections and make sure necessary lubrication and repairs are made.

Although the steel casing provides good protection, dust and dirt can penetrate into the mechanism through the top opening of the casing, as well as through the guide holes of the wire rope. The machine should therefore never be left lying about in mud and the wire rope should be cleaned before it is introduced into the machine.

I.1.1. General Maintenance Cleaning

Dip machine into a mineral spirits degreasing solution that will not attack nylon. Shake well to dislodge foreign matters and turn quickly upside down to remove them. To lubricate squirt lube oil through top opening into the internal mechanism in the direction of the jaws.

I.1.2. Very dirty machine

Considering that a certain number of precautions have to be taken for dismantling and reassembling, it is recommended to always take it to a repair shop agreed to by the manufacturer for overhaul of your GRIPHOIST machine.

I.1.3. Lubrication

For normal lubrication, squirt SAE 90 to 120 motor oil through the apertures in the casing. To allow lubricant to penetrate to all the parts of the mechanism, alternately operate power stroke lever and reversing lever.

An excess of lubrication will not cause the wire rope to slip. Lack of lubrication, is the greatest cause of malfunction, because it causes wear or jamming of bearings.

I.2. Wire Rope

Use only wire rope furnished by GRIPHOIST. Periodically clean and oil it with a rag impregnated with motor oil SAE 10 W 40.

Wire rope must be replaced, if any of the following conditions are noted:

- broken wires or strands,
- kinking, crushing, birdcaging, or any other distorsion of the wire rope structure,
- excessive corrosion,
- heat damage, evident through discolored wires,
- reduction from nominal diameter of more than 10 %.

I.2.1. How to measure wire rope

The correct diameter of the wire rope is the diameter of a circumscribed circle, which will enclose all strands. It is the largest cross-sectional measurement as illustrated in Fig. 12. The measurement should be made carefully with calipers. The illustration shows also the correct and incorrect method of measuring the wire rope diameter.

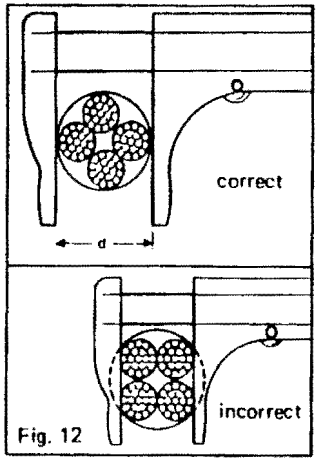


Fig. 12

REPLACEMENT WIRE ROPE MUST BE THE SAME SIZE, GRADE, AND CONSTRUCTION AS THE GRIPHOIST SPECIFIED WIRE ROPE FOR THE HOIST IN USE! THE MANUFACTURER DECLINES ALL RESPONSIBILITY FOR MACHINES USED WITH OTHER NONSPECIFIED WIRE ROPE.

P/855
008400915

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SCAFFOLD INDUSTRY ASSOCIATION, INC.

CODE OF SAFE PRACTICES
FOR

SUSPENDED POWERED SCAFFOLDS

It shall be the responsibility of all employees and users to read and comply with the following common sense rules which are designed to promote safety in the erection and use of suspended powered scaffolds. These rules do not purport to be all inclusive nor to supplant or replace other additional safety and precautionary measures to cover usual or unusual conditions. If these rules conflict in any way with any state, local or federal statute or regulation, said statute or regulation shall supersede these rules and it shall be the responsibility of each employee and user to comply therewith.

A. GENERAL RULES:

1. **POST THESE SAFETY RULES** at every job site in a conspicuous place and make certain that all persons who will erect, use, relocate, or dismantle suspended systems are fully aware of them and other governing codes.
2. **READ, UNDERSTAND AND FOLLOW THESE RULES** and manufacturers' instructions located in manuals supplied with and on plates posted on scaffolding equipment.
3. **CONSULT YOUR SUSPENDED POWER SCAFFOLD EQUIPMENT SUPPLIER** when in doubt.
4. **OPERATE SAFELY – NEVER TAKE CHANCES.**

B. EQUIPMENT:

1. Use only suspended scaffolding system and personal safety equipment designed for the specific job operation.
2. Use equipment only in manner specified by equipment manufacturers.
3. Never use equipment that does not function properly.
4. Clean and maintain equipment as specified by equipment manufacturer. Contact supplier for required service.
5. Never alter, remove or substitute components of a scaffold system.
6. Make sure that platforms have toeboards, rails and other enclosure items which meet governing requirements, and are properly installed and secured.

C. INSPECTION:

1. Inspect all suspension and operators' safety equipment, before installation, each day before use and after moving to new drop location, for damage and that it meets manufacturer's operational performance and safety standards.
2. Inspect wire rope each ascent and descent to insure that it has not been damaged.

D. INSTALLATION:

1. Safe rigging installation is your responsibility.
2. Roof irons, hooks, parapet clamps, outrigger beams, or other rope supporting devices shall be capable of carrying the maximum applied loads with a safety factor of not less than 4:1. The strength of the building or structure to which such equipment is to be attached or on which it will rest, must be verified by a competent person prior to installation.
3. Tiebacks having strength equivalent to the hoisting ropes shall be installed without slack at right angles to the building and be firmly secured to a structurally sound portion of the structure. This structure shall have the capability of supporting the maximum suspended load with a safety factor of not less than 4:1. In the event that the tieback cannot be installed at right angles to the structure face, two tiebacks, without slack, shall be attached to each rope supporting device to prevent movement in any direction.
4. When outrigger beams are used for rope support, the inner end shall be restrained against vertical movement so that the beam is capable of supporting safely the maximum applied rope load with a safety factor of not less than 4:1. If counter-weights are used for beam restraint, they shall be of a non-flowable material, shall carry a weight value and be securely fastened to the beam.
5. When using traction type hoisting machines make sure that the wire rope is long enough to reach from the highest point of support to the lowest point of building structure plus rigging reeving lengths as defined in the hoisting machine manufacturer's instructions.
6. When using drum wrapping hoisting machines make sure that at least four wraps remain on the drum at the lowest point of descent, and the end of the rope is securely attached to the drum.
7. On two point suspension scaffolds make sure that the stirrups are directly under the suspension points.

E. WIRE ROPE:

1. Use only the wire rope and fittings specified by the hoisting machine manufacturer.
2. Use the number of wire rope clamps and tighten clamps in accordance with hoisting machine manufacturer's instructions. Before commencing work operations, preload wire rope with maximum work load, then retighten clamps to manufacturer's torque specifications. Check clamp tightening daily.
3. Inspect wire rope for damage daily. Do not use kinked, bird-caged, corroded, undersize, or damaged wire rope.
4. Clean and lubricate wire rope in accordance with manufacturer's instructions.
5. Handle wire rope with care – coil and uncoil properly. Do not drop coiled or uncoiled wire rope on ground from any height.
6. Do not expose wire rope to fire, undue heat, corrosive atmosphere or chemicals, to passage of electrical currents.
7. When welding on suspended scaffolds protect the wire rope from the welding torch or electrode. Make sure the platform is grounded and stray electrical currents cannot pass thru the suspension rope to ground thru the upper rope support or by contact of the rope with building structure or the ground.

F. SAFETY:

1. Always use safety belts attached by shortest effective lanyards and rope grabbing device to lifeline rigged to a separate building support point capable of carrying loads defined in governing regulations.
2. When working or riding on suspended scaffolds maintain the lanyard attachment to the lifeline at the highest point compatible with work movement.
3. The weight of men, work materials and components mounted on the scaffold must not exceed the manufacturer's rated loads.
4. Two or more scaffolds must not be combined into one by lapping platforms on one stirrup.
5. Do not overload the support rope.

Form No. 01045
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Timber Cribbing

Cribbing is an essential tool during rescue operations. In fact, cribbing is one of the most frequently used tools during rescue operations, and considered to be among the strongest means of support. Gravity is inescapable, thus cribbing is used to transfer the weight of a load into a „footprint". Cribbing provides a simple *temporary* support during rescue operations. In order to correctly and effectively transfer weight from top to bottom, full and direct contact must be made with both the load and lower surface. Rescuers should begin with a solid base of support, especially in soft surfaces such as mud, sand, snow, etc. This substantial base of support will assist in effective weight transfer, and should be level or nearly so if at all possible. Make an attempt to keep all cribbing plumb and level to provide greater stability. Remember, stabilization is a dynamic process frequently needing inspection to ascertain its effectiveness. **Three smart cribbing considerations are: 1. Avoid the area of danger, i.e. remain clear of the load's footprint, 2. Mitigate the hazard if possible, i.e. uprighting a heavy vehicle off a smaller vehicle, and 3. Crib or shore from a safe into an unsafe area.** Always place cribbing/shoring in a manner that provides both responder and patient egress! Prior to cribbing/shoring, rescuers should ask three questions, 1. Are the needed materials readily available, 2. Are the tools needed readily available, and 3. Are the rescuers trained and possess the expertise to perform the needed operations?

Wooden cribbing pieces seem to be the most commonly used, with softwood a popular choice. However, hardwood and softwood generally refer to the type of tree producing the wood and not the strength of the wood itself. Hardwood trees shed their leaves in the fall, while softwood trees retain their leaves/needles consistently. Softwoods most frequently used are Southern Yellow Pine and Douglas Fir, although other species are also used. Always attempt to obtain and use #1 Grade timber for cribbing/shoring. Advantages of softwood cribbing pieces include being lighter in weight compared to hardwood, and most importantly providing warnings of failure. These warnings include visible cracking or splitting of the wood, and sounds produced by such cracking. Generally the signs of failure begin near the ends of the timber piece as „checks" and „splits". Checks are separations in wood transecting the annular growth rings, while splits occur when wood cells tear apart, parallel to the grain of the wood. The properties of wood allowing the noticeable signs of failure result from the two primary growing season"s, spring and summer. Spring growth produces softer fibers while summer growth produces harder fibers. The softer fibers of spring growth produce the noise of cracking and the evident physical cracks during crossgrain loading. When building stack cribbing the load is perpendicular to the wood grain producing slow, noisy, and visible warnings of failure. This compression stress actually crushes a timber piece. Timber pieces with greater strength values in perpendicular compression (stated in psi) are better suited for wedges and bearing timbers (cribbing). Axial loading such as in shoring operations relies upon buckling failure. Greater strength in compression parallel to the grain is better suited for columns such as used in shoring.

In some instances, fifty pieces or more may be needed to stabilize an upright school bus. If your primary response vehicle doesn't carry this amount, is it easily obtainable? Preplanning for the need of cribbing is fundamental for heavy rescue. How can your agency obtain the needed timber 24/7/365? If not readily available, consider establishing a quantity to be stored at your agency. Pack this cribbing according to dimension or primary purpose into open mesh crates. These crates can be easily handled. Consider storing a hand truck with the cribbing to transport a large quantity quickly using minimal personnel.

Wooden cribbing should be left unfinished and unpainted. Cribbing pieces rely on gravity and friction between bearing points for stability. Painted surfaces become slippery when wet and may hide damage or defects of the pieces. The ends of cribbing may be painted or labeled to identify various types and sizes as well.

Cribbing should be inspected frequently for physical and chemical damage, or other deterioration. Cracks are obviously indicative of physical damage. Moisture is a bitter enemy of cribbing. Store it in a clean, dry and ventilated area with room for air movement among pieces if possible. If cribbing is found to be damaged it should be removed from service, and not used for training.

Varied lengths of cribbing may be used, however an accepted value is that the height of a stack crib **shouldn't exceed three times its width (footprint), provided all contact points are covered**. For example, if the footprint of a stack crib is 18" (calculated using 26" timber pieces, and allowing 8" of overlap measurement), the height shouldn"t exceed 54" (3:1). Therefore rescuers may gain insight into cribbing length based upon this value, especially if considerable height is anticipated. Although shorter lengths are most commonly used, longer cribbing pieces such as 4", 6", and 8" should be in a timber cribbing inventory.

The 2 x 2-construction method of building a stack crib uses two pieces of cribbing per layer, each layer at right angles.

3 x 3 construction method

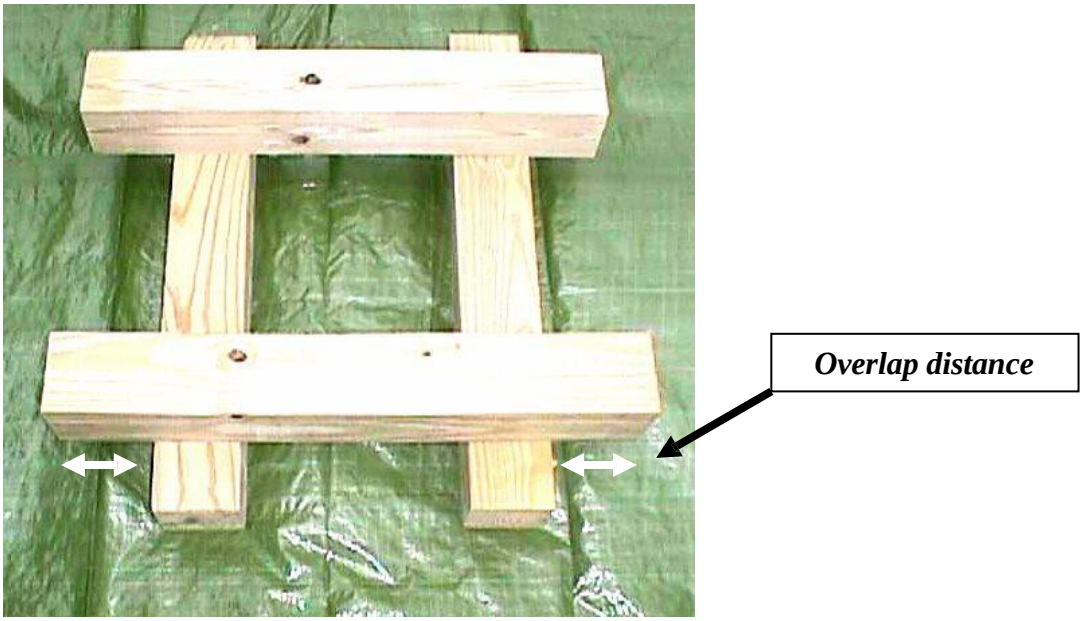
The 3 x 3 construction method uses three pieces per layer, each layer at right angles.

Using the 2 x 2 construction method with 4" x 4" timbers the weight bearing capacity of the stack crib is 24,000 pounds, 6,000 pounds per column (12 tons total), <u>if all four contact points are covered</u>. The weight bearing capacity would increase to 55,000 pounds, 6,111.1 pounds per column (27.5 tons total) if the 3 x 3-construction method was used and <u>all nine contact points were covered</u>. The 3 x 3 construction method increases the weight bearing capacity, however only uses 50% more cribbing pieces. The weight bearing capacity of a stack crib is calculated by the maximum perpendicular load to the grain (stated in psi) as accepted by structural engineers on the sum of all bearing points. It is important that stack cribbing be centered under the load if possible, maintaining majority of the load in the center 1/3 of the stack crib. Do not use the 2x2 construction method when using stack cribbing as a platform for air bag lifting systems, <u>*unless*</u> the top tier of cribbing is completely solid and capable of supporting the force imposed by the air bag as it lifts the load. Ideally the solid top tier of cribbing pieces is connected together by some means to prevent unwanted movement, i.e.

„scabs“. High pressure air bag lifting systems tend to inflate from the center outward and may dislodge a stack crib resulting in catastrophic failure during a lifting operation.

Using 6” x 6” timbers and the 2 x 2 construction method the weight bearing capacity is 60,000 pounds, 15,000 pounds per column (30 tons total). The weight bearing capacity would increase to 136,000 pounds, 15,111 pounds per column (68 tons total) if the 3 x 3- construction method were used. These capacities are valid if the load covers all contact points. The formula to calculate weight sustaining capacity *per column* is: Total surface (in square inches) of cribbing piece multiplied by the compression strength perpendicular to the grain (stated as psi).

The weight bearing capacity values expressed within this document are based on the use of undamaged #1 Grade Southern Yellow Pine or Douglas Fir, and accepted by FEMA for USAR response. It is vitally important for responders to determine specifically what the strength of their respective cribbing pieces are using accepted engineering values. There is no strength loss for treated vs. untreated wood provided the moisture content is less than 19%. Cribbing pieces should be of #1 Grade, which provides greater strength and better cosmetic appearance.

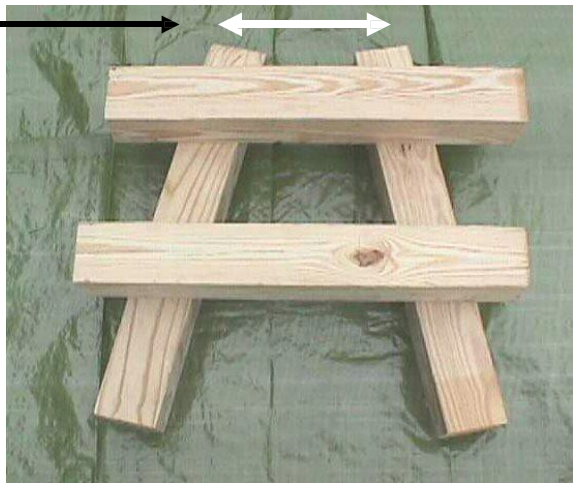


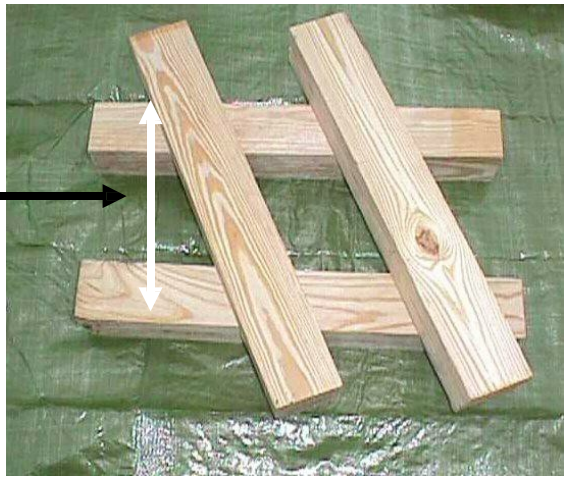
The ends of cribbing pieces should overlap the preceding layer by the width of that particular piece for two primary reasons, 1. Should the cribbing pieces slip minimally, some degree of integrity is maintained, and 2. Failure will begin at the ends of the cribbing pieces, showing warning signs of deteriorating integrity. For example, when using 4” timber the ends of each layer should overlap a minimum of 4”.

Rescue situations may dictate that cribbing pieces be placed in shapes other than a square. When other than a square shape is used the footprint will vary. Thus, the safe column height will vary.

Triangle shape of cribbing placement

Footprint



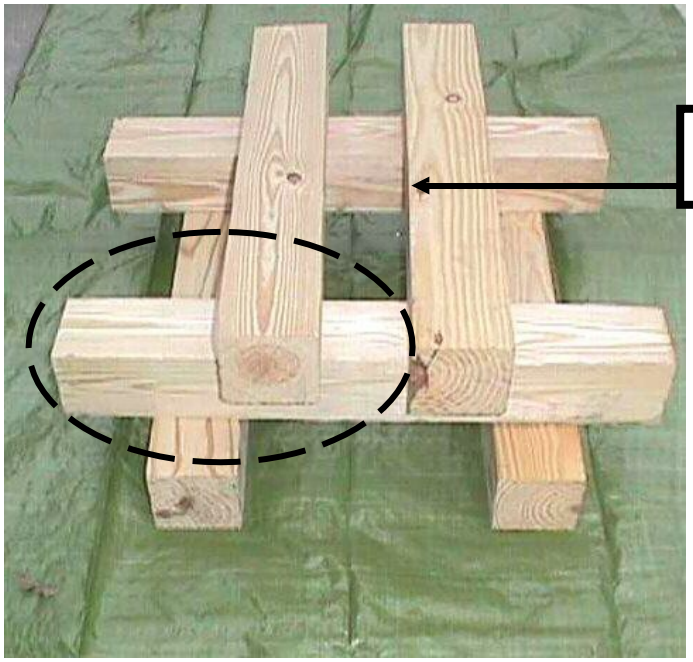


Parallelogram shape of cribbing placement

Footprint

If the square shape of a cribbing stack is modified, the safe height of the stack is limited to one times the footprint (1:1). For example, if the footprint of modified stack cribbing is 12”, the safe height of the column is limited to 12”.

Stack cribbing should form columns, which support the load. The pieces should be aligned vertically to form such a column and provide the required strength.

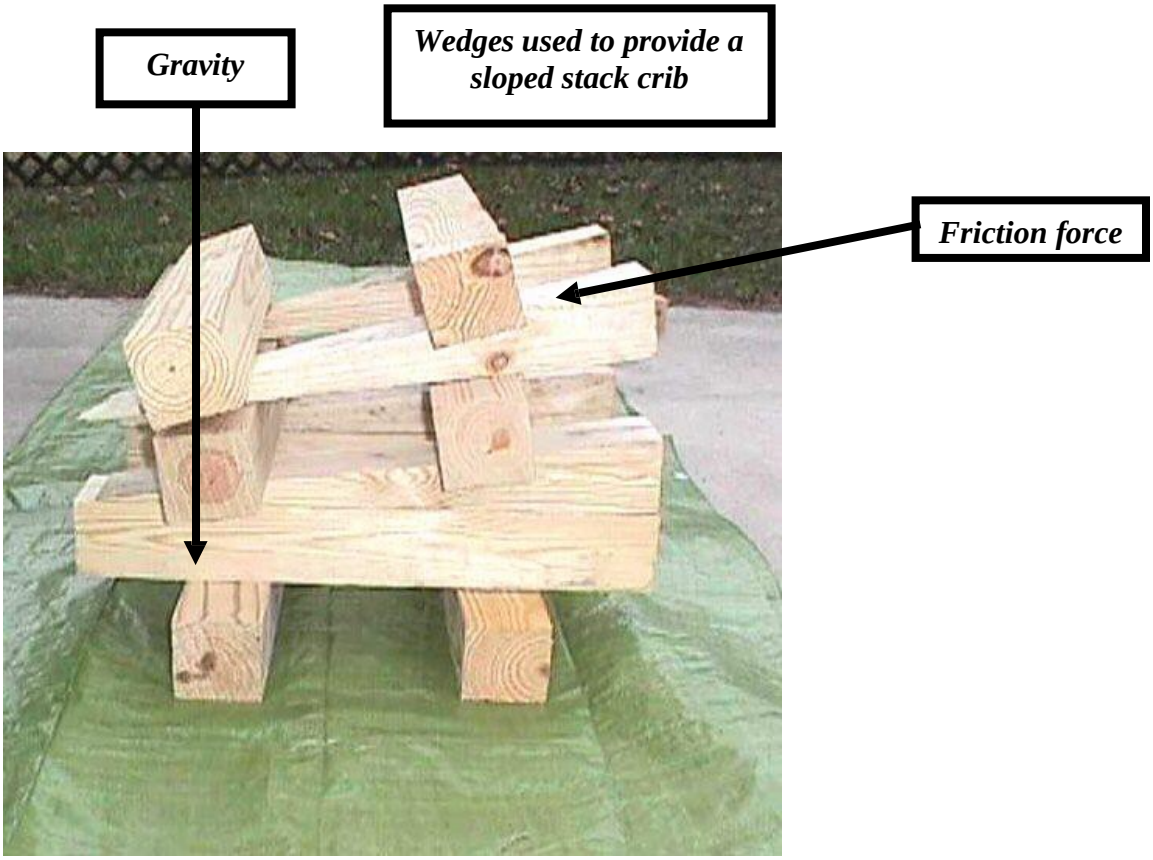


If all contact points of a stack crib aren‟t covered, the safe and stable height of the stack will be affected. Using 2 x 2 construction, if three of the contact points are covered, the safe and stable height for the stack crib is 2 times the footprint (2:1). If two of the contact points are covered, the safe and stable height of the stack crib is 1.5 times the footprint (1.5:1). If only one contact point is covered the safe and stable height for the stack crib is 1 times the footprint (1:1).

The weight bearing capacity of the stack crib will vary also if all contact points aren‟t covered. Rescuers can estimate 6,000 pounds of weight bearing capacity per contact point when using 4” x 4” timber. If 6” x 6” timber is used the weight bearing capacity per contact point is 15,000 pounds.

Wedges are be used to fill voids between the load and cribbing pieces, and should be the same width, preferably the same length as the cribbing pieces themselves. If 4” timber cribbing pieces are being used, the wedge should be 4” in width. The length of a wedge shouldn‟t exceed six times its width, i.e. 4” timber cribbing pieces are being used, thus a 24” wedge is the maximum size that should be used (6 x 4= 24). Proper placement of wedges serves to transmit the load into a column, with no more than two wedges stacked upon one another. Stacking more than two wedges upon one another will likely produce instability with the middle wedge becoming dislodged. Wedges can also be used to change the vertical direction of the stack crib allowing rescuers to support a sloped load. Sloped loads have two primary forces acting upon them, gravity and friction. Gravity produces a vertical load force while friction produces a load acting downslope. Friction is the resistance encountered when two solid surfaces slide or tend to slip. The degree of surface roughness has an influence on the Coefficient of Friction (the measurement of friction). When a surface is soft and coarse, greater frictional resistance is produced. The Coefficient of Friction is expressed as an angle, or its decimal equivalent, i.e. 15 degrees=.27. Stack cribbing generally may be used to a height of less than 3‟ against a

sloped surface with an angle less the 15 degrees (30%). Small protractors are useful in determining angles. When building a stack crib into a sloping surface the height of the cribbing shouldn‟t exceed 1.5 times the footprint, or instability may result. Optimally the stack crib should be constructed plumb and level with wedges used upon the top tier, or underneath the bottom tier to produce stability. Sloped surfaces may alter the direction of downward force upon the stack crib, necessitating frequent monitoring of stability.



When placing cribbing pieces, **never** put a part of your body between the load and the cribbing. Use a tool or another piece of cribbing to maneuver it into place. During cribbing operations the use of personal protective equipment is necessary to ensure safety.

Cribbing is an essential rescue tool, often supporting tremendous weight while rescuers operate underneath. It is necessary that all rescuers understand the safe and proper use of this vital tool.

TIMBER CRIBBING OPERATIONS REFERENCE INFORMATION

Billy Leach, Jr.

Weight Bearing Capacity/Stack Cribbing Height (All contact points covered)

Timber Size	Construction Method	Weight Bearing Capacity	Stack Cribbing Height
4” x 4”	2 x 2	24,000#	3x footprint
4” x 4”	3 x 3	55,000#	3x footprint
6” x 6”	2 x 2	60,000#	3x footprint
6” x 6”	3 x 3	136,000#	3x footprint

Weight Bearing Capacity/Stack Cribbing Height (Less than 4 contact points)

Timber Size	Contact Points	Weight Bearing Capacity	Stack Cribbing Height
4” x 4”	3	18,000#	2x footprint
4” x 4”	2	12,000#	1.5x footprint
4” x 4”	1	6,000#	1x footprint
6” x 6”	3	45,000#	2x footprint
6” x 6”	2	30,000#	1.5x footprint
6” x 6”	1	15,000#	1x footprint

Configurations other than square stack crib are 1x footprint

Cribbing of sloped surfaces are 1.5x footprint

FEMA published capacity **of timber cribbing using 4”x4” *Southern Yellow Pine* pieces (inclusive of 2:1 safety factor) in 2x2 configuration.**

PARATECH®

OPERATION, PREVENTIVE MAINTENANCE AND PARTS SUPPORT MANUAL

FOR

MAXIFORCE AIR LIFTING BAG SYSTEMS

23 APRIL 2012

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CHAPTER 1
GENERAL INFORMATION

1-1 **SAFETY PRECAUTIONS.**

Refer to the Safety First procedures preceding Chapter 1, General Information and Safety Precautions for the procedures to be observed to assure safe and efficient utilization of MAXIFORCE® Air Lifting Bag Systems.

1-2 **SCOPE OF MANUAL.**

This technical manual provides instructions for the operation, preventive maintenance and parts support for MAXIFORCE Air Lifting Bag Systems manufactured by Paratech Incorporated, 1025 Lambrecht Road, Frankfort, Illinois 60423-7000.

1-3 **ARRANGEMENT.**

Refer to the Table of Contents for arrangement of the subject matter in this manual.

1-4 **EQUIPMENT FUNCTION .**

1-4.1. MAXIFORCE Air Lifting Bag Systems are multi-application, portable inflation systems used for lift and displacement of heavy rigid objects, up to 146,000 pounds (66,637 kilograms), while requiring less than 1 inch (2.5 centimeters) of bag insertion clearance. Total capable lift (utilizing two stacked lift bags) is 40 inches (100 centimeters). Inflation may be obtained from any air source (self-contained compressed air cylinder, air compressor, truck air brake system, building compressed air system, foot pump, etc.) capable of supplying 118 psi (8.1 Bar) pressure.

1-4.2 MAXIFORCE Air Lifting Bag Systems are designed for use in emergency situations such as building collapse, structural containment, vehicular extrications, industrial entrapment, and excavation collapse and containment.

1-4.3 In addition to use during emergency situations, MAXIFORCE Air Lifting Bag Systems are also effectively used for:

a. Preventive and/or corrective maintenance procedures where positioning and aligning heavy equipment and machinery in mills, manufacturing facilities and maintenance shops is required such as removing wheels, pulleys and gears from large machinery.

b. Lifting or shifting pipelines requiring welding and maintenance.

c. Breaking out granite and marble blocks and slabs in quarrying operations.

d. Re-railing railroad and mining cars, pre-stressing support columns, general maintenance requiring lifting in rail, mining, underground and subway work.

e. Lifting operations underwater or on unstable, soft ground (mud, sand, snow, strewn debris, etc.) where conventional jacking equipment tends to sink.

f. Since the lift bags contain no spark producing parts, they may also be used safely in explosive environments.

1-5 **INTERRELATIONSHIP OF COMPONENTS.**

Refer to figure 1-1 for the interrelationship of the six basic components (air source, pressure regulator, controller, safety in-line relief valve, interconnecting hose, and lift bag) comprising MAXIFORCE Air Lifting Bag Systems and their relative sizes.

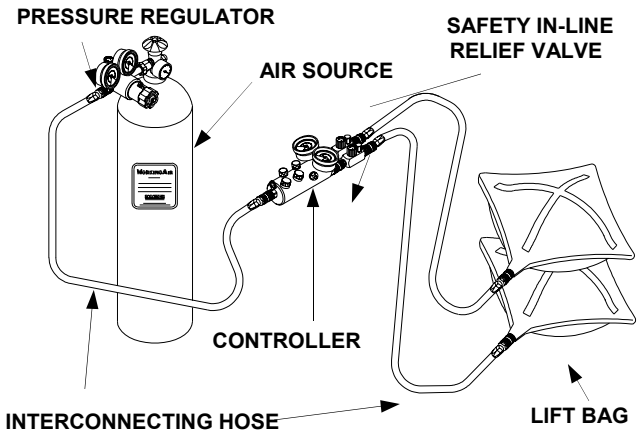


Figure 1-1. Typical MAXIFORCE Air Lifting Bag System

1-6 **EQUIPMENT DESCRIPTION.**

1-6.1 LIFT BAG**S.** MAXIFORCE Lift Bags (figure 1-2) are composite items fabricated from neoprene, reinforced with six layers (three per side) of Kevlar reinforced fabric for strength and rigidity even at full inflation pressure of 118 psi (8.1 Bar). All Lift Bags incorporate non-slip molded surfaces designed for maximum friction and holding capability. A bright yellow "X" is molded into each side to provide high visibility during pre-inflation centering. Each Lift Bag is proof tested at twice the operating (full inflation) pressure and has a minimum burst pressure of four times the operating (118 psi (8.1 Bar) pressure. Refer to Table 1-1 for a summary of the technical data for each MAXIFORCE Lift Bag.

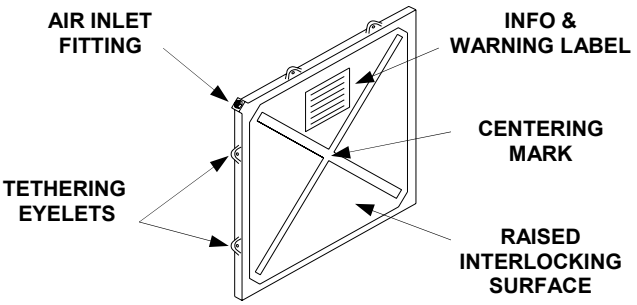


Figure 1-2. Typical MAXIFORCE Lift Bag

1-6.2 **PRESSURE REGULATORS.** Two pressure regulators are available for use with MAXIFORCE Air Lifting Bag Systems.

a. A piston type high pressure regulator (figure 1-3) that reduces inlet pressure of up to 6,000 psi (414 Bar) to 135 psi (9.3 Bar). The pressure regulator is designed to mate with a CGA-346/347 adapter fitting.

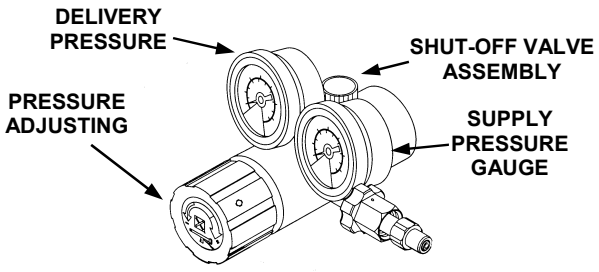


Figure 1-3. Piston Type High Pressure Regulator

b. A diaphragm type standard pressure regulator (figure 1-4) that reduces inlet pressure of up to 3,000 psi (206.8 Bar) to 135 psi (9.3 Bar). The pressure regulator is designed to mate with a CGA-346 adapter fitting.

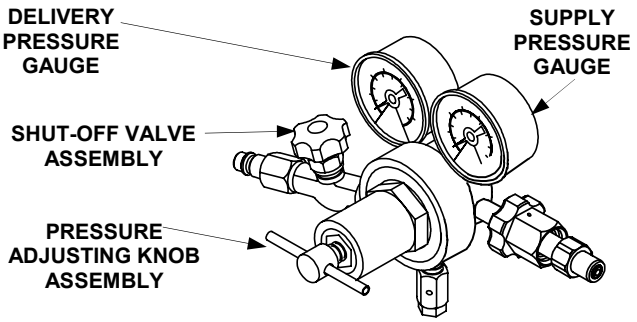


Figure 1-4 Diaphragm Type Pressure Regulator

Each pressure regulator is a self-contained, direct-acting, pressure-reducing type utilizing spring-loading to balance the outlet pressure and thereby reduce the effect of decaying or variations in the inlet pressure. The regulators are designed primarily for use with a SCBA (self-contained breathing apparatus) air cylinder or a SCUBA (self-contained underwater breathing apparatus; adapter required) air cylinder. However, a CGA-580 nitrogen cylinder adapter is available as optional equipment. The standard nipple and knob assembly may also be replaced to permit an optional DIN nipple and nut assembly or a British nipple and knob assembly to be installed in order to interface the pressure regulators with alternate breathing air cylinders.

Each pressure regulator incorporates a piston or diaphragm sensor and soft seated main valve to provide bubble tight service. The adjusting mechanism on the piston regulator, activated by a pressure adjusting knob, incorporates a high load thrust bearing to provide the desired setting sensitivity while maintaining a low operating torque.

The pressure regulators will operate with any breathing air. When using any gaseous media, it is necessary to remove moisture to prevent "icing"; a condition that occurs at high expansion ratios during regulator operation. A 10 micron internal filter is incorporated in the pressure regulator. However, if excessive contamination is a problem, a slightly coarser filter with increased capacity may be installed on the supply side of the pressure regulator.

1-6.3 **CONTROLLERS (SAFETY RELIEF AND CONTROL VALVE).** Four controllers are available for use with MAXIFORCE Air Lifting Bag Systems.

a. The single safety relief and control valve (figure 1-5) is a single input/single output controller incorporating quick disconnect hose fittings and single knob controls to apply and release air pressure to one lift bag. A gauge is provided to monitor the air pressure applied to the lift bag and a 118 psi (8.1 Bar) relief valve is incorporated to limit the applied air pressure. Inflation and deflation is accomplished by turning the associated valve knob.

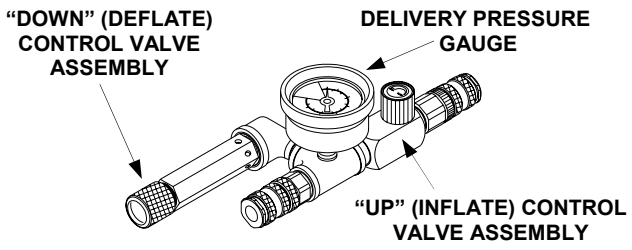


Figure 1-5. Single Safety Relief and Control Valve

b. The dual safety relief and control valve (figure 1-6) is a single input/dual output controller incorporating quick disconnect hose fittings and dual knob controls to apply and release air pressure to either one or two lift bags. Two gauges are provided to monitor the air pressure applied to either one or two bag(s) and a 118 psi (8.1 Bar) relief valve is incorporated to limit the applied air pressure. Inflation and deflation is accomplished by turning the associated valve knob.

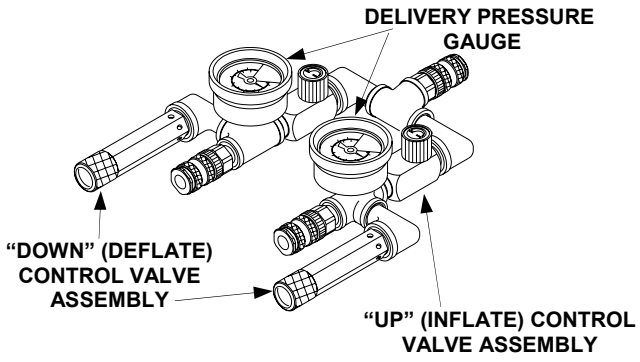


Figure 1-6. Dual Safety Relief and Control Valve

c. The single safety relief and control valve with bypass (figure 1-7) is a single input/single output controller incorporating quick disconnect hose fittings and single push-button controls to apply and release air pressure to a single lift bag. One gauge is provided to monitor the air pressure applied to the lift bag(s) and a 118 psi (8.1 Bar) relief valve is incorporated to limit the applied air pressure. Inflation and deflation is accomplished by depressing the associated valve spring loaded push-button. The bypass, located between the inflation and deflation valves, is used to "bypass" the inflation valve. This allows a continuous flow of air supply to a lift bag without having the operator manually keep the inflation valve open by constantly depressing the inflation valve. The use of the bypass compensates for any pressure drop inside of the lift bag that can be caused by a shifting load, undetected air leaks, etc... It is activated by turning the bypass knob counter-clockwise.

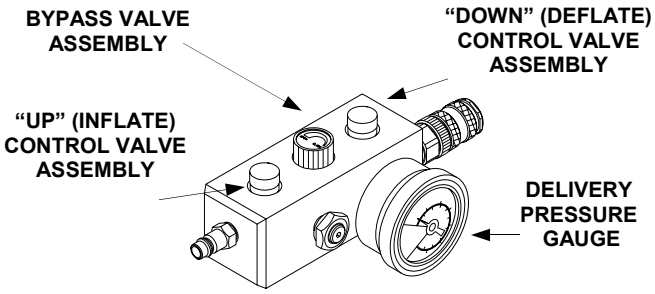


Figure 1-7. Single Push-button Safety Relief and Control Valve with Bypass

d. The dual "deadman" safety relief and control valve (figure 1-8) is a single input/dual output controller incorporating quick disconnect hose fittings and dual push-button controls to apply and release air pressure to either one or two lift bags. Two gauges are provided to monitor the air pressure applied to either one or two bag(s) and a 118 psi (8.1 Bar) relief valve is incorporated to limit the applied air pressure. Inflation and deflation is accomplished by depressing the associated valve spring loaded push-button.

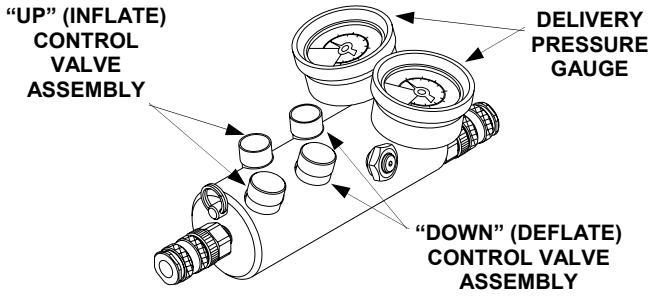


Figure 1-8. Dual "Deadman" Safety Relief and Control Valve

1-6.4 **HOSES.** Hoses are used to convey air from the air supply source to the lift bag(s). All hoses are equipped with dual locking quick disconnect fittings to prevent their accidental disconnection. All hoses are general purpose 3/8 inch inside diameter, pvc (vinyl) core, single spiral poly yarn braid reinforced and a pvc abrasion resistant cover. The service temperature range is -15°F to +150°F (-25°C to +65°C). All hoses have a working pressure of 300 psi (20.7 bar) with a 4 : 1 safety factor. Available hose lengths are 16 foot (5 meter), 32 foot (10 meter) and 50 foot (15 meter). Available colors in all lengths are red, yellow, blue, green, gray and black .

1-6.5 **SAFETY IN-LINE RELIEF VALVE.** The safety in-line relief valve (figure 1-9) is designed to keep MAXIFORCE lift bags fully and properly inflated when the lift bag(s) are; 1. Disconnected from the controller (safety relief and control valve) and 2. When excess pressure must be automatically relieved due to shifting

loads and/or temperature changes. The safety in-line relief valve consists essentially of an air inlet and air outlet (with safety locking ring) quick disconnect fitting, a shut-off valve to isolate the associated lift bag and an internal, non-adjustable spring loaded mechanism designed to relieve lift bag pressures in excess of 135 psi.

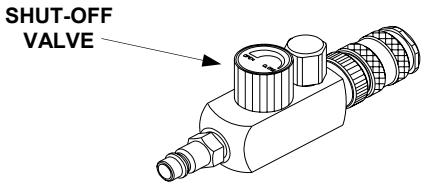


Figure 1-9. Safety In-Line Relief Valve

1-6.6 **FITTINGS.** A variety of adapters, couplings and air fittings are available to permit alternate air sources to inflate the MAXIFORCE lift bag(s) or enable various air-powered tools and accessories to be equipped with the same fittings permitting convenience of operation and/or combining equipment resources such as hoses, regulators, self-contained compressed air cylinders, etc.

1-7 **REFERENCE DATA**. Reference data pertaining to MAXIFORCE Lift bags and Lift bag System Components are summarized for quick reference in Tables 1-1 and 1.2.

1-8 **EQUIPMENT, ACCESSORIES AND DOCUMENTS**

1-8.1 **EQUIPMENT SUPPLIED.** Data pertaining to the dimensions and weight of MAXIFORCE Lift Bags are presented in Table 1-2.

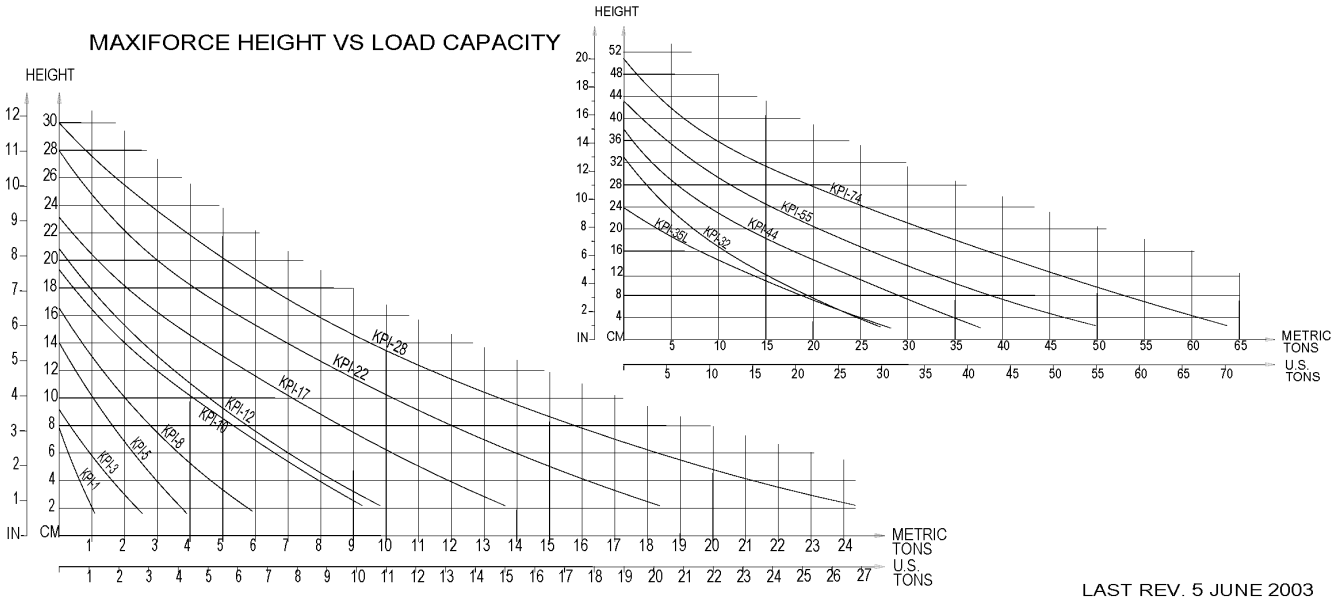
1-8.2 **ACCESSORIES.** Accessories used in conjunction with MAXIFORCE Lift Bag Systems are listed with sufficient descriptive information regarding their use and application in Chapter 4, Parts List.

1-8.3 **DOCUMENTS.** No documents other than this publication are required as supporting literature for MAXIFORCE Lift Bag Systems.

Table 1-1. MAXIFORCE Lift Bag Reference Data

LIFT BAG CONSTANTS:

Base Material	Neoprene
Reinforcing Material	Kevlar
Number of Reinforcing Layers (Each Side)	3
Surface Type	Molded Non-Slip
Short Term Temperature Range °F (°C)	-75 (-60) to +220 (+105)
Continuous Duty Temperature Range °F (°C)	-40 (-40) to +150 (+65)
Maximum Working Pressure PSI (Bar)	118 (8.1)
Test Pressure PSI(Bar)	236 (16.2)



LAST REV. 5 JUNE 2003

CHAPTER 2
OPERATION

2-1 **INTRODUCTION.**

2-1.1 MAXIFORCE Lifting Bag Systems are multi-application, portable inflation systems used for lift and displacement of heavy rigid objects, up to 146,000 pounds (66,225 kilograms), while requiring less than 1 inch (2.5 centimeters) of bag insertion clearance. Total capable lift (utilizing two stacked lift bags) is 40 inches (100 centimeters). Inflation may be obtained from any air source (self-contained compressed air cylinder, air compressor, truck air brake system, building compressed air system, foot pump, etc.) capable of supplying 118 psi (8.1 Bar) pressure.

2-1.2 MAXIFORCE Lifting Bag Systems are designed for use in emergency situations such as building collapse, structural containment, vehicular extrications, industrial entrapment, and excavation collapse and containment. The specific situation requiring the use of a MAXIFORCE Lifting Bag System will generally determine the size and quantity of lift bag(s) to be utilized in combination with each other. In addition to use during emergency situations, MAXIFORCE Air Lifting Bag Systems are also effectively used for:

a. Preventive and/or corrective maintenance procedures where positioning and aligning heavy equipment and machinery in mills, manufacturing facilities and maintenance shops is required such as removing wheels, pulleys and gears from large machinery.

b. Lifting or shifting pipelines requiring welding and maintenance.

c. Breaking out blocks and slabs in quarrying operations.

d. Re-railing railroad and mining cars, pre-stressing support columns, general maintenance requiring lifting in rail, mining, underground and subway work.

e. Lifting operations underwater or on unstable, soft ground (mud, sand, snow, strewn debris, etc.) where conventional jacking equipment tends to sink.

f. Since the lift bags contain no spark producing parts, they may be used safely in explosive environments.

2-2 **CONTROLS AND INDICATORS.**

2-2.1 **CONTROLS.** No controls are used on a lift bag. However, the standard components required for use in conjunction with a lift bag do contain the following operational controls indicated:

a. **Manual Compressor.** The only controls on a manual compressor (figure 2-1) are the foot lever used to deliver pressure and a sliding valve collar that permits isolating one of the two cylinders thereby increasing the delivered pressure and decreasing the delivered volume by a factor of 2.

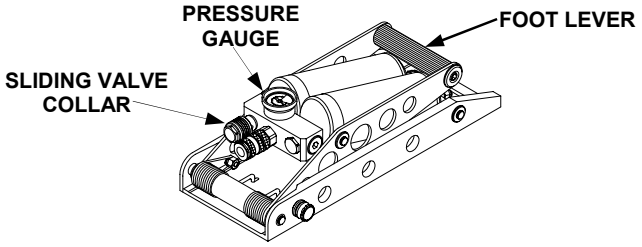


Figure 2-1. Manual Compressor Controls and Indicators

b. **Air Cylinder.** The only control on an air cylinder (figure 2-2) is the shut-off valve that permits or prevents the flow of compressed air.

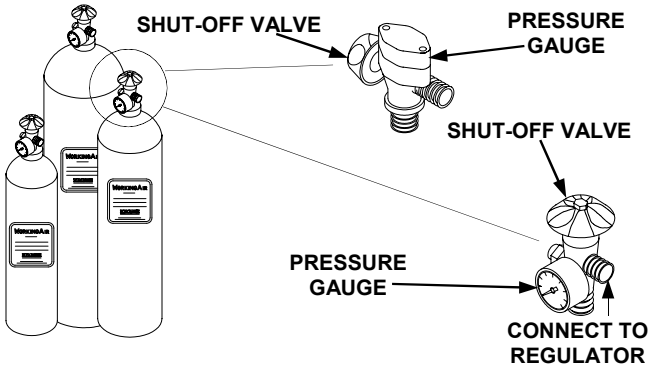


Figure 2-2. Air Cylinder Controls and Gauges

c. **Piston and Diaphragm Type Pressure Regulators.** The only controls on either a piston type pressure regulator (figure 2-3) or a diaphragm type pressure regulator (figure 2-4) are the shut-off valve assembly and the pressure adjusting knob assembly. The shut-off valve assembly is either opened to permit regulated delivery air to pressurize the lift bag system or closed to prevent (seal off) regulated delivery air from pressurizing the lift bag system. The pressure adjustment knob is turned to control the delivery pressure up to 135 psi (9.3 bar) maximum.

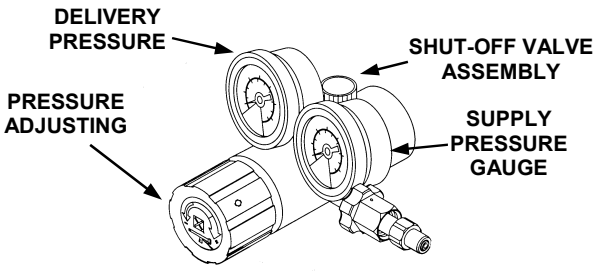


Figure 2-3. Piston Type Pressure Regulator Controls and Gauges

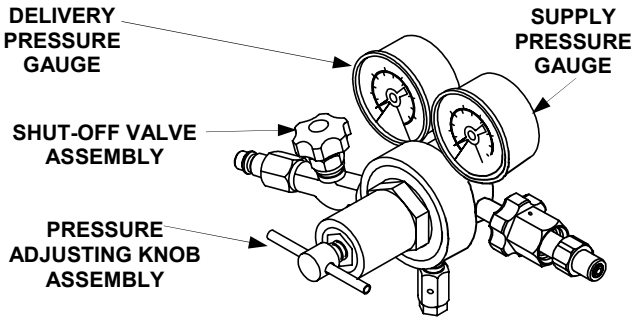


Figure 2-4. Diaphragm Type Pressure Regulator Controls and Gauges

d. **Single and Dual Safety Relief and Control Valve.** The only controls on a single or dual safety relief control valve (figures 2-5 and 2-6 respectively) are the "UP" (inflate) and "DOWN"(deflate) control valve assemblies. The control valve assemblies are either independently opened ("UP") to permit regulated air to inflate the lift bag(s) or closed ("DOWN") to relieve system air to deflate the lift bag(s) and prevent regulated air from pressurizing the system. Each of the "UP" and "DOWN" control valve assemblies on the dual safety relief and control valve operate independent of the other thereby permitting the application and release of air pressure to and from the lift bag(s)

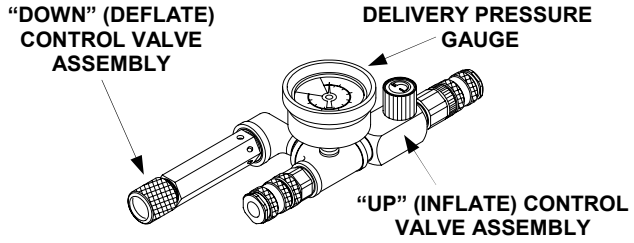


Figure 2-5. Single Safety Relief and Control Valve Controls and Gauges

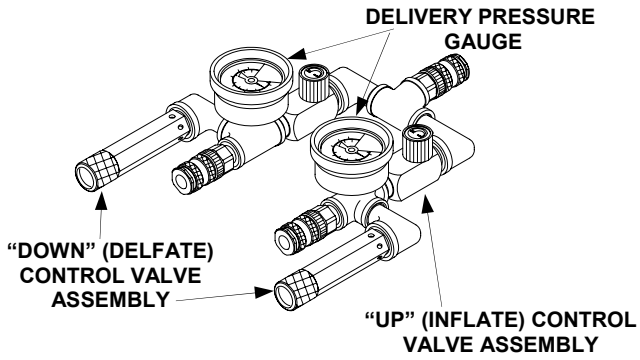


Figure 2-6. Dual Safety Relief and Control Valve Controls and Gauges

e. **Single Push-button Safety Relief and Control Valve with Bypass.** The only controls on the single push-button safety relief and control valve with bypass (figure 2-7) are the "UP" (inflate) and "DOWN"(deflate) control valve assemblies, and the bypass control valve assembly. The "UP" and "DOWN"control valve assemblies are either independently opened ("UP") to permit regulated air to inflate the lift bag or closed("DOWN") to relieve system air to deflate the lift bag and prevent regulated air from pressurizing the system. The bypass is independently opened to permit continuous regulated air to inflate the lift bag or closed to allow the relief of system air to deflate the lift bag and prevent regulated air from pressurizing the system.

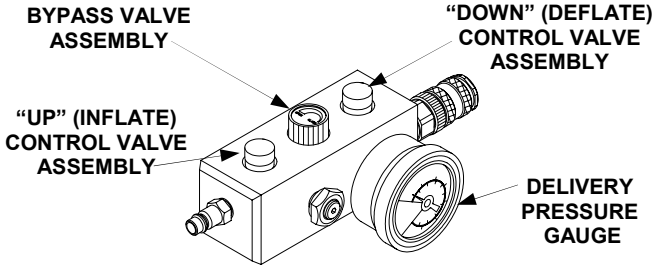


Figure 2-7. Single Push-button Safety Relief and Control valve with Bypass Controls and Gauges

f. **Dual "Deadman" Safety Relief and Control Valve** The only controls on the dual "deadman" safety relief and control valve (figure 2-8) are the "UP" (inflate) and "DOWN"(deflate) control valve assemblies. The control valve assemblies are either independently opened ("UP") to permit regulated air to inflate the lift bag(s) or closed("DOWN") to relieve system air to deflate the lift bag(s) and prevent regulated air from pressurizing the system. Each of the "UP" and "DOWN" control valve assemblies on the dual "deadman" safety relief and control valve operate independent of the other thereby permitting the application and release of air pressure to and from the lift bag(s).

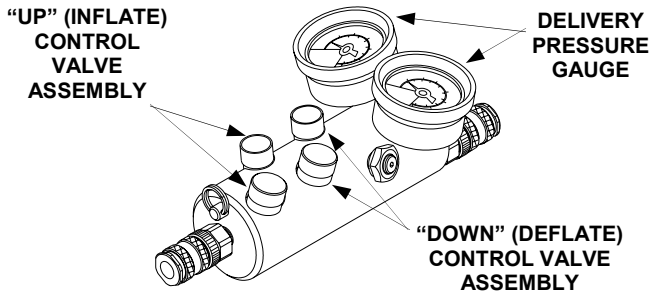


Figure 2-8. Dual "Deadman" Safety Relief and Control Valve Controls and Gauges

g. **In-Line Relief Valve.** The only control on an in-line relief valve (figure 2-9) is the shut-off valve that maintains pressure to the lift bag(s) when the dual safety relief or dual "deadman" safety relief and control valve must be disconnected during an operation requiring the use of multiple lift bags.

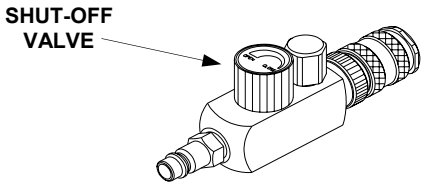


Figure 2-9. In-Line Relief Valve Controls

2-2.2 **INDICATORS.** No gauges are used on a lift bag. However, the standard components required for use in conjunction with a lift bag do contain the following operational controls indicated:

a. **Manual Compressor (Figure 2-1).** A delivery pressure gauge is provided on the manual compressor. The gauge is marked in 20 psi increments from 0 psi to 200 psi and is scribed each 2 psi.. The pressure gauge is also marked each 200 kPa from 0 to 1400 kPa and is scribed each 20 kPa.

b. **Air Cylinder (Figure 2-2).** A supply pressure gauge is provided on the air cylinder. The gauge is marked in 1000 psi increments from 1000 psi to 4000 psi and is scribed each 200 psi.

c. **Piston and Diaphragm Type Pressure Regulators (Figures 2-3 and 2-4 Respectively).** Two pressure gauges are provided; the supply pressure gauge and the delivery pressure gauge. The supply pressure gauge is marked in 1000 psi increments from 1000 psi to 6000 psi (890401) and is scribed each 200 psi. The supply pressure gauge is also marked each 10,000 kPa from 10,000 kPa to 40,000 kPa and is scribed each 1000 kPa. The delivery pressure gauge is marked in 50 psi increments from 50 psi to 400 psi and is scribed each 10 psi.

d. **Single and Dual Safety Relief and Control Valves (Figures 2-5 and 2-6 Respectively).** A delivery pressure gauge is provided for each of the "UP"/"DOWN" control valve assembly(s), respective to the controller (single or dual safety relief and control valve). The gauge is marked in 20 psi increments from 0 psi to 200 psi and is scribed each 2 psi. The pressure gauge is also marked each 200 kPa from 0 to 1400 kPa and is scribed each 20 kPa.

e. **Single Push-button and Dual "Deadman" Safety Relief Control Valves (Figure 2-7 and 2-8 Respectively).** A delivery pressure gauge is provided for each of the "UP"/"DOWN" control valve assembly(s), respective to the controller (single push-button or dual "deadman" safety relief and control valve); one therefore per each lift bag. Each gauge is marked in 20 psi increments from 0 psi to 200 psi and is scribed each 2 psi. The pressure gauge is also marked each 200 kPa from 0 to 1400 kPa and is scribed each 20 kPa.

2-3 <u>SYSTEM FUNCTIONAL OPERATION.</u>

Functionally, an interconnected MAXIFORCE® Lift bag System operates as follows:

a. A self-contained air cylinder, air compressor, foot pump or alternate air supply provides the necessary volume and pressure to pressurize the system and ultimately inflate the lift bag.

b. After a lift bag(s) is properly positioned for a lift/ displacement, the air supply is "turned on". High pressure air is reduced by an in-line pressure regulator to a usable 135 psi (9.3 Bar).

c. The reduced air pressure is supplied via an air hose to a controller (safety relief and control valve). The controller permits air to flow via air hose(s) to either one or two lift bags permitting a controlled lift/ displacement. In the line between the controller and the lift bag(s) are in-line relief valve(s) to maintain proper pressure in the lift bags while disconnected from the controller.

d. As air flows into the lift bag, it increases in height resulting in a corresponding lift/displacement. Maximum lift/displacement force occurs at

approximately one inch of inflation height (minimum reduction of the lift bag cross section). As additional air flows into the lift bag, the cross section reduces as the height increases resulting in a corresponding reduction in lift/displacement capacity .

e. When the lift bag(s) are to be partially or fully deflated, control(s) on the controller are operated to perform this function as well as prevent any further inlet air pressure from flowing beyond the controller.

f. At the conclusion of operation, the air supply is "turned-off", any residual system air pressure is relieved ("bled-off") through the controller, the system components are disconnected, inspected and stored for future use.

2-4 COMPONENT INTERCONNECTION PRIOR TO INFLATION.

WARNING

Refer to the SAFETY FIRST instructions preceding chapter 1 for those safety first procedures to be followed for each specific operational phase of the application at hand. Regardless of the lift bag application and/or environmental conditions, strict adherence to SAFETY FIRST is essential to prevent personnel injury/death and/or equipment damage. It may make the difference between saving a life or endangering/sacrificing another life.

2-4.1 The following procedures describe in detail a typical interconnection of the previously described components comprising a MAXIFORCE Air Lifting Bag System. This procedure can be accomplished by trained personnel in less than one minute. If the specific application does not require the use of all of the referenced components or some of the components are not available, eliminate the non-applicable steps and proceed with the interconnection. Any adapters, couplings and/or air fittings required in conjunction with the components are addressed generally but not specifically during the interconnection. It is assumed these parts are available and will be installed where required in the system.

2-4.2 Refer to Table 1-1 to determine the required lift bag (s) for the load/displacement and full inflation height demands for the application at hand. Once the proper lift/ displacement and height configuration is determined and the individual components selected, it is only necessary to clean, where required, the individual components sufficiently to clear them of any contaminants that would prevent their full engagement and proper locking to each other and to interconnect the components.

WARNING

Refer to the SAFETY FIRST instructions preceding chapter 1 and adhere to the applicable "prior to inflation" procedures.

a. Remove all dust, dirt, oil or grease from the MAXIFORCE Air Lifting Bag System components. Do not use any system components without first cleaning off any contaminants.

b. Inspect all inlet and outlet fittings for any damage that will permit air leakage. Do not use any component if an air leakage condition is suspected or exists.

c. Attach the air inlet connector on a pressure regulator (diaphragm or piston type) to an air supply using the appropriate interconnecting fittings as required. Be certain to turn the safety locking ring on any quick connect coupling to the locked position as shown in figure 2-10. Tighten all connections just enough to prevent air leakage. Do not overtighten.

d. Check that the pressure regulator shut-off valve is closed (full clockwise). Check that the pressure regulator pressure adjusting knob is full counterclockwise to close the internal needle valve (no flow through the pressure regulator).

e. Attach an air hose quick connect coupling to the pressure regulator outlet port using the appropriate interconnecting fittings as required. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10.

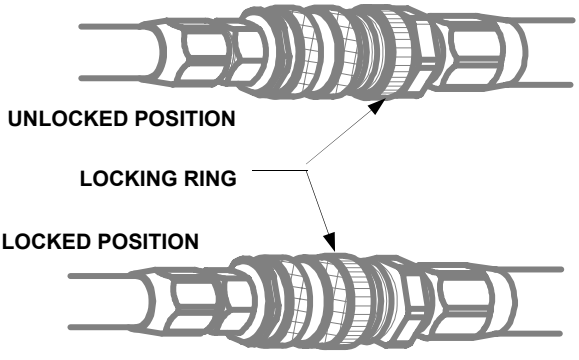


Figure 2-10. Quick Connect Coupling Safety Locking Ring

f. Attach the inlet port quick connect coupling on a controller (single, dual, single push-button, or dual "deadman" safety and relief valve) to the air hose quick connect nipple. Check that the quick connect

coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10.

g. Attach the inlet port quick connect nipple on a safety in-line relief valve to the outlet port quick connect coupling on a controller (single, dual, single push-button, or dual "deadman" safety and relief valve). Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10. Check that the safety in-line relief valve shut-off valve is closed (full clockwise).

h. If using a dual or dual "deadman" safety and relief valve, attach the inlet port quick connect nipple on a second safety in-line relief valve to the second outlet port quick connect coupling on the dual or dual "deadman" safety and relief valve. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10. Check that the safety in-line relief valve shut-off valve is closed (full clockwise).

i. Attach an air hose quick connect nipple to the safety in-line relief valve outlet port coupling using the appropriate interconnecting fittings as required. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10. Connect additional lengths of air hose of the same color as required.

j. If a second safety in-line relief valve is used, attach an air hose quick connect nipple to the second safety in-line relief valve outlet port coupling using the appropriate interconnecting fittings as required. A different colored air hose should be used to permit the rapid and positive identification of the lift bag connected to each side of the controller. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10. Connect additional lengths of air hose of the same color as required.

k. Attach a lift bag nipple to the air hose quick connect coupling. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10.

l. If a second lift bag is being used, attach the second lift bag nipple to the other air hose quick connect coupling. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10.

m. The MAXIFORCE Air Lifting Bag System is now fully interconnected and can be positioned with any required shoring and/or cribbing, and inflated for a lift/displacement.

2-5 **NORMAL OPERATING PROCEDURE DURING INFLATION.**

Proceed as follows to inflate the lift bag(s) after the individual components are interconnected, the lift bag(s) are positioned and the necessary shoring and/or cribbing is in position.

WARNING

Refer to the SAFETY FIRST instructions preceding chapter 1 and adhere to the applicable "during and while inflated" procedures.

WARNING

Be sure **all** shut-off valves are in a closed position prior to opening the air supply to the system; this will prevent an uncontrolled lift/displacement.

a. **Slowly** open (turn counter clockwise) the air supply to the pressure regulator. The supply pressure will be indicated on the air supply pressure gauge as well as on the pressure regulator supply pressure gauge. The delivery pressure gauge on the pressure regulator should indicate 0 psi.

WARNING

Do not adjust the pressure regulator to exceed the maximum pressure rating of any component in the system apparatus or 135 psi (9.3 Bar) which ever is less.

b. Adjust the pressure regulator pressure adjusting knob (turn clockwise) to increase the delivery pressure from 0 psi to 135 psi (9.3 Bar).

c. **Slowly** open (turn counterclockwise)the pressure regulator shut-off valve. The delivery pressure should remain at 135 psi (9.3 Bar).

d. Open the shut-off valve on the safety in-line relief valve(s).

NOTE:
When operating the lift bag, always inflate slowly and only lift or move the amount necessary.

e. Press and release the single push-button or dual "deadman" controller inflation valve(s), or open (turn counter clockwise) and close (turn clockwise) the single/dual controller inflation valve repeatedly to **slowly** inflate the lift bag to the required height or 118 psi (8.1 Bar). Inflating the lift bag(s) slowly will minimize the possibility of shifting. If a second lift bag is interconnected to the controller, operate the associated inflation valve to **slowly** inflate the second lift bag. The lift bags may be inflated simultaneously or alternately as desired by the operator.

f. With the lift bag inflated to the desired height/ pressure close (turn clockwise) the shut-off valve on the safety in-line relief valve(s).

g. If additional lift bags are required for the application, proceed as follows:

1. Determine the lift bag to remain inflated and in position. Be sure the shut-off valve on the associated safety in-line relief valve is closed.

2. Release the safety locking ring on the quick connect coupling between the controller and the safety in-line relief valve. Disengage the coupling lock ring to release the safety in-line relief valve from the controller.

3. Attach the inlet port quick connect nipple on a safety in-line relief valve to the outlet port quick connect coupling on the controller. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10. Check that the safety in-line relief valve shut-off valve is closed (full clockwise). Do not overtighten.

4. Attach an air hose quick connect nipple to the safety in-line relief valve outlet port coupling using the appropriate interconnecting fittings as required. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10. Connect additional lengths of air hose as required.

5. Attach a lift bag nipple to the air hose quick connect coupling. Check that the quick connect coupling is fully engaged and locked in position to assure a leak-free connection. Be certain to turn the safety locking ring on the quick connect coupling to the fully locked position as shown in figure 2-10.

6. Press and release the single push-button or dual "deadman" controller inflation valve(s), or open (turn counterclockwise) and close (turn clockwise) the single/dual controller inflation valve repeatedly to **slowly** inflate the lift bag to the required height or 118 psi (8.1 Bar). Inflating the lift bag(s) slowly will minimize the possibility of shifting.

7. Adhere to procedural steps 1 through 6 to add any additional quantity of lift bags required for the application.

2-6 CHANGING AIR CYLINDERS.

NOTE

If the air source for a given application requires the use of air cylinder, it should be changed during inflation whenever the air cylinder pressure falls below 200 psi (13.8 Bar).

a. Close (turn clockwise) the air cylinder and the pressure regulator shut-off valves. The supply pressure gauge on the pressure regulator should indicate 0 psi. The delivery pressure gauge will indicate the regulated pressure until the internal

pressure is relieved, any residual system air pressure will be relieved through the controller.

b. Turn the pressure regulator pressure adjusting knob full counter clockwise to close the internal needle valve (no flow through the pressure regulator).

c. As required, turn the nut on the pressure regulator air inlet connector or interconnecting air cylinder to pressure regulator fitting to the unlocked position. Disengage the inlet nipple to release the air cylinder from the pressure regulator.

d. Attach the air inlet connector on the pressure regulator to a full air cylinder using the appropriate interconnecting fittings as required. Tighten all connections just enough to prevent air leakage. Do not overtighten.

e. **Slowly** open (turn counter clockwise) the air supply to the pressure regulator. The supply pressure will be indicated on the air supply pressure gauge as well as on the pressure regulator supply pressure gauge. The delivery pressure gauge on the pressure regulator should indicate 0 psi.

f. Adjust the pressure regulator pressure adjusting knob (turn clockwise) to increase the delivery pressure from 0 psi to 135 psi (9.3 Bar).

g. **Slowly** open (turn counter clockwise) the pressure regulator shut-off valve. The delivery pressure should remain at 135 psi (9.3 Bar).

2-7 NORMAL OPERATING PROCEDURE DURING DEFLATION.

NOTE

If a lift bag(s) is to be removed after it is deflated, shoring or cribbing must be in position, as required, to restrain the load permitting the removal of the lift bag(s).

a. To either partially or fully deflate an inflated lift bag(s) **disconnected** from a controller, open and close as required the shut-off valve on the safety in-line relief valve to slowly achieve the desired deflation. The lift bag design prevents it from deflating rapidly. Alternately opening and closing the shut-off valve will permit a more slowly controlled deflation. This prevents any quick load movements that may cause damage or personnel injury. Repeat for any additional lift bag(s) disconnected from the controller that can be partially or fully deflated.

b. To either partially or fully deflate an inflated lift bag (s) **connected** to a controller, press and release the single push-button or "deadman" dual controller deflation valve(s), or open (turn counterclockwise) and close (turn clockwise) the single/dual controller deflation valve repeatedly to **slowly** deflate the lift bag. Repeat for an additional lift bag connected to the controller if it can be partially or fully deflated.

c. Gather the system components together in preparation for movement to another work area or for disconnection, post inspection and storage.

2-8 COMPONENT DISCONNECTION AFTER DEFLATION.

The following procedures describe in detail a typical disconnection of the previously described components comprising a MAXIFORCE Air Lifting Bag System. This procedure can be accomplished by trained personnel in less than one minute. If the specific application did not require the use of all of the referenced components or some of the components are not available, eliminate the non-applicable steps and proceed with the disconnection. Any adapters, couplings and/or air fittings used in conjunction with the components are not addressed during the disconnection.

a. After the lift bag(s) has been removed from its lift/ displacement position and the interconnected system components are gathered together, check that the supply pressure gauge and delivery pressure gauge on the pressure regulator indicate 0 psi.

1. If the supply pressure gauge indicates a pressure other than 0 psi turn off the air supply. Any residual system air pressure will be relieved through the controller. If a significant pressure is still indicated, the air supply shut-off valve is probably defective and air leakage should be anticipated when the air supply is disconnected from the pressure regulator.

2. If the delivery pressure gauge on the pressure regulator indicates a pressure other than 0 psi , be sure the air supply is turned off and press the single push-button or "deadman" dual controller deflation valve(s), or open (turn counterclockwise) the single/dual controller deflation valve to exhaust air from the system.

b. Turn the safety locking ring on the air hose quick connect coupling, interconnecting the lift bag, to the unlocked position. Disengage the coupling lock ring

to release the lift bag from the air hose.

c. Turn the safety locking ring on the safety in-line relief valve quick connect coupling, interconnecting the air hose, to the unlocked position. Disengage the coupling lock ring to release the air hose from the safety in-line relief valve.

d. Turn the safety locking ring on the single push-button or dual "deadman" or single/dual safety and relief valve quick connect coupling, interconnecting the safety in-line relief valve, to the unlocked position. Disengage the coupling lock ring to release the safety in-line relief valve from the dual "deadman" or single/dual safety and relief valve.

e. If a dual "deadman" or dual safety and relief valve is used with two safety in-line relief valves and associated lift bags, repeat preceding steps b through d.

f. Turn the safety locking ring on the single push-button or dual "deadman" or single/dual safety and relief valve quick connect coupling, interconnecting the air hose, to the unlocked position. Disengage the coupling lock ring to release the single push-button or dual "deadman" or single/dual safety and relief valve from the air hose.

g. Turn the safety locking ring on the air hose quick connect coupling, interconnecting the pressure regulator (diaphragm or piston type), to the unlocked position. Disengage the coupling lock ring to release the air hose from the pressure regulator (diaphragm or piston type).

h. As required, turn the safety locking ring on the air source fitting quick connect coupling, interconnecting the pressure regulator (diaphragm or piston type), to the unlocked position. Disengage the coupling lock ring or other fitting to release the pressure regulator (diaphragm or piston type) from the air source.

i. If the components are not to be immediately reused, perform the post operation inspection and storage in accordance with Chapter 3.

2-9 **APPLICATIONS.**

2-9.1 MAXIFORCE Air Lifting Bag Systems are multi-application, portable inflation systems used for lift and displacement of heavy rigid objects, up to 146,000 pounds (66,637 kilograms), while requiring less than 1 inch (2.5 centimeters) of bag insertion clearance. Total capable lift (utilizing two stacked lift bags) is 40 inches (100 centimeters).

2-9.2 As shown in figure 2-11, MAXIFORCE Air Lifting Bag Systems are designed for use in emergency situations such as building collapse, structural containment, vehicular extrications, industrial entrapment, and excavation collapse and containment.

2-9.3 In addition to use during emergency situations, MAXIFORCE Air Lifting Bag Systems are also effectively used for:

a. Preventive and/or corrective maintenance procedures where positioning and aligning heavy equipment and machinery in mills, manufacturing facilities and maintenance shops is required such as removing wheels, pulleys and gears from large machinery.

b. Lifting or shifting pipelines requiring welding and maintenance.

c. Breaking out granite and marble blocks and slabs in quarrying operations.

d. Re-railing railroad and mining cars, pre-stressing support columns, general maintenance requiring lifting in rail, mining, underground and subway work.

e. Lifting operations underwater or on unstable, soft ground (mud, sand, snow, strewn debris, etc.) where conventional jacking equipment tends to sink.

f. Since the lift bags contain no spark producing parts, they may also be used safely in explosive environments.

2-9.4 In addition to the Safety First Procedures in the front of this publication, the following general application notes and procedures should be followed whenever a MAXIFORCE Air Lifting Bag System is to be employed.

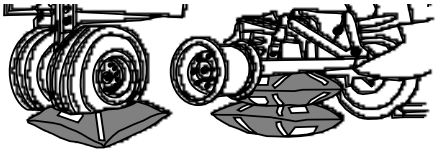
a. All procedures should be used as guidelines, not absolute dictates. Any previous application may, as a result of a seemingly inconsequential change, require modification or possibly completely new procedures to achieve the same result.

b. Lift bags are relatively lightweight. The maximum weight is 60 pounds (27.2 kg). All lift bags over 9 pounds incorporate at least two lifting eyelets.

c. If a lift bag is being used to lift or displace a thin surface or material, use plywood between the lift bag and the surface to more evenly distribute the applied force.

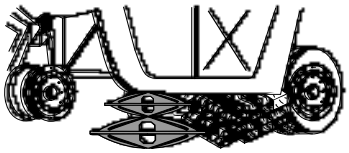
d. If a lift bag will be used on an icy, greasy or otherwise slick surface, use a grainular material between the lift bag and the surface to increase the coefficient of friction, thereby preventing the lift bag from slipping.

e. Build support cribbing/bracing height to a point that just allows the lift bag(s) to be inserted. Safety cribbing/bracing may also be installed as the load is being lifted, but care must be exercised to avoid

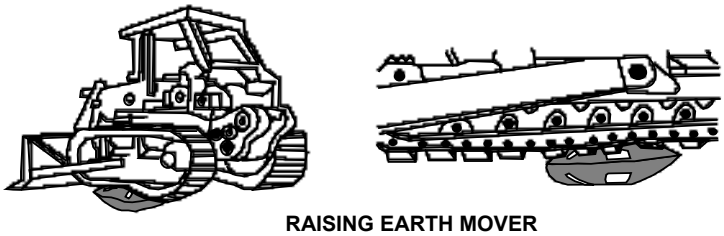


AIRCRAFT FLAT TIRE
SUPPORT & REPAIR

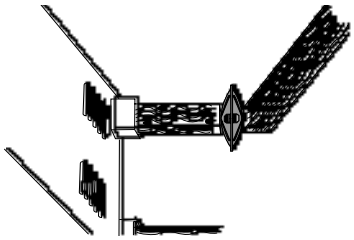
HALF-TRAK TIRE REPAIR



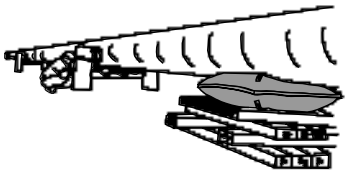
VEHICLE JACKING OPERATION



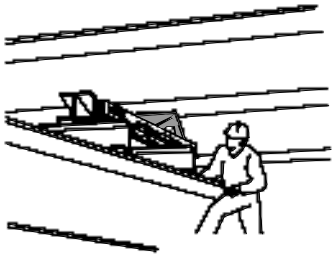
RAISING EARTH MOVER
MIRED IN MUD



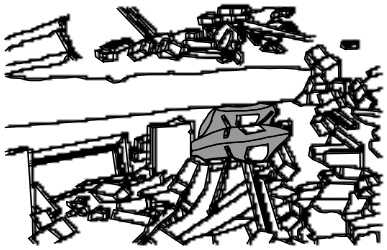
POSITIONING OF HEAVY MACHINERY



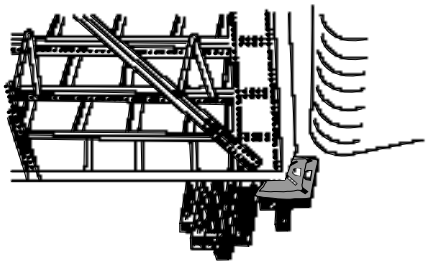
RAISING PIPELINE FOR INSPECTION



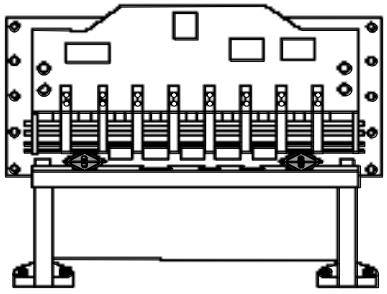
LIFTING SECTION OF COLLAPSED
HIGHWAY OVERPASS



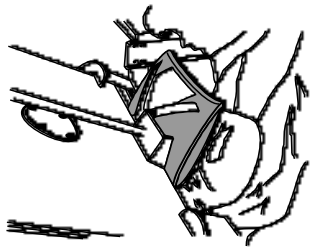
RAISING SECTION OF COLLAPSED
BUILDING TO ALLOW RESCUE ACCESS



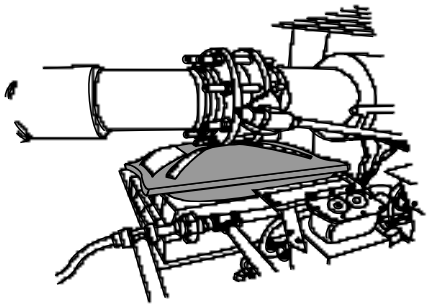
JACKING UP CANAL LOCK GATE
DURING MAINTENANCE



LIFTING AND STABILIZING CUTTER



OPENING DOOR OF GRINDING
MACHINE TO FREE VICTIM'S ARM



ALIGNING AND STABILIZING
PIELINE SECTIONS

PRYING OPEN FENCE TO RESCUE
TRAPPED ANIMAL

Figure 2-11. Typical Applications

injury and damage in the event of a drop and/or load shift (Figure 2-12). The top support cribbing/bracing layer must be sufficiently solid to prevent a cribbing/bracing shift and collapse during inflation when the lift bag(s) take on the characteristic double dome shape. Build safety cribbing/bracing after the desired lift to minimize the drop distance in the event of air loss after inflation. A generally applied safety rule is: lift between one and two inches (three and six cm.), then safety crib/brace between one and two inches (three and six cm.). After full safety cribbing/bracing is in place, the lift bag may be slowly deflated and removed, and the support cribbing/bracing removed, allowing the load to rest fully on the safety cribbing/bracing.

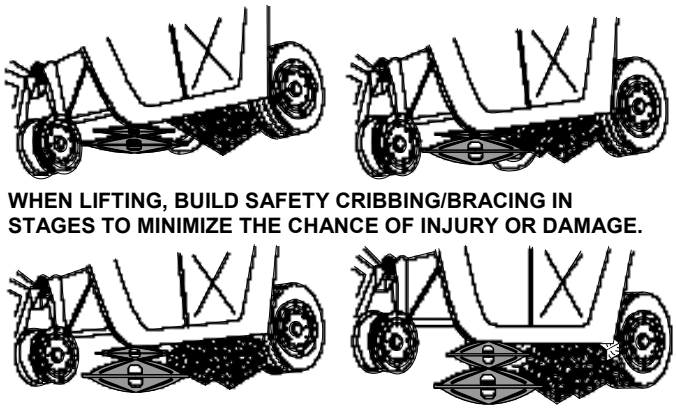


Figure 2-12. Correct Method of Safety Cribbing/Bracing

f. Lifting capacity does not increase by stacking two lift bags one on top of the other; only lifting height increases. Lifting capacity is controlled by the smaller bag capacity. Use lift bags, side-by-side, to additively increase capacity by inflating the lift bags simultaneously. (Figure 2-13)

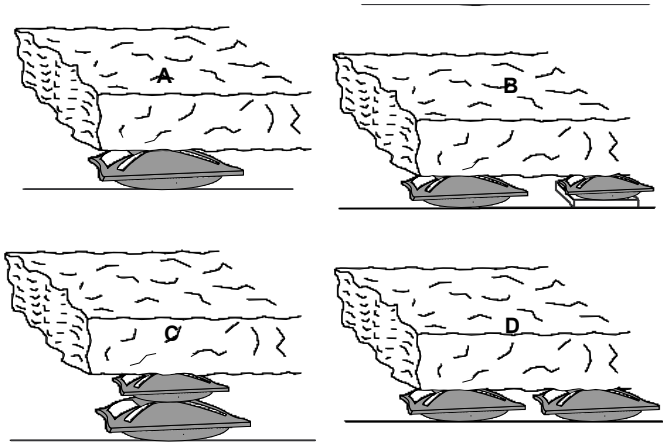


Figure 2-13. Lift bag Stacking and Tandem Combinations

g. If the lift height requirement demands the use of two stacked lift bags, (Figure 2-14) the smaller lift bag shall be on the top (A) and the bottom lift bag inflated first until the top lift bag contacts the load (B). The top lift bag is then inflated to achieve the desired lift (C). If additional lift is required at full inflation of the top lift bag, the bottom lift bag is further inflated (D).

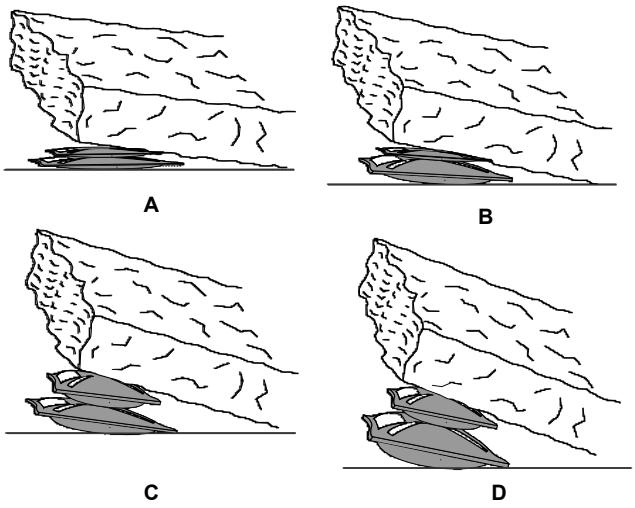


Figure 2-14. Correct Method for Inflating Stacked Lift Bags

h. When lifting large cylindrical objects (Figure 2-15), use a lift bag on both sides of the cylinder and wedges to provide an even lift.

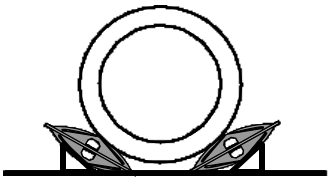


Figure 2-15. Using Two Lift Bags to Lift Cylindrical Objects

2-10 LIFT BAG **CHEMICAL COMPATIBILITY.**

Use the following chemical compatibility table only as a guide in determining the MAXIFORCE Lift Bag resistance to solvents, acids, salts and other chemical solutions. Each commodity is assigned an alpha character to denote its expected effect upon the lift bag. The specific ratings in this table are based upon published literature from various polymer suppliers and manufacturers and "Chemical Resistance Guide For Elastomers II" published by Compass Publications, copyright 1994. Paratech is unable to guarantee their accuracy and therefore assumes no liability for the use thereof.

CHAPTER 3
MAINTENANCE AND STORAGE

3-1 GENERAL.

The major components and accessories of a MAXIFORCE Air Lifting Bag System require little maintenance to ensure optimum performance. However, this maintenance must be performed to ensure personnel and equipment safety, and the assurance that when the system is to be utilized, it will function as designed and intended. This chapter provides preventive and corrective maintenance procedures that are necessary to verify that the MAXIFORCE Air Lifting Bag System will operate satisfactorily.

Do not drag or drop the bag on the nipple, as this can cause breakage of the brass inflation fitting and render the bag useless. ***BREAKAGE OF THE BRASS INFLATION FITTING IS NOT COVERED UNDER WARRANTY.***

3-2 PREVENTIVE MAINTENANCE PLAN.

Preventive maintenance of the MAXIFORCE Air Lifting Bag System is accomplished in accordance with paragraphs 3-3 and 3-4.

3-3 POST OPERATION PREVENTIVE MAINTENANCE.

Because of the contaminants present where a MAXIFORCE Air Lifting Bag System is generally used (maintenance sites, construction sites, accident sites, etc.), it is important that the system components be thoroughly cleaned, inspected and prepared for their next use before being placed in storage.

3-3.1 CLEANING.

Do not use any petroleum base product to clean components of the MAXIFORCE Air Lifting Bag System. Petroleum base products could adversely react with the non-metallic parts of the system components and may result in a component failure when none should be expected or tolerated.

a. Keep the exterior of all components clean of all dirt, grit, oil and grease accumulations. Except for the lift bag(s), wipe exterior surfaces with a lint-free cotton machinery wiping towel **LIGHTLY** dampened with a soap and warm water solution. Be particularly careful to remove all dirt, sand, grit, etc. from quick connect couplings and nipples. Swirl in a bucket with the soap and water solution until clean. Rinse with a wiping towel **LIGHTLY** dampened with clean water. Then dry the surfaces thoroughly with a clean, dry wiping towel or low pressure compressed air. Also clean the lift bag with a soap and warm water solution, but scrub the lift bag with a stiff bristle broom or brush and rinse by spraying with cold water. If the cleaning solution or rinse water gets into the lift bag through the nipple, allow the lift bag to dry thoroughly before its next use.

3-3.2 INSPECTION.

a. While the lift bag is still wet with the cleaning solution, inflate to 30 psi and check for air bubbles denoting a leak(s). Except for air leakage from between the air inlet fitting and the male nipple, replace rather than attempt to repair a leaking lift bag. If air leakage is detected from around the male nipple threads, proceed as follows:

1. Deflate the lift bag.

2. Disconnect the quick connect coupling from the lift bag male nipple.

When removing/installing a replaceable male nipple from/into a lift bag inlet fitting, be sure to hold the inlet fitting stationary while turning the male nipple. Turning the inlet fitting, or allowing it to turn, will loosen its bond with the lift bag. During operation, this will result in air leakage or possibly the ejection of the fitting, resulting in a hazardous condition and rendering the lift bag useless.

3. Unscrew the lift bag male nipple while holding the inlet fitting stationary.

4. Clean the interfacing threads and inspect the male nipple for visual damage. If damaged, discard. If not damaged, wrap teflon tape (two wraps) around the male nipple threads and tighten back into the inlet fitting.
5. Reconnect the lift bag to an air source, reinflate to 30 psi and recheck for air leaks. If none are found, deflate the lift bag, disconnect the quick connect coupling and install a protective cap (optional part) over the male nipple in preparation for storage.

b. After a lift bag is clean and dry, all surfaces should be thoroughly inspected for cuts, abrasion, air bubbles and bulges (ply separation), and other similar damage. Remove all debris from the surface. Minor surface cuts and abrasion can be repaired with rubber cement and should not be considered a problem unless they are deep enough to expose the kevlar reinforcment layer.

c. Inspect hose assemblies for cuts, cracks, crimps and brittleness. Inspect the hose quick connect coupling and nipple for secureness of attachment and burrs, nicks, corrosion or other similar damage that would prevent a leak proof interconnection.

d. Refer to the separate instruction manuals provided with the pressure regulator and controller (safety relief and control valve) to inspect these components.

e. If during the last three (3) months the MAXIFORCE Air Lifting Bag System and accessories have not been used for training or actual operational functions, they should be field tested to ensure they do not leak and are fully operational in preparation for their next use.

3-3.3. **REPAIR.**

The only repairs authorized on the MAXIFORCE Air Lifting Bag System components are those designated in the separate instruction manuals provided with the pressure regulator and controller (safety relief and control valve) and the following procedures detailing replacement of the quick connect couplings and nipples.

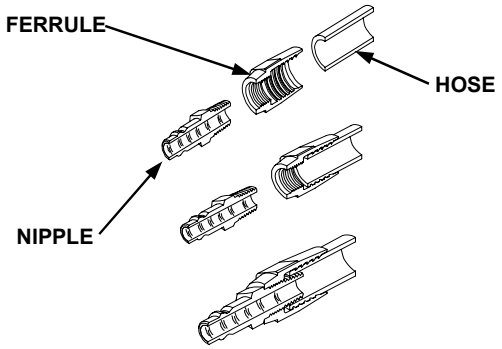


Figure 3-1. Air Hose Nipple Replacement

a. AIR HOSE NIPPLE REPLACEMENT. Refer to figure 3-1 and replace a worn or otherwise damaged air hose nipple in accordance with the following procedure.

1. Square cut the air hose just behind the ferrule to release the nipple. Discard the nipple and ferrule.

2. Screw a new ferrule counterclockwise fully onto the hose and back the ferrule out 1/2 turn. There should be approximately 1/16 inch clearance between the ferrule inside shoulder and the end of the hose.

3. Hold the ferrule stationary and turn the nipple clockwise into the ferrule until it is fully seated (not required for emergency or field replacement).

b. AIR HOSE QUICK CONNECT COUPLING REPLACEMENT. Refer to figure 3-2 and replace a worn or otherwise damaged air hose quick connect coupling in accordance with the following procedure.

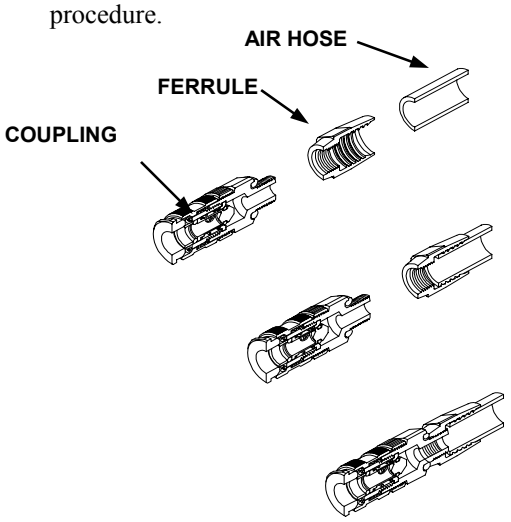


Figure 3-2. Air Hose Quick Connect Coupling Replacement

1. Square cut the air hose just behind the ferrule to release the quick connect coupling stem and the assembled ferrule (quick connect coupling). Discard the quick connect coupling.

2. Unscrew the new ferrule from the quick connect coupling stem. Screw the new ferrule counter clockwise fully onto the hose and back the ferrule out 1/2 turn. There should be approximately 1/16 inch clearance between the ferrule inside shoulder and the end of the hose.

3. Hold the ferrule stationary and turn the quick connect coupling stem clockwise into the ferrule until it is fully seated (not required for emergency or field replacement) .

c. COMPONENT QUICK CONNECT COUPLING AND NIPPLE REPLACEMENT. The quick connect couplings and nipples assembled into the pressure regulator, controller (safety relief and control valve) and the safety in-line relief valve are screw-type fittings. When their replacement is required, it is only necessary to unscrew the damaged part (quick connect coupling and/or nipple), remove and discard the "O" ring and screw in a replacement part using a new "O" ring. If an "O" ring is not used, be sure to wrap the male threads with two turns of teflon tape to assure a leak free connection.

3-4 **STORAGE.**

3-4.1 Storage of the MAXIFORCE Air Lifting Bag System components at a stationary facility requires the following:

a. The short term (1 hour or less) temperature range must be within the limits of -75°F (-60°C) to +220°F (+105°C). The continuous temperature range must be within the limits of -40°F (-40°C) to +150°F (+65°C).

b. The components must be protected from any extreme environmental conditions where blowing dust, sand, grit and other similar materials could cause damage. If these environmental conditions are likely to be encountered, plastic wrap all components for protection.

c. Regardless of whether the lift bag(s) are to be stored flat or upright, the inlet nipple shall be covered with a protective cap over the inlet nipple. If stored upright, be sure the inlet nipple is upright where it will not rub the floor or sides of its storage container.

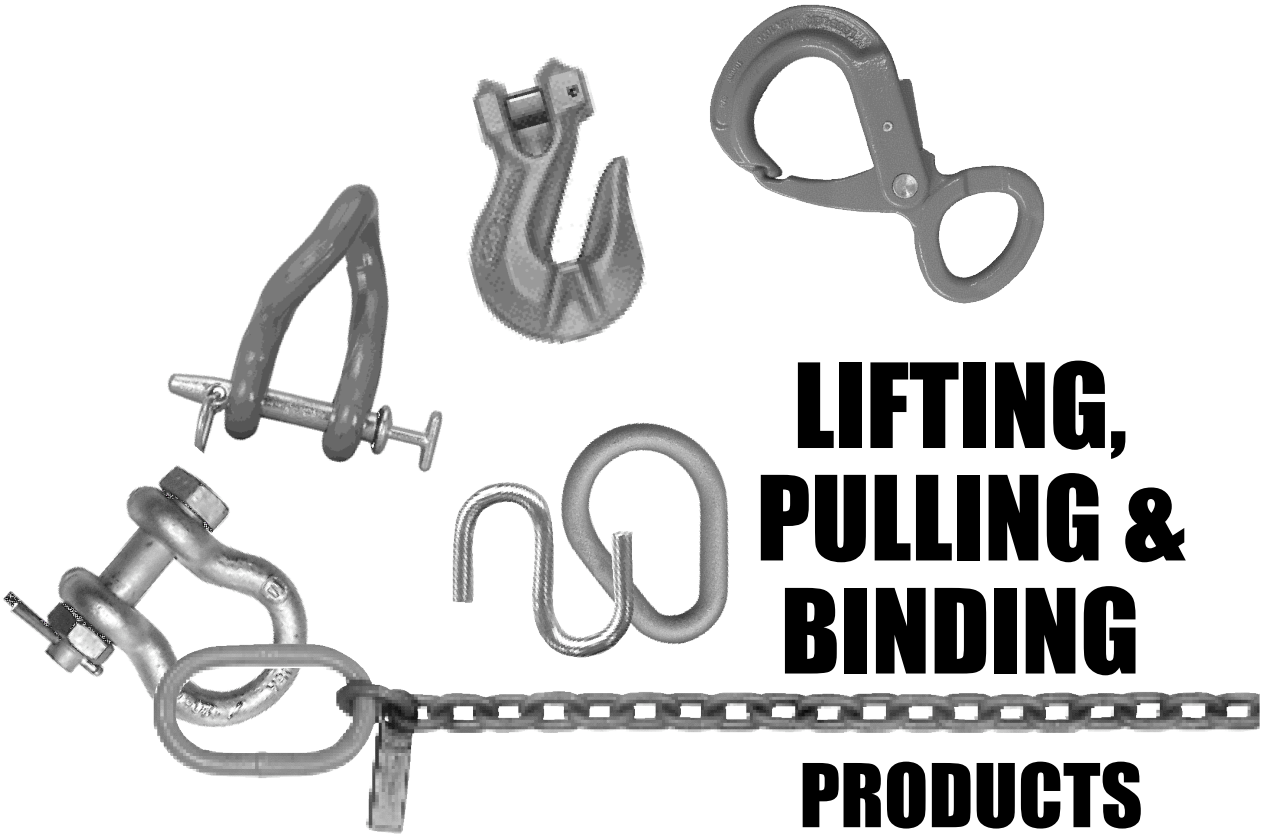
3-4.2 Storage of the MAXIFORCE Air Lifting Bag System components in a truck or at a movable facility requires the following:

a. System components (pressure regulator, controller, safety in-line relief valve and other metallic items) that are stored in a truck compartment where they are subjected during transport to constant bumping will eventually be damaged. It is strongly recommended that these components be stored in their own cushioned cartons. It is further recommended that all components be strapped down, braced or otherwise secured within the compartment during transport.

b. The short term (1 hour or less) temperature range must be within the limits of -75°F (-60°C) to +220°F (+105°C). The continuous temperature range must be within the limits of -40°F (-40°C) to +150°F (+65°C).

c. The components must be protected from any extreme environmental conditions where blowing dust, sand, grit and other similar materials could cause damage. If these environmental conditions are likely to be encountered, plastic wrap all components for protection.

d. Regardless of whether the lift bag(s) are to be stored flat or upright, the inlet nipple shall be covered with a protective cap over the inlet nipple. If stored upright, be sure the inlet nipple is upright where it will not rub the floor or sides of its storage container.



LIFTING, PULLING & BINDING

PRODUCTS MANUAL

CM®

INTRODUCTION

This manual is provided as a users' guide for the various lifting, pulling, and binding products available from Columbus McKinnon Corporation. It is not an all-encompassing guide to the broad and detailed subjects of lifting, rigging, and load binding; but is intended to educate users on general applications and uses of Columbus McKinnon's products. It will also serve to educate inspectors and maintenance personnel on inspection requirements and maintenance criteria for these products. This manual provides sufficient information which, when properly implemented, assures safe product use.

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NOTE:

Columbus McKinnon Corporation assumes no responsibility for the misuse or misapplication of any of its products. Products are provided with the express understanding that the purchaser and/or user are thoroughly familiar with the correct application and proper use of such products in rigging. Warnings and definitions are provided as an aid to the user in understanding the correct application and for proper use of the product.

Working Load Limit— refers to the maximum load (rated capacity) in pounds that shall be applied to the product. See Working Load Limits in Table II, Table IV, and Table V. The manufacturer does not accept any liability for damages which result from their products being used in excess of the working load limit or from abuse.

ASTM— American Society of Testing and Materials. Specifications published by ASTM, 100 Bar Harbor Drive, W. Conshohocken, PA, 19428-2959, (610) 832-9500.

ASME— The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, (212) 591-7722.

ANSI— American National Standards Institute. Specifications published by ANSI, 25 West 43rd St. New York, NY 10036, (212) 642-4900.

CVSA— Commercial Vehicle Safety Alliance, 1101 17th Street, N.W. • Suite 803 Washington, DC 20036 • (202) 775-1623

NACM— National Association of Chain Manufacturers. Specifications published by NACM, P.O. Box 22681, Lehigh Valley, PA 18002-2681, (610) 691-8708

OSHA— Occupational Safety & Health Administration, U.S. Department of Labor.

CM CHAIN SYSTEMS

Because of its flexibility and ability to follow contours readily, chain is a versatile medium for lifting, towing, pulling, securing, or for any application where a tensile force is to be exerted. Its ability to elongate prior to rupture gives the user warning to remove it from service before bodily injury or property damage occurs.

Columbus McKinnon Corporation supplies a number of welded and weldless chains manufactured in accordance with the NACM Chain Specifications, Fed. Spec. RR-C-271 and ASTM Specifications for chain. In the welded category they include graded chains and non-graded chains. Graded chain is marked with the grade number approximately every 10 inches. Welded graded chains find applications in industry and construction, while welded non-graded chains are used primarily in non-technical applications where lower strength chain than graded chain is acceptable.

Columbus McKinnon Corporation also manufactures three sizes of welded stainless steel chain. Stainless steel chain is considered a specialty product and will not be covered in detail in this manual. For more information contact Columbus McKinnon Corporation. Information presented in this manual for chains and slings may also be used as a guide for stainless steel chain and slings.

WELDED GRADED CHAIN

Welded graded chain is an industrial grade used extensively in rigging and towing. The welded alloy steel chain is used in overhead lifting applications. CM graded chains are manufactured in accordance with the NACM specification for chain, ASTM Standard A391, and ASTM Standard A413. The grade number equates to the strength level of the chain with the grade number increasing as the strength of the chain increases. The standardized grade designations are 30, 43 and 70 for carbon steel, and 63, 80 and 100 for alloy steel chain.

USE

Always observe the following when working with chain:

> **⚠ WARNING**
>
> **Improper use or care of chain can result in loss of load and personal injury**
>
> **To avoid injury:**
> - Never exceed the working load limit
> - Always inspect chain before use for wear, damage, and elongation
> - Do not impact load or jerk chain. Apply load slowly.
> - Protect chain from corrosion and high temperatures
> - Use only alloy chain for overhead lifting
> - Do not use twisted, knotted, or kinked chain

Table I (page 4) provides specification and application data for CM Grade 30, 43, 63, 70, 80 and 100 chains. Grades 63, 80, and 100 are alloy chains and due to their strength/toughness properties are the only chains recommended for overhead lifting by NACM, OSHA Standard 1910.184, ASTM Standard A391 and ANSI/ASME Standard B30.9. See Table II (page 5) for the "Working Load Limits" of CM Grade 30, 43, 70, 80 & 100 chains.

1. Inspect chain before each use as indicated in the "chain inspection" section.
2. Do not exceed the working load limit.
3. Free all twists, knots and kinks, and protect chain from sharp corners and objects.
4. Avoid sudden jerks or impacts when applying the load to the chain.
5. Select the proper grade and size chain for the application. Refer to Tables I and II.
6. Select attachments such as hooks to match the grade, size and working load limit of the chain.
7. Be aware of the environment the chain is being used in. Extreme temperatures and corrosive media can affect the working load limit of the chain.

CARE

Care should be exercised so that the chain is not abused in any way.

1. Links should not be subjected to or exposed to sharp objects that could cause nicks or gouges.
2. Avoid exposure to corrosive mediums or high temperatures that could affect thermal treatment and strength of the chain, refer to Table VI (page 15).

GRADES 30, 43, 63, 70, 80 and 100 INSPECTION

Visually inspect all chain before use. For a meaningful examination the chain should be cleaned to permit proper viewing of links. Examine each link for the following conditions:

1. Twists or bends
2. Nicks or gouges
3. Excessive wear at bearing points (Interlink Area)
4. Elongation (Link Elongation)
5. Corrosion or other obvious damage

Since any of the above noted conditions can affect chain performance and/or reduce the chain strength, chains containing any of the conditions should be removed from service. A qualified person should examine the chain, assess the damage, and make a decision on whether or not repair is necessary before returning it to service. Extensively damaged chain should be scrapped. Because of its use in critical lifting applications, repair of alloy steel chain is not recommended except that nicks and gouges must be removed from the chain by a qualified person as instructed in the "Nicks and Gouges" section of this document. A more thorough discussion of damage assessment can be found in the "Grade 63, 80, and 100 inspection" section of this document.

GRADES 63, 80, AND 100 INSPECTION (IN DEPTH)

Since grade 63, 80, and 100 chains are used for overhead lifting, and used frequently as part of a sling component, the potential for bodily injury or property damage is greater than uses involving other graded chains. For this reason a more detailed and in depth inspection is necessary. These grades can also be used for pulling and binding when a higher strength chain system is required for these purposes. The following instructions and information address Grade 63, 80, and 100 chain, but are of value for all chain uses and chain systems.

OSHA CHAIN SLING INSPECTION

Since first published in final form on July 27, 1975, the OSHA Chain Sling Inspection section remains little changed. Specifically, the applicable sections of Code of Federal Regulations (29 CFR 1910.184) are quoted as follows:

(d) INSPECTIONS — Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use, where service conditions warrant. Damaged or defective slings shall be immediately removed from service.

(e) ALLOY STEEL CHAIN SLINGS

(3) inspections (i) in addition to the inspection required by paragraph (d) of this section, a thorough periodic inspection of alloy steel chain steel slings in use shall be made on a regular basis, to be determined on the basis of (A) frequency of slings in use; (B) severity of service conditions; (C) nature of lifts being made; and (D) experience gained on the service life of slings used in similar circumstances. Such inspections shall in no event be at intervals greater than once every 12 months.

(ii) The employer shall make and maintain a record of the most recent month in which each alloy steel chain sling was thoroughly inspected, and shall make such record available for examination.

(iii) The thorough inspection of alloy steel chain slings shall be performed by a competent person designated by the employer, and shall include a thorough inspection for wear, defective welds, deformation and increase in length. Where such defects or deterioration are present, the sling shall be immediately removed from service."

Note that while the requirements under (d) for daily inspections are not explicit as to scope or maintenance of records, it is possible that individual OSHA inspectors may have different views on conformity. However, the minimum 12-month interval inspections required under (e) call for thorough inspection and written records. It is this thorough type inspection which the procedures recommended in this booklet and in CM Chain seminars are designed to satisfy. Of course, the fundamentals are equally applicable to the more cursory daily inspections made by the riggers, users, or inspectors (a competent person) and will enable them to fulfill their responsibility efficiently.

TABLE I

APPLICATIONS AND SPECIFICATION DATA FOR CM GRADED WELDED STEEL CHAIN

ASTM & NACM Grade	CM Chain Embossment	ASTM Specification	Name	Typical Uses
30	G30	A413	Proof Coil	General purpose low carbon chain with industrial and agriculture applications including guard rail chain, logging and load securement. **Not to be used for overhead lifting.**
43	G43	A413	High Test	A carbon steel chain with industrial, construction, and agricultural applications including towing, logging, and load securement. Preferred over Grade 30 because of its higher strength to weight ratio. **Not to be used for overhead lifting.**
63	A	A413	Alloy	A special heat treated alloy steel chain used extensively by the steel manufacturing industry. May be used in rigging and lifting applications.
70	G70	A413 Binder	Transport	A higher strength heat treated carbon steel chain typically used by truckers, loggers and highway crews. Load ratings of grade 70 chain are approximately 20% higher than Grade 43. Uses include load securement, towing, lashing, and as trawler chain. **Not to be used for overhead lifting.**
80	HA 800	A391	Alloy	A higher strength heat treated alloy steel chain primarily used as a sling component for overhead lifting, but can be used in rigging and tie down applications where a lighter weight, higher strength chain is desirable. Recommended for overhead lifting by NACM, ASME, and OSHA.
100	HA 1000	A973	Alloy	Has approximately 25% higher strength than Grade 80 is also used primarily as a sling component for overhead lifting. Can also be used for any of the previously mentioned applications. Recommended for overhead lifting by NACM, ASME, and OSHA.

TABLE II

WORKING LOAD LIMIT OF CM GRADES 30, 43, 70, 80, AND 100 CHAIN

SIZE							WORKING LOAD LIMIT (LBS.)				
NOMINAL		ACTUAL (IN.)									
IN.	MM	GRADE 30	GRADE 43	GRADE 70	GRADE 80	GRADE 100	GRADE 30	GRADE 43	GRADE 70	GRADE 80	GRADE 100
3/16″	4.7	0.213					800				
7/32″	5.5				0.218	0.218				2,100	2,700
1/4″	6.0	0.270	0.270	0.281			1,300	2,600	3,150		
9/32″	7.0				0.281	0.281				3,500	4,300
5/16″	8.0	0.309	0.327	0.327	0.315		1,900	3,900	4,700	4,500	
3/8″	10.0	0.386	0.386	0.394	0.394	0.394	2,650	5,400	6,600	7,100	8,800
7/16″	11.0	0.468	0.468	0.468			3,700	7,200	8,750		
1/2″	13.0	0.512	0.512	0.531	0.512	0.512	4,500	9,200	11,300	12,000	15,000
5/8″	16.0	0.625	0.625	0.625	0.630	0.630	6,900	13,000	17,100	18,100	22,600
3/4″	20.0	0.750	0.750	0.750	0.787	0.787	10,600	20,200	24,700	28,300	35,300
7/8″	22.0		0.875		0.875		12,800	24,500		34,200	
1″	26.0	1.000	1.000		1.024		17,900	34,100		47,700	
1¼″	32.0				1.260					72,300	

INSPECTION (IN DEPTH) GRADES 63, 80 AND 100

TWISTING and BENDING

Twisted and bent links are relatively easy to recognize and affect chain performance significantly. Twisting and bending of links results from use of slings around sharp corners without padding, use of links with grab hooks under certain adverse conditions, and from loading of chain that is twisted, knotted, or kinked. (Refer to hook section for a more detailed discussion of grab hooks.)

Consider that chain is evaluated by applying loads in a pure tensile link end to link end fashion and rated accordingly. Bent or twisted links alter this normal loading pattern significantly and thus alter inner link stresses accordingly. For this reason all chain containing twisted or bent links must be removed from service.

NICKS and GOUGES

Outsides of the link barrels are exposed to contact with, and therefore damage from foreign objects. Most often, nicks and gouges occur on the ends. Therefore, they usually are located in surfaces under compressive stress and their potentially harmful effects fortunately are reduced. In this connection we might note that the unique geometry of a chain link tends to protect tensile stress areas against damage from external causes. **Figure 1** shows that these tensile stress areas are on the outside of the link body at the link ends where they are shielded against most damage by the presence of interconnected links. Tensile stress areas are located also on the insides of the straight barrels, but these surfaces are similarly sheltered by their location.

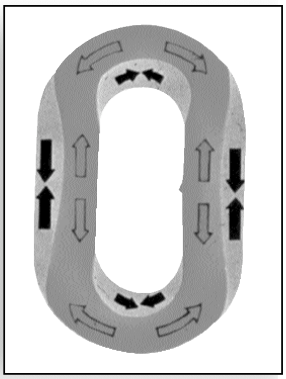


Figure 1 – Pattern of tensile and compression stress shown by a link under load

However, gouges cause localized increases in the link stress. They can be harmful if they are located in areas of tensile stress and particularly so if they are perpendicular to the direction of stress. refer to **Figure 1.**

Figure 2 shows nicks of varying degrees of seriousness. Reading clockwise, at three o'clock there is a longitudinal mark in a compressive stress area. Since it is longitudinal and located in a compressive stress area, its effect is mitigated, but good workmanship calls for it to be ground out. At about five o'clock there is a deep transverse nick in an area of high shear stress. A similar nick is located at six o'clock in the zone of maximum tensile stress. Both of these can create a potentially dangerous escalation of the local stress and must be filed out. A nick that was located at eight o'clock has been filed out properly. Although the final cross section is smaller, the link is stronger because the stress riser effect of the notch has been removed. The remaining cross section can now be evaluated for acceptability by measuring it and applying the criterion for worn chain. See Table III (page 7).

Figure 2 – Location of nicks, gouges, and notches will dictate their seriousness.

WEAR and CORROSION

Corrosion is included in this discussion because it results in a reduction of link cross-section and can be detected using the same criteria as that for wear. Wear can occur in any portion of a link that is subject to rubbing contact with another surface. A glance at a strand of chain will reveal that its natural shape confines wear, for practical considerations, to only two areas. These are, in order of importance, (a) at the bearing points of interlink contact, and (b) on the outsides of the straight side barrels which may be abraded from dragging chains along hard surfaces or from under loads.

Figure 3 – Inspection for interlink wear can be detected easily by collapsing the chain.

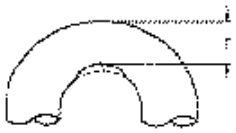
Figure 3 (page 6) illustrates the condition of interlink wear and shows how to inspect for it. Notice how easily such wear cab be detected by collapsing the chain to separate each link from its neighbors.

When wear has been observed the question arises as to whether the amount is tolerable. This question can be resolved quickly by making a caliper measurement across the worn section and comparing this with the minimum allowable dimension. See Table III giving minimum section dimensions or wear allowances for Columbus McKinnon Grade 80 and 100 Chain.

Table III

WEAR ALLOWANCES OF HERC-ALLOY 800 AND 1000 CHAIN*

Measure cross section at link ends to determine wear. If chain is worn to less than the minimum allowable thickness, remove from service.



CHAIN SIZE		MINIMUM ALLOWABLE THICKNESS (T)	
INCHES	mm	INCHES	mm
7/32	5.5	0.189	4.8
9/32	7.0	0.239	6.1
3/8	10.0	0.342	8.7
1/2	13.0	0.443	11.3
5/8	16.0	0.546	13.7
3/4	20.0	0.687	17.5
7/8	22.0	0.750	19.1
1	26.0	0.887	22.5
1 1/4	32.0	1.091	27.7

Note: For sizes not listed, the Minimum Allowable Thickness can be calculated as 87% of the original material diameter.

*May also be used as a guide for CM G63 Alloy Chain

Fortunately, the strength of welded link chain is relatively unaffected by a moderate degree of wear. The reason for this will be understood better if we take a brief look at the pattern of stress distribution in a chain link supporting an axial tension load.

Figure 4 shows in exaggerated manner the change in shape that takes place under such loading conditions. Note that the ends move farther apart while the side barrels move closer together. If the link were in a neutral stress condition to start with, the loaded link shown in broken outline would contain stresses of compression and tension. This is clearly illustrated in **Figure 5** showing an inflated inner tube which is sustaining a load in the manner of a chain link. The wrinkled sections clearly indicate the areas of compression.

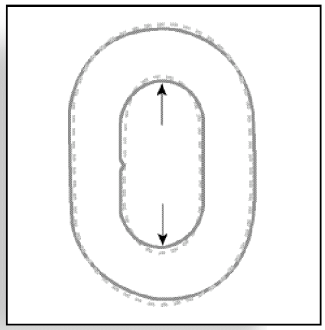


Figure 4 — Changes in link shape that take place under axial tension loading.

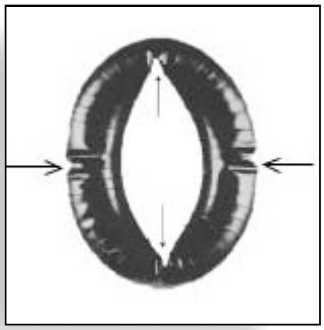


Figure 5 — The tube "under load" shows by wrinkles the areas of compression.

Figure 1 (page 6) shows the location of these stresses in a chain link. Tensile stresses are represented by arrows pointing away from each other, and compression stresses are depicted by arrows pointing toward each other. Notice that the bending, which occurs when link elongation takes place, induces compressive stresses at the interlink bearing surfaces and on the outside surfaces of the side barrels. Hence, we see that these surfaces, which are the potential wear areas, play a lesser role in supporting the tensile load on the chain. For that reason some amount of interlink or side barrel wear can occur before chain tensile strength decreases significantly.

Corrosion will generally be exhibited in the form of rusting and pitting. Rusted chain with a smooth unpitted surface finish may be continued in service provided that the minimal section dimensions or wear allowances published by the chain manufacturer are complied with. Visually discernable pitting, however, should be carefully inspected using the technique outlined for "Nicks and Gouges", paying particular attention to areas of tensile stress.

Alloy steel sling chain typically exhibits well over 15% elongation before rupture. The combination of elongation and high strength provides energy absorption capacity. However, high elongation or stretch, by itself, is not an adequate indicator of shock resistance or general chain quality and should not be relied upon by riggers to provide advance warning of serious overloading and impending failure. Overloading must be prevented before it happens by selection of the proper type and size of slings.

A STRETCHED CHAIN INDICATES OVERLOADING

A visual link-by-link inspection is the best way to detect dangerously stretched links. The least sign of binding or loss of clearance at the juncture points of links indicates collapse in sides of links due to stretch. **Any amount of stretch indicates overloading, and the chain should be removed from service.**

Note that a significant degree of stretch in a few individual links may be hidden by the apparent acceptable length gage of the overall chain. This highlights the importance of link-by-link inspection.

There is no short-cut method that will disclose all types of chain damage. Safety can only be achieved through proper inspection procedures. There is no adequate substitute for careful link-by-link scrutiny.

WELDED NON-GRADED CHAINS

CM manufacturers a number of welded non-graded chains as shown in **Figure 6.** While not classified as industrial grade chain, they find use in a variety of light duty applications where bodily injury or property damage is not likely. Such applications include use with guard rails, as a security chain, to support signs and light suspended loads and as a curtain chain. These chains are not covered in detail in this manual since they are not considered towing, lifting, or pulling chains. Information under "Welded Graded Chains" "Use, Care, and Inspection," may be used as a guide in the use and inspection of these chains.

For complete specifications and code numbers refer to CM Bulletin IPC-10

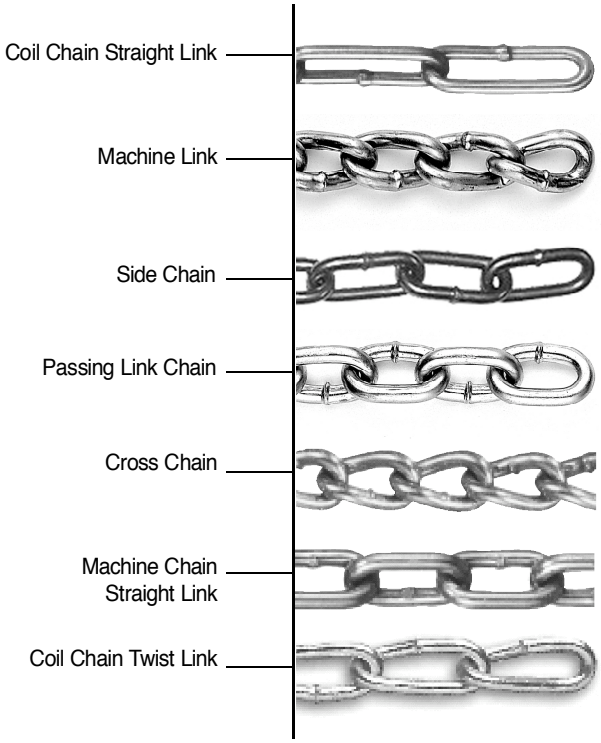


Figure 6

Chain

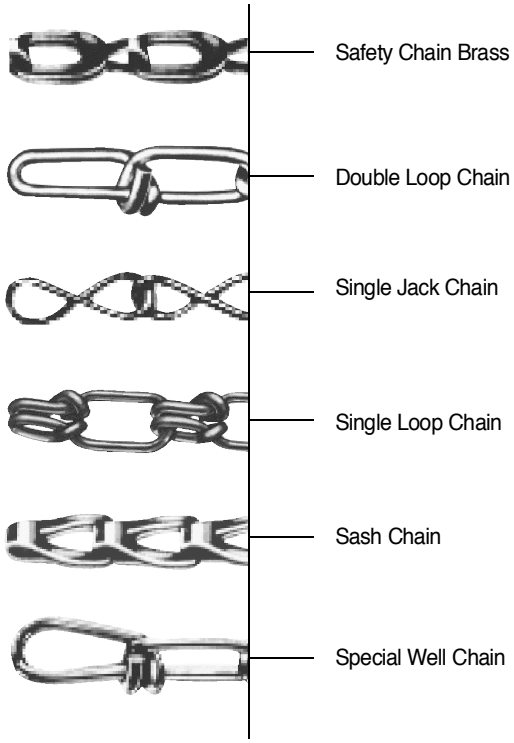


Figure 7

WELDLESS CHAINS

CM markets a number of light duty weldless chains as shown in **Figure 7.** Some uses include plumbing applications, boats, gates, animal leashes, window sashes, support fixtures, and playground equipment. These chains are not covered in detail in this manual since they are not considered towing, pulling, or lifting chains.

CHAIN SLINGS

Chain slings are used primarily for overhead lifting and are generally used in conjunction with a crane or some type of lifting device. Standard sling configurations consist of chain branches which are affixed on one end to a master link or ring with some type of attachment, usually a hook, affixed to the opposite end. **Figure 8** (page 12) shows a number of standard sling configurations manufactured by Columbus McKinnon Corporation.

American National Standard ANSI B30.9, the National Association of Chain Manufacturers, and the Occupational Safety & Health Administration recommend only the use of alloy steel chain for overhead lifting i.e. for sling chain. Slings may be constructed by the user using CM grades 63, 80 or 100 Chain, CM alloy attachments and CM mechanical coupling links (Hammerloks). Columbus McKinnon uses Grade 80 or 100 chain and alloy steel welded coupling links instead of Hammerloks for construction of welded slings. Refer to the sections in this manual entitled "Welded Graded Chain," "Hooks," "Mechanical Coupling Links," and "Rings and Links" for detailed information on components which may be used in the construction of slings.

CM Alloy steel chain slings are provided with a durable metal identification tag. This tag is typically affixed to a master coupling link and contains the following data.

A) Size

B) Reach — **Figure 8** (page 12)

C) Working load limit at 90 degrees on single and 60 degrees from horizontal on multi-leg slings

D) Serial number

E) CM (manufacturer's name) and grade

F) Number of branches (sling type)

USE

Always observe the following when working with Chain Slings:

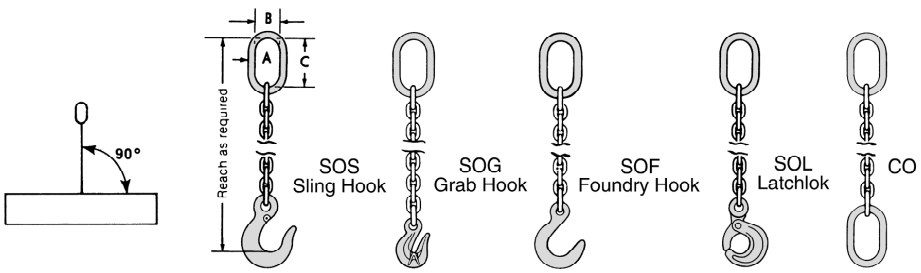
⚠ WARNING

Improper use and care of chain slings can result in bodily injury or property damage.

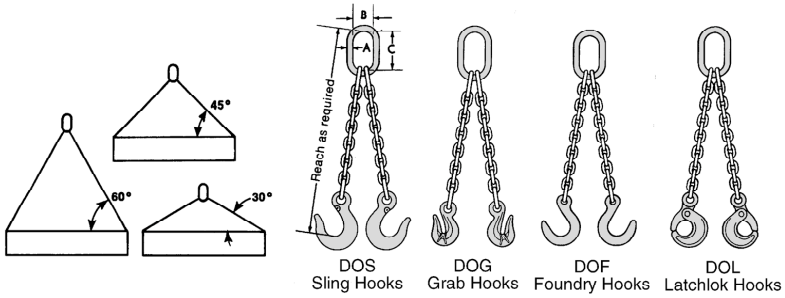
To avoid injury or damage:

- Never exceed the working load limit. Make certain all sling components are matched in strength - Table IV (page 13)
- Always inspect slings before use for wear damage or elongation - refer to ANSI B30.9, OSHA regulation,and this manual
- Do not impact load or jerk the sling
- Protect slings from corrosion and high temperatures - Table VI (page 15)
- Use only alloy chain for overhead lifting
- Do not use twisted, knotted, or kinked chain

Single Chain Slings-Type S & C



Double Chain Slings -Type D



Triple Chain Slings -Type T
Quad Chain Slings -Type Q

SAFETY NOTE: A quad branch chain sling especially when used on a load of rigid structure, is usually not sustaining the load evenly distributed on each of its four branches. The maximum working load limits are therefore set at the same values as for triple branch chain slings of equal quality and size and used with branches at same angle of inclination.

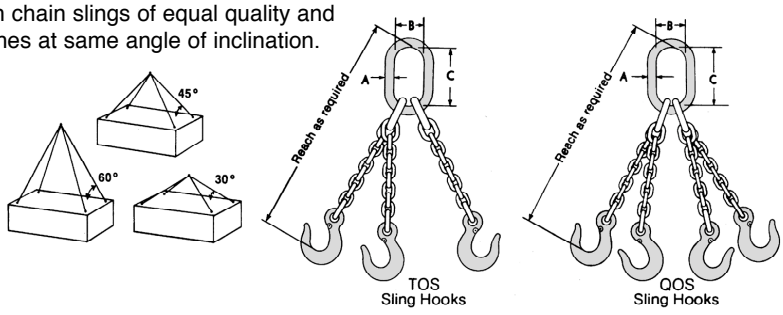


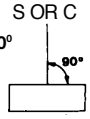
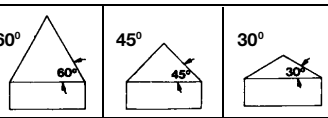
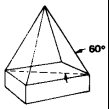
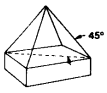
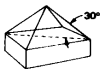
FIGURE 8-CM GRADE 80 AND 100 HERC ALLOY WELDED CHAIN SLINGS

USE (Continued)

1. Inspect chain slings before each use as indicated in"GRADE 80 and 100 CHAIN INSPECTION" and sling "INSPECTION" sections.
2. Do not exceed working load limit as indicated on sling identification tag. Any of the following factors can lead to a reduction in the strength of the sling and possible pre mature failure:
   - Rapid load application can produce dangerous overloading.
   - Variation in the angle of the load of the sling. As the angle decreases, the working load of the sling will decrease. Refer to Table IV and Table V— Working Load Limit Chart.
   - Twisting, knotting, and kinking subjects links to undesirable loading which decreases the working limit of the sling.
   - Conditions other than that for which slings are intended can reduce the working load limit of the sling. For example, use at elevated temperatures will result in a reduction in working load limit. Refer to Table VI — "Use of Chain Under Heat Conditions."(page 15)
3. Free all twists, knots and kinks.
4. Center load in hook(s). Hook latches must not support load.
5. Avoid sudden jerks when lifting and lowering.
6. Balance all the loads; avoid tipping of loads.
7. Use pads around sharp corners.
8. Don't drop load on chains.
9. Select attachments such as hooks or rings for use with chain to match the size and working load limit of the chain.
10. Use only alloy steel chain for overhead lifting.

TABLE IV

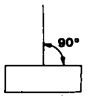
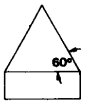
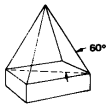
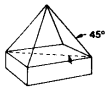
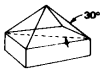
***WORKING LOAD LIMITS OF CM Herc-Alloy 800 CHAIN SLINGS IN POUNDS**

CHAIN SIZE IN INCHES		SINGLE TYPES S OR C 	DOUBLE BRANCH TYPE D 			60° 	45° 	30° 
IN.	MM.	Herc-Alloy 800	Herc-Alloy 800	Herc-Alloy 800	Herc-Alloy 800	Triple/Quad	Triple Quad	Triple/Quad
7/32″	5.5	2,100	3,600	3,000	2,100	5,500	4,400	3,200
9/32″	7.0	3,500	6,100	49,000	3,500	9,100	7,400	5,200
3/8″	10.0	7,100	12,300	10,000	7,100	18,400	15,100	10,600
1/2″	13.0	12,000	20,800	17,000	12,000	3,1200	25,500	18,000
5/8″	16.0	18,100	31,300	25,600	18,100	47,000	38,400	27,100
3/4″	20.0	28,300	49,000	40,000	28,300	73,500	60,000	42,400
7/8″	22.0	34,200	59,200	48,400	34,200	88,900	72,500	51,300
1″	26.0	47,700	82,600	67,400	47,700	123,900	101,200	71,500
1 1/4″	32.0	72,300	125,200	10,2200	72,300	187,800	153,400	108,400

Factory assembled HERC-ALLOY 800 chain slings have the "HERC - ALLOY 800" trademark on serial number tags and on the sling hooks. On chain sizes 9/32″ thru — 1 1/4″ links are embossed with with grade symbol "HA-800". This data applies to Herc-Alloy 800 Chain only. Ratings apply to both factory assembled slings and slings assembled with **Hammerlok** coupling links, **Clevlok** hooks, or Lodelok hooks

TABLE V

HERC-ALLOY 1000 CHAIN SLINGS

*WORKING LOAD LIMITS IN POUNDS							
	TYPES S OR C	DOUBLE BRANCH TYPE D					
							
SIZE OF CHAIN IN INCHES	POUNDS LIFT WHEN USED SINGLE	POUNDS LIFT WHEN USED AT 60° ANGLE	POUNDS LIFT WHEN USED AT 45° ANGLE	POUNDS LIFT WHEN USED AT 30° ANGLE	TRIPLE/QUAD 60° ANGLE	TRIPLE/QUAD 45° ANGLE	TRIPLE/QUAD 30° ANGLE
7/32″	2,700	4,700	3,800	2,700	7,000	5,700	4,000
9/32″	4,300	7,400	6,100	4,300	11,200	9,100	6,400
3/8″	8,800	15,200	12,400	8,800	22,900	18,700	13,200
1/2″	15,000	26,000	21,200	15,000	39,000	31,800	22,500
5/8″	22,600	39,100	32,000	22,600	58,700	47,900	33,900
3/4″	35,300	61,100	49,900	35,300	91,700	74,900	53,000

Factory assembled HERC-ALLOY 1000 chain slings have the “HERC-ALLOY 1000” trademark on serial number tags and on the sling hooks. On chain sizes 9/32″ thru — 3/4″ links are embossed with with grade symbol “HA-1000.” This data applies to Herc-Alloy 1000 Chain only. Ratings apply to both factory assembled slings and slings assembled with **Hammerlok** coupling links, **Clevlok** hooks, or Lodelok hooks.

HOW LIFTING ANGLES REDUCE WORKING LOAD LIMITS OF SLINGS.

Percentages shown represent the maximum working load limit of the sling when used at the designated angle.

For example, a 3/8″ Herc-Alloy 800 double sling used at 90° would have a working load limit of 2 times the working load of a 3/8″ Herc-Alloy 800 single or 2 x 7, 100 lbs. = 14,200 lbs.

The same double sling used at 35° would have a maximum working load limit of 57% of 14,200 lbs. or .57 x 14,200 lbs. = 8,094 lbs.

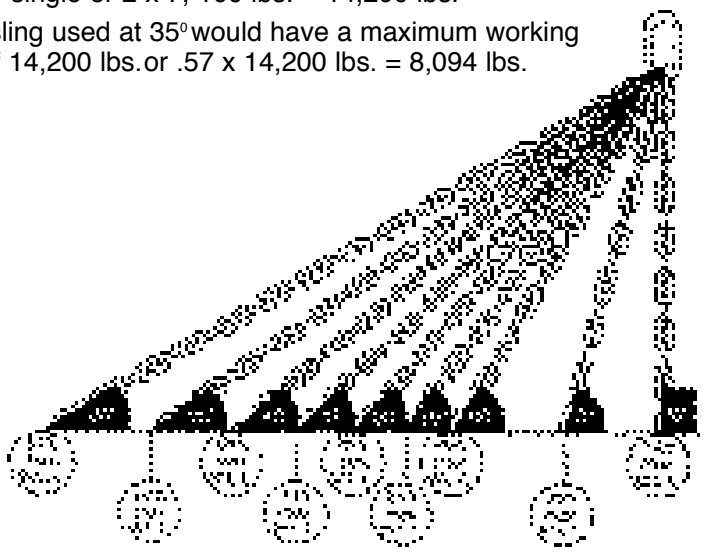


TABLE VI

EFFECT OF ELEVATED TEMPERATURES ON THE WORKING LOAD LIMIT OF ALLOY CHAIN

Temperature		Grade 80		Grade 100	
(F)	(C)	REDUCTION OF WORKING LOAD LIMIT **WHILE AT** TEMPERATURE	REDUCTION OF WORKING LOAD LIMIT **AFTER EXPOSURE** TO TEMPERATURE	REDUCTION OF WORKING LOAD LIMIT **WHILE AT** TEMPERATURE	REDUCTION OF WORKING LOAD LIMIT **AFTER EXPOSURE** TO TEMPERATURE
BELOW 400	BELOW 204	NONE	NONE	NONE	NONE
400	204	10%	NONE	15%	NONE
500	260	15%	NONE	25%	5%
600	316	20%	5%	30%	15%
700	371	30%	10%	40%	20%
800	427	40%	15%	50%	25%
900	482	50%	20%	60%	30%
1000	538	60%	25%	70%	35%
OVER 1000	OVER 538	OSHA 1910 .184 REQUIRES ALL SLINGS EXPOSED TO TEMPERATURES OVER 1000° F BE REMOVED FROM SERVICE			

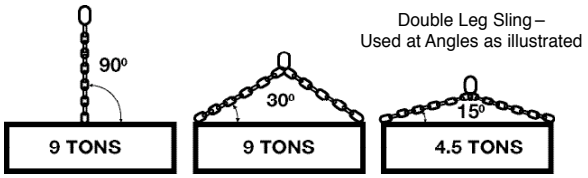
SLING LOADING, ANGLES, AND CHOKING

A simple and necessary precaution is expressed in the phrase “Do not overload!” The use of slings of ample size pays off in longer service life and added safety.

All chain manufacturers publish working load ratings for single chain slings in straight tension, and for double, triple and quad-branch slings when used at various angles (Table VI). **Figure 9** illustrates how such tables would rate the capacity of a commercial Grade 80 sling made from 5/8 inch alloy chain. Working load limit tables are helpful and easily understood. - refer to Table IV, and Table V (pages 13 and 14).

However, the fact is often overlooked that a single strand sling may be rigged to be, in part, like a double branch sling and as such to involve sharp angles of loading. This is the reason that chain damage and overloading are usually localized in the lower portion of the sling near the load. **Figure 10** illustrates this important point. On the left we see a double branch sling used in the conventional manner. Unfortunately, such idealized rigging, where sling hooks are neatly seated in eyebolts or clevises and all portions of the chain are in straight tension, is not always possible.

A more typical and frequent arrangement is shown in the illustration on the right of **Figure 10.** Here a single sling equipped with a hook is being used in a choke hitch. Above the crotch the tension in the chain is 9 tons, the same tension as that in the illustration on the left. Let us assume the 9 tons to be an acceptable load for this size chain in straight tension. One could think that everything is in proper order. We can pick up our 9 ton load and safely move it away. Or can we? Take another look below the hook! Here, surprisingly, you see what looks like a little double branch sling. As a matter of fact, it is a double branch sling. Furthermore, typical of the flat branch angles in tight choke hitches, the legs are at angles of only 15 degrees from the horizontal. At those angles the tension load in each leg of our 9 ton capacity is 17.4 tons — an overload of nearly 100%.



Working load limits for 5/8 inch alloy steel chain slings, (single and double leg configurations.)

Figure 9 - WORKING LOAD LIMITS FOR 5/8˝ CM HA 800 ALLOY STEEL CHAIN SLINGS

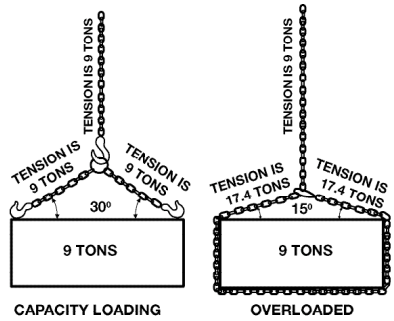


Illustration shows how chain can be greatly overloaded due to reduction below critical hitch angle of 30° even if the load does not exceed chain WLL.

Figure 10 - 5/8˝ CM HA 800 ALLOY STEEL CHAIN

Obviously the chain used in this example is too small for the job. From a safe rigging standpoint, it is important that the worker be aware of the load that will be imposed on the sling in a given situation, and select the proper size chain for the job. From an inspection standpoint, it should be clear that most damage is likely to occur in the lower portion of a sling. The chain inspection must therefore give particular attention to this section. Since the sections most subject to damage are those with which the workers come into contact during the process of making hitches, it is advantageous to enlist the riggers' aid. By reporting promptly any damaged links they notice, caused by overloading or by contact with loads and grab hooks, riggers can make the job of chain inspection much more effective.

SHOCK LOADING

It should be remembered that the dynamic load applied to a chain if a payload is raised with a jerk or permitted to fall and snubbed by a slack chain can vastly exceed the static weight being lifted.

For example, 1/2˝ Herc-Alloy 800 has a working load rating of 12,000 lbs. It will sustain this amount of total load many years in trouble-free service. However, a payload weighing considerably less than 12,000 lbs. can break the chain in a one-time situation if permitted to drop and produce high dynamic stresses.

Herc-Alloy 800 1/2˝ chain in this example has a rupture work (impact strength) capacity of about 9,000 ft.lbs./ft. this means that if a 9 foot long sling were being used to raise a 12,000 lb. payload and if the load some how snagged and then dropped onto the slack sling hook, a drop of about 7 feet would break the chain. Ex. 9,000 ft. lbs./ft x 9 ft. approximately equals 12,000 lbs. x 7 ft.

The amount of dynamic load imposed on a chain in such a situation can, of course, not be planned on and allowed for. Although the cited example is rather extreme, it can happen, and should serve to emphasize the warning, **"Do No Overload!"**

CARE

Chain slings require proper care as follows:

1. Store slings on an “A” frame in a clean dry place.
2. Avoid exposure to corrosive mediums. Oil chain before prolonged storage.
3. Never alter the thermal treatment of CM Herc-Alloy 800 chain or components by heating.
4. Do not plate or change surface finish of chain or components. Contact Columbus McKinnon for special requirements.

INSPECTION

It is important to inspect chain slings regularly and to keep a record of each chain inspection. The following is a guide for such an inspection procedure. CM will supply sling record cards or sheets as requested.

Before inspection, clean the chain sling so that marks, nicks, wear and other defects can be seen. Use a non-acid/non-caustic solvent. Each chain link and sling component should be individually inspected for the conditions noted below. For a more detailed discussion of each of the following conditions listed in steps 1-4, refer to the section entitled “INSPECTION OF GRADES 63, 80, and 100 CHAINS”.

1. Excessive wear and corrosion at chain and attachment bearing points. Refer to Table III, “Wear Allowance chart for HA 800 and HA 1000 chain”. Table III should also be used as a guide when inspecting coupling links.

2. Nicks or gouges.

3. Stretch

4. Twists or bends

5. Distorted or damaged master links, coupling links, or attachments, especially spread in throat opening of hooks. Each link or component having any condition listed above is to be marked with paint to clearly indicate rejection and elimination form service until properly repaired or replaced.

6. Refer to sections in this manual entitled “HOOKS,” “MECHANICAL COUPLING LINKS,” and “RINGS AND LINKS” for inspection guideline regarding distortion and wear of hooks, master links and Hammerloks. In general, any linear reduction in section of 10% or more is cause for removal of the attachment from use.

Slings exhibiting any of the above noted conditions should be removed from service for repair or replacement.

CM ATTACHMENTS

Attachments are load transmitting components frequently used in conjunction with other rigging equipment. Primarily used in the construction of slings, they also find use in tie down applications, temporary repair of low carbon chain, and joining other attachments such as hooks to chain. Attachments manufactured and marketed by Columbus McKinnon include hooks, mechanical coupling links, master links, and rings.

HOOKS

Hooks may be used in a wide variety of applications for lifting, towing, pulling, and securing. In many of these applications hooks are frequently used in conjunction with chain. There are specialty tailored hooks to be used with the graded chains discussed earlier in this product m anual. Refer to American National Standard ANSI B30.10 for a discussion on hooks, inspection procedures, and operating practices.

There are two general classifications of hooks supplied by Columbus McKinnon Corporation. Sling hooks to which the load or force is applied to the base (bowl saddle) of the hook and grab hooks which contain a slot or throat of uniform width for securement on a link of the chain usually to form a chain loop for supporting the load.

In addition to the hooks discussed above there are a number of specialty and non-conventional hooks supplied by Columbus McKinnon Corporation. They include foundry hooks, claw hooks, “S” hooks, plate hooks, sorting hooks, trek hooks, tie-down hooks, “C” hooks, and tarp hooks.

All CM conventional style hooks are manufactured of drop forged steel.

USE

Always observe the following when using hooks:

⚠ WARNING

Improper use of hooks can result in bodily injury or property damage.
To avoid injury or damage:
- Do not exceed the working load limit.
- Do not tip load or use in any manner for which th hook was not intended.
- Do not shock or dynamic load.
- Do not apply load to hook latches. Latches are to retain slack slings and chain only.

1. Inspect hooks before each use as indicated in the hook “Inspection” section.

2. Hooks attached to chain should be selected to match the size and working load limit of the chain.

3. Do not exceed the working load limit or shock load the chain. Note: Loads less than the working load limit if applied rapidly or dropped freely can result in serious overloading of the hook.

4. Use proper size chain in the slot of the grab hook.

SLIP HOOKS

CLEVIS SLIP HOOKS

Clevis slip hooks must be matched to the chain size. Designed for use primarily with graded chains and affixed directly to the chain. Available in heat treated carbon and heat treated alloy steel (compatible with Grade 63 chain). Load must be applied in line with clevis, placed firmly in the base (bowl saddle) of the hook.

Clevis Slip Hook

CLEVLOK SLING HOOKS

Clevlok sling hooks must be matched to chain size and grade. Designed for sling use primarily with Grade 80 chain and affixed directly to the chain. Available in heat treated alloy steel only with optional latch. Load must be applied in line with clevis, placed firmly in the base (saddle-bowl) of the hook. **Note:** The latch is designed to retain such items as slings and chains under slack conditions only and is not intended to support the load.

Clevlok Sling Hook

EYE SLIP/SLING HOOKS

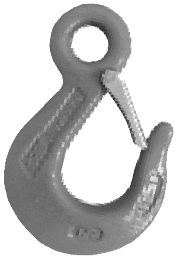
Eye slip hooks should be matched to the size and grade. Designed for use primarily with graded chains. Must be affixed to the chain either with a welded coupling link or with a mechanical coupling link. Load must be applied in line with eye placed firmly in the base (bowl-saddle) of the hook.

TYPE I — EYE SLIP HOOKS — Available in un-heat treated carbon, and heat treated carbon, and heat treated alloy steels. **Note:** The alloy steel version will not develop the strength of grade 80 chain, but meets alloy Grade 63 chain requirements.

Eye Slip Hook

TYPE II — EYE SLING HOOKS — Available only in heat treated alloy steel* — latch optional. Designed for sling use primarily with grade 80 chain. **Note:** The latch is designed to retain such items as slings and chains under slack conditions and is not intended to support the load.

*This hook is also available in stainless steel for use in stainless steel slings.



Eye Sling Hook

TYPE III — LODELOK HOOKS — Available in two types made of heat treated alloy steel only. Can be used with Grade 80/100 chain. Clevis type (under development)must be matched to the size of the chain. Rigging type has enlarged eye to accept larger couplers and thimbles used in rigging applications. Also ideal for use in slings. The latch is an integral part of the upperhook. Note: The latch is designed to retain such items as slings and chains under slack conditions and is not intended to support the load.

Lodelok

TYPE IV — LATCH SLIP HOOK — Available in un-heat treated carbon steel with latch designed for use on small winches, cable pullers, and towing assemblies. **Note:** Latch is designed to retain such items as slings and chain under slack conditions and is not intended to support the load.

Latch Slip Hook

RIGGING HOOKS

Similar to eye slip hooks except with an enlarged eye for larger couplers such as thimbles, etc. Available in heat treated carbon or heat treated alloy steels. A general purpose rigging hook with optional latch. Load must be applied in line with eye firmly in the base (bowl-saddle) of the hook. **Note:** The latch is designed to retain such items as slings and chain under slack conditions and is not intended to support the load. See also "Type III - Latchlok Hooks."

CM Rigging Hook

GRAB HOOKS

A conventional grab hook is designed to be hooked back onto the chain in a choker arrangement. The full working load limit can be achieved if the hitch angle is 30° or greater. See **Figure 10** (page 16) and Table IV (page 13) and Table V (page 14) — outlining derating for slings in section entitled "CHAIN SLINGS."

If used in other configurations such as direct tension, the working load limit of the assembly must be derated by 25%. **Figure 11** shows why the link in the slot of a conventional grab hook is stressed more than the adjacent links. In addition to carrying its share of the straight tension load, the link must also withstand an additional bending caused by contact with the hook saddle. The link usually fractures in this arrangement at about 75% of the chain's normal breaking load.

With the cradle style grab hook as shown in the illustration, the outrigger's cradle action reduced bending distortion of the link in the chain slot and the chain typically develops full strength.

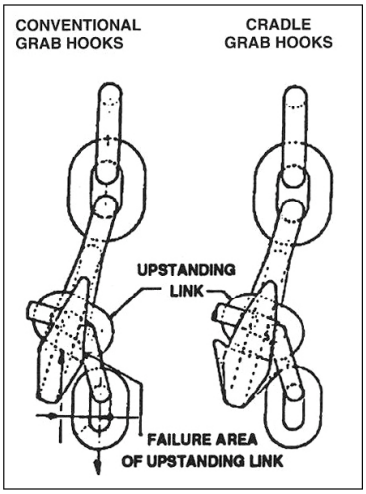


Figure 11
Comparison of conventional and cradle grab hooks

Refer also to warning on page 21.

CONVENTIONAL CLEVIS GRAB HOOKS

Clevis grab hook must be matched to the chain size. Designed for use primarily with graded chains and affixed directly to the chain. Available in heat treated carbon and heat treated alloy steels.

CLEVLOK CRADLE GRAB HOOKS

Clevlok Cradle Grab hooks must be matched to chain size. Designed for use primarily with grade 80 chain and affixed directly to the chain. Available in heated treated alloy steel only.

CONVENTIONAL EYE GRAB HOOKS

Eye grab hooks must be matched to the chain size. Designed for use primarily with graded chains. Must be affixed to the chain with a welded coupling link or with a mechanical coupling link. Available in unheat treated carbon, and heat treated alloy steels.*

*This hook is also available in stainless steel for use in stainless steel slings.

EYE CRADLE GRAB HOOKS

Cradle Grab hooks must be matched to the chain size. Designed for use primarily with Grade 80 chain. Must be affixed to chain with a welded link or with a mechanical coupling link. Available in heat treated alloy steel only.

⚠ WARNING

Improper use and care of grab hooks can result in bodily injury or property damage.

To avoid injury or damage:

When using grab hooks in a choker arrangement, derate working load limit of the assembly according to the angle of chains forming the choker.
See also Figure 10 (page 16) Table IV (page 13) and Table V (page 14)– outlining derating information for slings shown in section entitled “CHAIN SLINGS”.

NON-CONVENTIONAL HOOKS

FOUNDRY HOOKS

Foundry Hooks should be matched to the chain size. Available in heat treated alloy steel only. Designed for use primarily with Grade 80 chain. Must be affixed to the chain either with a welded coupling link or with a mechanical coupling link. Hook is suitable for sling use and in applications requiring a uniform throat opening or applications where the hook may be subjected to tip loading.

CLAW HOOKS

Claw hooks must be matched to the chain size. Available in heat treated carbon steel. Designed for easy hook up to loose or taught chain with a hand connection.

"S" HOOKS

A utility type hook made of heat treated alloy steel. Most popular in applications requiring speed and convenience of attachment such as conveyor systems. Also available in low carbon steel material.

ALLOY SWIVEL HOOKS

Alloy swivel hooks are primarily used in rigging applications where the swivel feature allows other rigging elements such as wire rope and chain to remain straight without twists.

SPECIALTY HOOKS

PLATE HOOKS

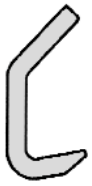
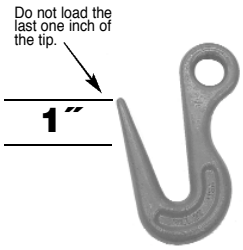


Plate hooks should be matched to the chain size. Available in heat treated alloy steel only. Designed for use primarily with Grade 80 chain in a sling arrangement for the lifting of steel plates or flat planes. Optimum angle of the sling branches is 55-60 degrees. Sling capacity must be derated accordingly.

SORTING HOOK



Made of heat-treated alloy steel, available in one capacity. Sorting hooks may be loaded within 1" of the tip. The working load limit with the load sitting in the bowl (or saddle) of the hook is 7.5 tons whereas the working load limit is 2 tons if the hook is being loaded 1" from the tip. Do not load the last one inch of the tip. The working load limit of 2 tons is forged on the side of the hook. The hook is most useful for efficient handling of cylindrical shapes. The long tapered point is designed for easy grab in rings, pear links, and lifting holes.

TRACTOR DRAWBAR GRAB HOOK

Hook must be matched to the chain size. Made of heat treated carbon steel. Available in only one capacity. For use with 5/16″-1/2 inch graded chain. Fits all tractor draw bars up to $1\frac{5}{8}$ inch thick.

TREK HOOKS

Made of heat treated carbon steel. Ref: Army ordinance drawing PN7336460.

AIRCRAFT TIE DOWN HOOKS/CHAIN TYPE

Made of heat treated alloy steel. Available in only one size. Designed for use with 9/32 inch grade 80 chain.

AUTOMOTIVE TIE DOWN HOOKS

Made of heat treated alloy steel. Conform to requirements set forth in American Association of Railroads Specifications. American Automotive manufacturers have standardized on these two styles. (R-Hook & T-Hook)

TARP HOOKS

Made of carbon steel in one size only (3/8″ x $3\frac{1}{2}$″). A general purpose light duty hook with a variety of uses. Secured in place with bolts.

VEHICLE RECOVERY HOOKS

These hooks include “R” and “T” hooks listed as Automobile Tie Down Hooks plus “J” hooks, which are forged and heat treated. “J” hooks are available in clevis style and eye style in lengths from 8 to 15 inches.

CARE

Care should be exercised during use so that the hook is not abused or damaged.

1. Hooks should not be subjected to bending, exposed to sharp objects, tip loaded (unless specified by the manufacturer) or loaded in a manner inconsistent with its design.
2. Avoid exposure to corrosive mediums or high temperatures that could effect the thermal treatment and strength of the hook.

INSPECTION

Inspect hooks prior to each use. Observe the following:

1. Discard hooks that are worn more than 10% of the original dimension or are worn beyond a specific dimension or tolerance as provided in a wear allowance table, chart, or diagram.

2. Discard hooks that have an increase in throat or slot opening more than 15% of the original opening or in excess of that recommended in the appropriate CM bulletin.

3. Discard hooks that are bent or twisted more than 10 degrees from the plane of the unbent hook.

4. Replace load pins that are permanently distorted.

5. Replace damaged cotter pins.

6. Replace damaged hook latches.

7. Replacement load pins to be obtained from the manufacturer of the hook.

MECHANICAL COUPLING LINKS

Columbus McKinnon Corporation supplies a number of coupling links, some of which are suitable in the construction of slings, others which afford quick repair or splicing of welded carbon steel chain,

Note that alloy steel chain Grade 80 and Grade 100 is not to be spliced or repaired using mechanical coupling links.

USE

Always observe the following when using Coupling Links.

⚠ WARNING

Improper use of coupling links can result in bodily injury or property damage.

To avoid injury or damage:

- Do not exceed the working load limit of the coupling link.
- Be certain that the working load limit of the coupling link matches the working load limit of the chain and the recommended chain size.
- Do not impact or shock load coupling links.
- Do not use excessively worn or damaged coupling links.
- Do not use coupling links to repair alloy chains used for over-head lifting.
- Inspect coupling links before each use.

HAMMERLOKS

Constructed of drop forged alloy steel and primarily used in the construction of overhead lifting slings. Specifically used for connecting the chain branches to the master link and to the hook attachments. Meets the strength of Grade 80 chain. Must be matched to the chain size. **Not to be used for repair or splicing of the chain.**

MID-LINKS (DOUBLE CLEVIS)

Used for quick temporary or permanent repair of chain and for attaching chain hooks, rings, swivels, etc. Must be sized to the chain. Available in a range of sizes to fit 1/4 inch through 5/8 inch chain. Will develop the strength of grade 70 chain. **Not to be used for overhead lifting.**

LAP LINKS

A quick permanent way to repair the chain. Chain link and attachments are threaded onto the lap link and the link flattened. Made of low carbon steel, available in a variety of sizes with stock diameters ranging from 1/8 inch thru 5/8 inch chain. Must be matched to the working load limit of the chain. **Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA.**

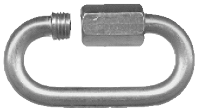
CONNECTING LINKS

A repair link intended for use with Grade 30 chain. Available in a range of sizes to fit 3/16 inch thru 1 inch stock diameter chain. Both halves are placed together and small protrusions are peened over. **Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA.**

COLD SHUTS

A permanent repair link available for use with Grade 30 and Grade 43 chain. After threading link onto the chain, the plain end is inserted through the hole in the link and peened over. Working load limit of the cold shut must be matched to that of the chain. Typically this can be achieved by selecting a cold shut one size larger than the chain. **Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA.**

QUICK LINKS



Afford quick and easy chain repair and/or attachment of fittings. Easy closing by threading nut onto threaded end. Reusable. Working Load limit of link must be matched to that of the chain. Available in stock diameters ranging from 1/8″ to 1/2 inch. **Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA**

CARE

Care should be exercised so that the coupling link(s) is not abused in any way during use.

1. Links should not be subjected to bending or exposed to sharp corners or objects.

2. Avoid exposure to corrosive mediums or high temperatures.

INSPECTION

Visually inspect all coupling links before each use for the following conditions

1. Twists or bends.
2. Nicks or Gouges*
3. Excessive wear at bearing points (innerlink area)*
4. Elongation (link elongation)
5. Corrosion or other obvious damage

*The “Grades 30, 43, 63, 70, 80, and 100” Inspection section of this manual (page 3) may be used as a guide.

Since any of the above conditions can affect the coupling strength, a qualified person should conduct the inspection and determine whether replacement is necessary.

RINGS AND LINKS

While alloy steel rings and links may be used individually for overhead lifting and rigging applications, they are used most frequently as a component of a sling. Figure 8 under the section entitled “Sling Systems” (page 12) which illustrates a number of sling configurations using a Master Link. They are sized for use with Grade 80 chain and enable the user to construct a balanced sling system for lifting and rigging. Shown below are various alloy steel rings and links manufactured and sold by Columbus McKinnon Corporation:

USE

Always observe the following when using rings and links.

⚠WARNING

Improper use of master rings and master links can result in bodily injury or property damage.

To avoid injury or damage:

- Never exceed the working load limit. Always inspect before use for wear, damage, and elongation.
- Do not impact or shock load. Apply load slowly.
- Do not use on oversize crane hooks where link does not fit in saddle of the hook
- Protect from corrosion.
- Use with alloy chain for overhead lifting.

Inspect rings and links before each use as indicated in the “INSPECTION” section.

MASTER RINGS

Because of their round configuration, they have a universal use in rigging applications

OBLONG MASTER LINKS

Oblong master links are the optimum design for use in the construction of slings.The oval design is an optimum configuration for use with crane hooks since the depth of a hook is normally greater than the width. The link may be used in any rigging application including overhead lifting and may be used independent of chain. Oblong master links have a greater capacity size -for-size than master rings because of their smaller width.

OBLONG MASTER LINK SUB-ASSEMBLY

Designed primarily for sling construction with multiple branches. They allow the user to construct a sling using mechanical couplers between the welded master couplers and the chain branches. Also available in stainless steel for use in construction of stainless steel slings.

PEAR SHAPED MASTER LINKS

May be used for the same applications as oblong master links. The design is not optimum for multiple branch slings and in some cases may interfere with the crane hook.

GRAB LINKS

Can be used to create a variable length loop type sling. A link of the chain is captured in the link slot similar to that of a grab hook.

CARE

Rings and links, because of their large size, are prone to bending and distortion. Care should be taken so that such abuse does not occur. They should not be used in extremely corrosive environments without protective coating such as galvanizing. Before galvanizing, to avoid altering metallurgy or heat treatment, contact CM for instructions. If subjected to high temperatures the load rating should be derated as indicated in Table VI in the Grade 80/100 chain inspection section (page 15).

INSPECTION

Before use, inspect the link or ring for wear, bending, distortion (elongation or collapse), cracks, corrosion damage, nicks and gouges.

1. Links or rings which are worn more than 10% of the original diameter should be discarded.

2. Corrosion will deteriorate link material. Unless corrosion is very granular, apply wear criterion in step 1 to determine if link must be discarded. Discard all components with granular corrosion.

3. Wear criterion in step 1 should be applied after nicks and gouges are ground out. See section entitled “Nicks and Gouges” under Grade 80 Chain Inspection (page 6).

4. Links bent more than 10 degrees in the plane of the link should be discarded.

5. Links visibly distorted or twisted should be discarded.

CM SHACKLES & CLEVISES

Shackles and clevises are mechanical couplers which consist of a U-shaped body closed by a “pin.” Shackles are used for construction, rigging, and lifting applications while clevises are used for less demanding applications such as farming and towing. Shackles/clevises are made in two general styles and several special styles. The general styles are “Anchor” and “Chain” while special styles include “Twist” and “Web.” The “Anchor” pattern has a more generous loop better suited to multiple connections. Various “Pin” styles are also available. They range from a round pin secured with a cotter pin or screw pin secured by tightening, to a bolt nut or cotter pin arrangement.

USE

Always observe the following when using shackles/clevises.

⚠ WARNING

Improper use or care of shackles/clevises can result in bodily injury or property damage.

To avoid injury or damage:

- Do not exceed the working load limit.
- Do not shock or load.
- Do not side load – center line of load must coincide with center line of shackle/clevis
- Do not replace pin or bolt with other than original equipment parts.
- Inspect before use for wear, deformation, and pin engagement.

Inspect shackles/clevises before each use as indicated in the “INSPECTION” section (page 3).

SHACKLES

Screw Pin Anchor Shackles / Screw Pin Chain Shackles

Screw pin shackles afford quick and easy removal of the screw pin which is secured by torque. Desirable in applications where the shackle is frequently removed. While the threaded pin can resist axial forces, it is vulnerable to backing out and the shackle is not reliable in applications where the pin is subjected to a torque or twisting action.

Available in the following materials with capacities up to 43 tons:

A) Forged, heat treated special bar quality steel body with forged heat treated alloy steel pin.

B) Forged, heat treated alloy steel body with forged heat treated alloy steel pin.

C) Stainless steel body and pin. Available only in anchor pattern.

Alloy steel shackles are acceptable for overhead lifting.

1. Meets or exceeds Fed. Spec. RR-C-271
2. Meets or exceeds Mil-S-24214
3. Meets or exceeds Mil-F-17280

Logging/Trawling Shackles

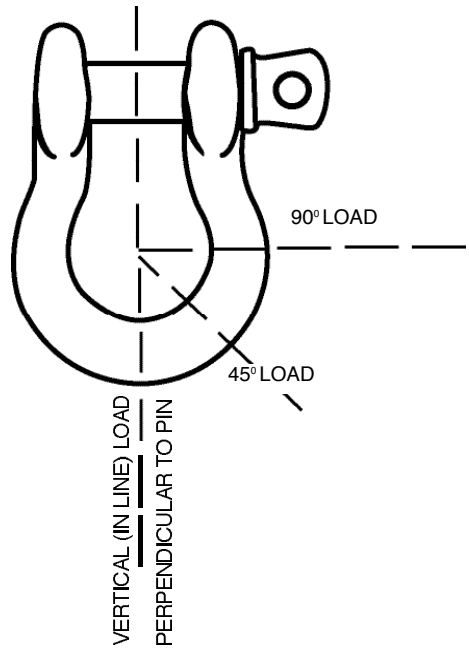
Similar to screw pin chain shackles except the pin has a hex head for convenience in wrench tightening and loosening. Shackle body is made of drop forged heat treated steel and the pin is made of heat treated alloy steel. Available in capacities up to 81/2 tons.

SHACKLES-SIDE LOADING

DO NOT SIDE LOAD ROUND PIN SHACKLES

ANGLE OF SIDE LOAD

0^0, VERTICAL OR IN LINE 100% WLL
45^0 .....70%
90^0 .....50%



SHACKLE INSPECTION:

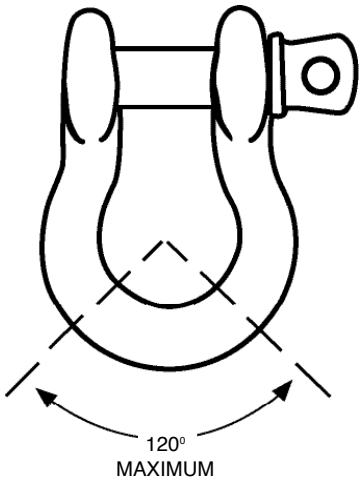
DISCARD CM SHACKLES IF:

1. Any parts worn more than 10% of original dimension.
2. Visibly distorted
3. Bent or twisted more than 10^0
4. Load pins have bent or visibly damaged threads.

SYMMETRICAL LOADING

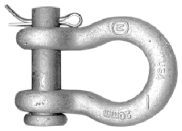
Shackles symmetrically loaded with two legs at a maximum angle of 120^0 can be used to full working load limit.

SIDE AND SYMMETRICAL LOADING DATA APPLIES TO SCREW PIN AND BOLT, NUT, AND COTTER TYPE SHACKLES ONLY.



DO NOT EXCEED 120^0
INCLUDED ANGLE

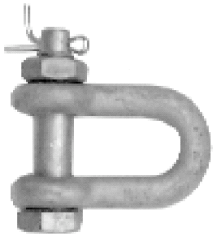
Round Pin Anchor Shackles
Round Pin Chain Shackles



Round pin shackles afford easy removal of the pin which is secured by a cotter pin. Perform well where the pin is subjected to a torque or twisting action. Unsatisfactory in applications where the pin is subjected to an axial load. Available in capacities up to 35 ton. Forged, heat treated steel body with forged heat treated alloy steel pin.

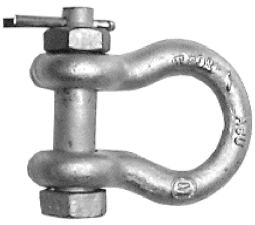
Bolt, Nut, and Cotter Pin Anchor Shackles
Bolt, Nut and Cotter Pin Chain Shackles

Bolt, nut, and cotter pin shackles provide the most secure pin(bolt) arrangement of all styles. Will resist axial loading and torsional loading. Should be used in applications where shackle is semi-permanent with infrequent removal. Available in the following materials with capacities up to 50 tons:



A) Forged, heat treated special bar quality steel body with forged heat treated alloy steel pin (bolt).

B) Forged, heat treated alloy steel body with forged heat treated alloy steel, pin (bolt). Available only in anchor pattern.



Alloy steel shackles are acceptable for overhead lifting.

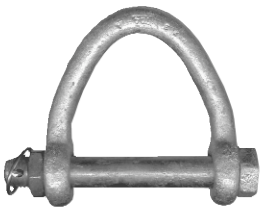
Meets or exceeds Fed. Spec. RR-C-271
Meets or exceeds MIL -S-24214

KILN SHACKLES

Available in “anchor” pattern only, made of carbon steel, alloy steel, or stainless steel. The following shackle closures are available: Loose pin for welding, hex head screw pin, and full nut and bolt. Pin diameters available in 3 sizes for a given size shackle for match with type of service. Can be used in service at elevated temperatures. Heat treatment optional to customer specifications.

WEB SLING SHACKLES

Designed primarily for use with web slings up to 6 inches in width. Available in capacities up to 12 ton. Body is made of heat treated carbon steel and pin is made of heat treated alloy steel.



CLEVISES

Available in configurations depicted. Forged of steel components, designed principally for farm or towing applications. **Not to be used in construction or rigging applications.**

⚠ WARNING

Improper use of/clevises can result in bodily injury or property damage.

To avoid injury or damage:

Do not use for overhead lifting.

STRAIGHT CLEVIS / TWIST CLEVIS

Heavy duty tractor clevis with T-handle pins and hair-pin retainers for close hook ups. Steel pin heat treated. Available in capacities up to 12 tons.

UTILITY CLEVIS

Loose pin harrow clevis. Heat treated steel body with heat treated alloy steel pin.

FARM CLEVIS

Screw pin “anchor” pattern body configuration for multiple hook up. Heat treated steel body with heat treated alloy steel pin. The threaded pin cast axial loads, but is vulnerable to backing out and the clevis is not reliable in applications where the pin is subjected to a torque or twisting action.

CARE

Care should be exercised so that the shackle/clevis is not abused during use.

1. Spacers should be used if necessary on the shackle/clevis pin to assure that the shackle/clevis is not loaded at an angle. Load line of action should be through the center line of the shackle/clevis body and the middle of the shackle/clevis pin.

2. The shackle/clevis should be protective coated such as zinc plated or galvanized if exposed to a corrosive medium.

3. The shackle/clevis should not be subjected to high temperatures that could affect thermal treatment and the strength of the shackle/clevis.

INSPECTION

Visually inspect shackles/clevis before each use.

Discard CM shackles/clevis or shackle/clevis parts that:

1. Are worn more than 10% of the original dimension.

2. Are visibly distorted due to side loading.

3. Are bent or twisted more than 10 degrees in the plane of the unbent shackle/clevis.

4. Have load pins that are visibly bent or have damaged threads.

5. Have damaged cotter pins or hairpin retainers.

Replacement load pins to be obtained from the manufacturer of the shackle/clevis.

CM ACCESSORIES

Accessories offered by Columbus McKinnon Corporation include wire rope clips and thimbles. Used in conjunction with one another, their primary purpose is for wire rope turn back (loop formation).

WIRE ROPE CLIPS

Wire rope clips are used to secure the end of wire rope when forming a loop, i.e, for wire rope turn back. Available in two configurations, mid-grip (double saddle) and single saddle. Each is equally effective and strong; care does have to be exercised in the proper installation of single saddle clips. When installing single saddle clips, saddle must rest against live end of wire rope thimble.

Mid-grip clips are available in a drop forged carbon steel material and single saddle clips are available in malleable iron or drop forged carbon steel. Available in sizes up to 1-1/2 inches. Malleable iron clips are manufactured in accordance with Fed. Spec. RR-C-271 and ASTM Spec. A47, while forged clips are manufactured in accordance with Fed. Spec. FF-C-450.

USE:

Always observe the following when using wire rope clips:

⚠ WARNING

Improper use or care of wire rope clips can result in bodily injury or property damage.

To avoid injury or damage:

- Use only forged carbon steel wire rope clips for critical or lifting applications.
- Do not use malleable iron wire rope clips for critical or lifting applications.
- Use clips in conjunction with wire rope thimbles.
- Inspect periodically for wear, abuse and general adequacy.
- Do not shock or impact load.

When applying wire rope clips observe the following general instructions:

1. Refer to specific instructions which accompany clips for spacing, number of clips, and torque values.
2. Apply wire rope clips with the live rope in the clip in the saddle and the “U” bolt over the end of the rope.
3. Apply first clip as close as possible to thimble.
4. Tighten clips evenly to recommended torque.
5. After applying the initial load to the rope, retorque the clip nuts to the recommended torque to compensate for any decrease in rope diameter caused by load application.
6. Retorque rope clip nuts periodically to compensate for any further decrease in rope diameter.
7. Use only drop forged clips for lifting applications.

CARE

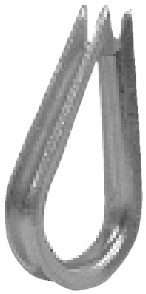
Care should be exercised in the installation and use of wire rope clips so that the clip, wire rope, or thimble is not damaged.

1. Do not over torque or under torque the nuts. Too much torque can result in damage to the clip and/or the wire rope. Too little torque can result in the wire rope slipping. Torque nuts to the value specified in the accompanying instructions.
2. Clips should not be subjected to bending or come in contact with sharp object.
3. Avoid exposure to corrosive mediums.

INSPECTION

Visually inspect wire rope clips before each use.

1. Be certain threads are not stripped and that nuts are tight.
2. Check torque of nuts periodically.
3. Replace distorted thimbles.
4. Shorten wire rope and form new loop if damaged.
5. Replace distorted thimbles.



THIMBLES-WIRE ROPE USE

Made specifically for wire rope turn back forming a cable loop. Used in conjunction with wire rope clips. Manufactured of hot rolled steel in accordance with FED. SPEC. FF-T-276. Available in sizes to fit a maximum of 1-1/2 inch diameter wire rope.

⚠ WARNING

Improper use and care of wire rope thimbles can result in bodily injury or property damage.

To avoid injury or damage:

- During use be certain that crown of thimble is uniformly loaded by appropriate size crane hook.
- Do not point load crown of thimble.
- Inspect periodically for wear and distortion.

SHOULDER EYEBOLTS

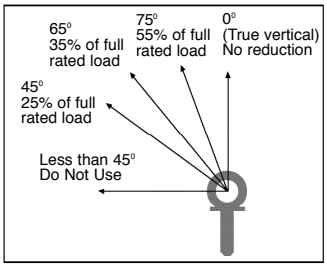
USE

Shoulder eyebolts find numerous uses as “lifting rings” in large, usually metal objects, such as dies, to assist in moving and handling.

Do not exceed the working load limit — reduce the working load limit according to the adjacent table if loading other than true vertical.

Shoulder Eyebolt Working Load Limit Angle to Horizontal

True Vertical	75°	65°	45°	Less than 45°
Full working load limit (refer to full catalog page)	55% of full working load limit	35% of full working load limit	25% of full working load limit	Do not use



If in doubt, consult a rigging handbook or discuss with a qualified person.

Install with shoulder at 90° to axis of hole to assure total contact of shoulder. Torque nut/eyebolt to assure proper seating. Check seating after initial loading.

If installing in tapped hole, make sure depth of thread engagement is at least $1\frac{1}{2}$ times bolt diameter. Thread fit must also be good-tight, not loose-sloppy.

Where eyebolts must be aligned, a washer or shim may be placed under the shoulder to permit alignment when tightened.

To minimize the bending moment, always apply load in the direction of the plane of the eye. Reduce working load limit according to table if loaded other than true vertical.

Never insert a hook tip in an eyebolt; always use a shackle to connect eyebolt to load.

Do not use a sling reeved through an eyebolt or a pair of eyebolts. Attach each single sling leg to an eyebolt using a shackle.

⚠ WARNING

Improper use and care of shoulder eyebolts can result in bodily injury or property damage.

To avoid injury:

- Inspect eyebolt before use for distortion and wear.
- Make sure shoulder is at 90° to axis of hole and seated.
- Always apply load in the plane of the eye.
- Do not exceed working load limit; if loaded other than true vertical, de-rate according to values in table.

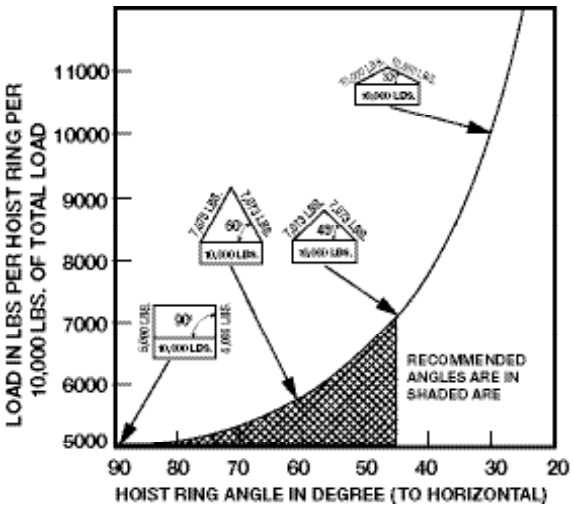
CARE AND INSPECTION

Inspect eyebolts before use.

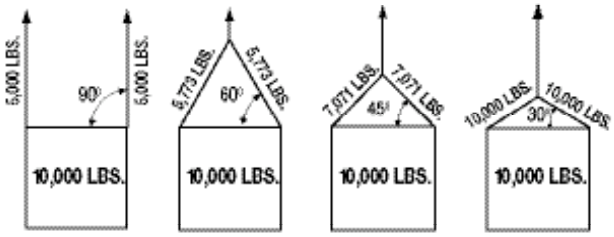
- Do not use if bent more than 15°.
- Do not use if worn more than 10% from any original dimension.
- Do make sure eyebolt shoulder is seated.

HOIST RINGS

Used in the same manner as shoulder eyebolts, hoist rings pivot or swivel to provide a steady lift and maintain higher working load limits than shoulder eyebolts when lifting at angles.



EFFECT OF HOIST RING ANGLE ON LOAD



1. Never exceed the rated capacity of the hoist ring.
2. Mounting surface should be flat and smooth for full contact with the hoist ring.
3. Drill and tap the workpiece so that the hoist ring bolt is installed perpendicular to the surface of the workpiece.
4. Spacers should not be used between the hoist ring and the mounting surface.
5. Mounting screws should always be tightened to recommended torque.
6. After installation, check hoist ring to be sure it swivels and pivots freely in all directions.
7. When lifting, apply force gradually.

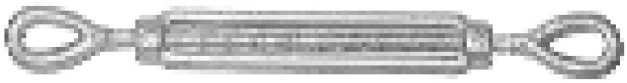
⚠ WARNING

Improper installation and use of hoist rings can cause injury.

To avoid injury:

- Do not exceed rated load
- Install rings per instructions. Verify full 360° seating—retorque periodically
- Consult angular lifting graph when lifting at other than 90°

TURNBUCKLES



USE

Turnbuckles find many uses to apply tension to wire rope or cable. They are composed of a forged body and two end fittings. End fittings can be eyes, jaws, or hooks. They must,however, be applied only up to loads within their working load limit as specified for the particular end fitting being applied.

Apply turnbuckles in a straight in-line manner only. Do not allow anything to contact the turnbuckle body or end attachment threaded shanks.

Apply load to the center of end attachment eyes and bowl of hooks. Do not tip load hooks or side load eyes.

CARE AND INSPECTION

Inspect turnbuckles before use for bent components and worn threads. Do not use if body or end fitting is bent more than 10^0 from the axial center line. Do not use if threads are visibly worn or feel loose. **If in doubt, consult a rigging handbook or discuss with a qualified person.**

⚠ WARNING

Improper use and care of turnbuckles can result in bodily injury or property damage.

To avoid injury:

- Inspect turnbuckles for distortion and wear.
- Do not use if anything is in contact with the turnbuckle body or an end fitting
- Do not apply load only to center of eyes and bowl of hooks.
- Do not exceed working load limit.

PLATE CLAMPS

(refer also to ANSI/ASME B30.20)

USE

Plate clamps are used to lift and handle sheets (plates) of metal that are up to 300 Brinell in surface hardness. They tend to grip the metal and thus should not be used where marks may be injurious to the sheet being handled. Special jaws may be required to handle “soft” metals.

Plate Clamps are available in Universal, Hinged, and Horizontal styles.

Handle no more than one sheet at a time within the clamp’s working load limit. Avoid sudden jerks and unbalanced loads.

Lift load a short distance to make sure clamp grips before making complete lift.

Use lifting clamps only if authorized and properly trained.

CARE AND INSPECTION

Inspect clamps before use. Do not use if components are bent, elongated, gouged, nicked excessively, worn, or damaged. Make sure that nuts, bolts, pins, and other fastners are tightened and secure. Make sure clamps are functional and will grip the load before use. Refer also to “CM Lifting Clamps Repair Parts” publication which contains operating instructions as well as care, use and inspection information.

⚠ WARNING

Improper use and care of lifting clamps may result in bodily injury or property damage.

To avoid injury:

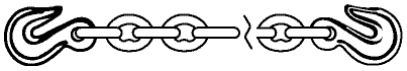
- Do inspect clamps and equipment before use.
- Do not exceed clamp rated load.
- Use clamps only if authorized and properly trained.
- Do not move unbalanced load.
- Do pick up a minimum of 20% of rated load for proper tooth grip.

CM LOAD SECUREMENT SYSTEM COMPONENTS

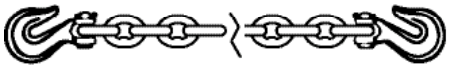
Load securement (tie down or load binding) is a complex matter governed by state and federal regulations involving a number of factors. CM offers a number of components, including chain, that conforms with National Association of Chain Manufacturers (NACM) Welded Steel Chain Specifications and the American Society of Testing (ASTM) and Materials Specifications. The available load securement system components are discussed herein.

BINDER CHAIN ASSEMBLIES

Binder chain assemblies are used most often to retain loads to trucks, rail cars, or truck trailers. They typically consist of a length of chain ranging from 6 to 26 feet in length with a grab hook at each end. The grab hook can be clevis style or eye style connected to the chain via a welded coupling link. Standard binder chain assemblies are available in G30, G43, and G70 with G80, and G100.



Binder Chain Assembly
W/Welded Coupling Links



Binder Chain Assembly
W/Clevis Style Hooks

BINDER CHAIN USE

This chart indicates the minimum number of chains required to secure loads in the forward direction (0.8g deceleration)* per Federal Motor Carriers Safety Administration, DOT Regulations; per 49CFR, Part 393 – Paragraph 393.102.

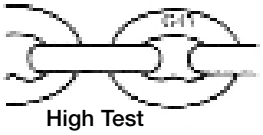
*Refer to 49CFR, Parts 392 and 393, for North American Standard for Protection Against Falling and Shifting Cargo for complete regulations

TABLE VII

GRADE OF CHAIN	Size (in.)	Working Load Limit (lbs.)	Working Load Limit (kg.)	Minimum number of chains required to secure loads in forward direction by Weight of article in lbs. (kg.) 5,000 (2,270)	10,000 (4,540)	15,000 (6,800)	20,000 (9,070)	25,000 (11,340)	30,000 (13,600)	35,000 (15,870)	40,000 (18,140)	45,000 (20,410)	50,000 (22,680)
CM Grade 30 Proof Coil	5/16	1,900	862	3	5	7	9	11	13	15	17	19	22
	3/8	2,650	1,202	2	4	5	7	8	10	11	13	14	16
CM Grade 43 High Test	5/16	3,900	1,770	2	3	4	5	6	7	8	9	10	11
	3/8	5,400	2,450	1	2	3	3	4	5	6	6	7	8
CM Grade 70 Transport	1/4	3,150	1,429	2	3	4	6	7	8	9	11	12	13
	5/16	4,700	2,132	1	2	3	4	5	6	6	7	8	9
	3/8	6,600	2,994	1	2	2	3	4	4	5	5	6	7
CM Grade 80 Herc-Alloy *HA800*	7/32	2,100	953	2	4	6	8	10	12	14	16	18	20
	9/32	3,500	1,588	2	3	4	5	6	7	9	10	11	12
	5/16	4,500	2,041	1	2	3	4	5	6	7	8	9	10
	3/8	7,100	3,220	1	2	2	3	3	4	4	5	6	6
CM Grade 100 Herc-Alloy *HA1000*	7/32	2,700	1,225	2	3	5	6	8	9	11	12	14	15
	9/32	4,300	1,950	1	2	3	4	5	6	7	8	9	10
	3/8	8,800	3,992	1	1	2	2	3	3	4	4	5	5

CHAIN SPECIFICATIONS

Chain Grade Identification Samples†


High Test

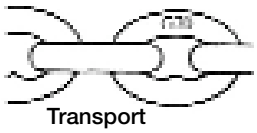

Transport

TABLE VIII

GRADES OF CHAIN

Proof Coil Grade 30			High Test Grade 43			Transport Grade 70			Herc Alloy Grade 80			Herc Alloy Grade 100		
CM Embossing G30 Other embossing includes 3, G-3, M-3, P-30, CG3, L3 Note: Unmarked chain is to be treated as Proog Coil			CM Embossing G43 Other embossing includes 4, G4, G40, M4, CG4, L4, P43, T4, HT			CM Embossing G70 Other embossing includes 7, G7, G40, M7, CG7, L7, P70, W7, P70, TS7			CM Embossing HA 800 Other embossing includes 8, A8A, WB-80, CA8, CG8, 8G, G8, 8GJC, L8, P8, PWA80, KWS-8, W8A			CM Embossing HA 1000 Other embossing includes A10, C10, CG10, P10, PWA100, VIP,		
Size(in)	Working Load Limits (Lbs.	(Kg.)	Size(in)	Working Load Limits (Lbs.	(Kg.)	Size(in)	Working Load Limits (Lbs.	(Kg.)	Size(in)	Working Load Limits (Lbs.	(Kg.)	Size(in)	Working Load Limits (Lbs.	(Kg.)
1/4	1300	580	1/4	2600	1180	1/4	3150	1430	9/32	3500	1570	7/32	2700	1225
5/16	1900	860	5/16	3900	1770	5/16	4700	2130	5/16	4500	2040	9/32	4300	1950
3/8	2650	1200	3/8	5400	2450	3/8	6600	2990	3/8	7100	3200	3/8	8800	3990
1/2	4500	2030	1/2	9200	4170	1/2	11300	5130	1/2	12000	5400	1/2	15000	6800

†Markings shown are for CM chain, samples of other markings are displayed in Chain Grade boxes depending on product and manufacturer, chain grade identification mark spacing varies from every link to one in every 3 feet (91.5 cm). Chain grade identification is accomplished using embossed (raised) numbers and letters. Embossing may be difficult to see on chain which has been in service and is rusty, dirty or worn. Typically, marked links contain only one marked area. Wire brushing and illumination will help improve visibility of markings.

⚠ WARNING

Death/injury can occur from improper use or maintenance of tie down equipment.

To avoid injury:

- Inspect before use — remove from service if cracked, worn, or deformed.
- Do not overload.
- Do not use handle extender on load binders.
- Do not use binder components for overhead lifting.

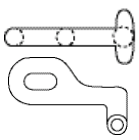
TIE DOWN HOOKS

AIRCRAFT

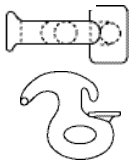
CM Aircraft Tie-Down Hook/Chain-Type

CM Aircraft Tie-Down Hook/Cargo-Type

AUTOMOTIVE

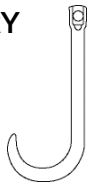


T-Hook



R-Hook

VEHICLE RECOVERY



J-Hook

See page 18, 23, and 24 under CM ATTACHMENTS for detailed information on these hooks including “USE,” “CARE” AND “INSPECTION.”

LOAD BINDERS

Load binders are typically used to take up slack and apply tension to a tie down system. They are designed primarily for use with graded chains. They are available in two general configurations, e.g. Lever Type (over the center) and Ratchet Configuration. They are rated by working load limit and are provided with hooks of various styles that will accept chain size and grade consistent with the load rating.

LOAD BINDER USE

To assure safe operation, operate binders only as outlined in the following steps:

⚠ WARNING

Improper use of load binders can result in bodily injury or property damage.

To avoid injury or damage:

- Never exceed working load limit.
- Always inspect binder before use for wear, damage, and elongation.
- Do not use cheater bar or handle extension.
- Do not operate load binder while anyone is on the load.
- Release load on lever type binders with extreme care. Make sure everyone is clear of the load. Handle may whip suddenly.

1. Always follow safe work practices and take precautions in use of binders. Particular attention is called to the following sections of the Federal Motor Carrier Safety Regulations: S392.9(relating to safe loading) S393.100 (relating to protection against shifting or falling cargo); and S393.102 (relating to securement systems).
2. Visually inspect binder as detailed in “Load Binder Inspection“ section.
3. Always position the load binder so the handle goes downward when securing or tightening the load.
4. Operate only by hand from a firm standing position.
5. Do not use a handle extension. Extensions can dangerously overload the binder system and may result in serious injury. Use a ratchet type binder if sufficient leverage is difficult to develop.

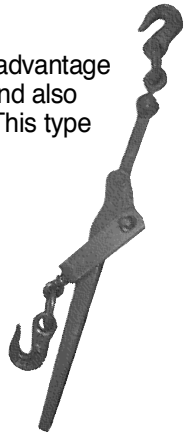
6. Make certain that the lever of the lever type binder is over center and locked. Always secure the handle in locked position with a positive retaining method. The handle must be secured since there is a possibility of relaxation of the load which may result in the lever moving from the locked over center position to relaxed mode resulting in loss of tension in the system.

7. Be sure no one is in a position to be struck by the handle when releasing the lever type binder. Handle may whip suddenly.

8. Retighten binders periodically.

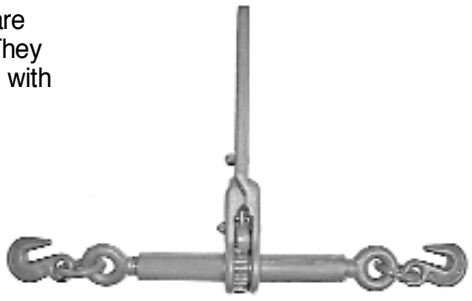
LEVER TYPE BINDERS

Lever type (over the center) binders utilize the principle of mechanical advantage associated with a system of linkages. Tension can be applied quickly and also released quickly. Lever (handle) stores unobtrusively in line with load. This type binder is available with a variety of attachments.



RATCHET TYPE BINDERS

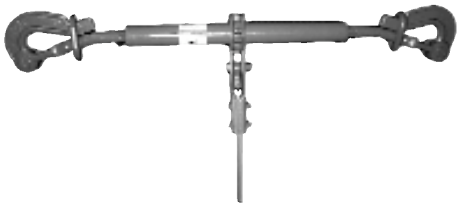
Ratchet binders utilize the principle of the screw and are slower but easier to operate than lever type binders. They do not require locking of handle. Available in one style with grab hooks.



RIVER RATCHETS

Similar in operation to ratchet type binders but with a substantially larger capacity. Used to gang barges. Double pawl construction gravity operated. Available in a variety of attachments. One version shown here.

Meets or exceeds Fed. Spec. GGG-B-325



LOAD BINDER CARE

Care should be exercised during use so that the binder is not abused or damaged.
See "Care" section under Hooks (page 23).

1. The binder or hooks should not be subjected to bending or sharp objects. Loading should be in a straight line.

2. Avoid exposure to corrosive mediums. Rust or corrosion can increase operating forces and prevent ease of operation of the unit. Lubricate pivot swivel points and threads periodically.

LOAD BINDER INSPECTION

Inspect binder prior to each use for damage, distortion, cracks, nicks, or wear.
See "Inspection" section under hooks (page 24).

1. Bending of any feature in any plane of more than 10 degrees is cause for removal of the unit from service. Any distortion indicates overloading or misuse.

2. Distorted or elongated connecting links indicate overloading or misuse and is also cause for removal of the unit from service.

3. If wear of connecting link ends is more than 10% of the original stock, remove unit from service.

4. On lever type binders inspect yoke periodically for distortion and make certain it is seated on the pins.

5. Deep nicks and gouges should be smoothed out to relief stress concentrations providing that the material removed does not exceed 10% of the total material.

6. If distortion, cracks, nicks, or wear affect more than 10% of the stock, discard the unit.

⚠ WARNING

Improper use of load binders can result in bodily injury or property damage.

To avoid injury or damage:
- Never exceed working load limit.
- Always inspect binder before use for wear, damage, and elongation.
- Do not use cheater bar or handle extension.
- Do not operate load binder while anyone is on the load.
- Release load on lever type binders with extreme care. Make sure everyone is clear of the load. Handle may whip suddenly.

PARATECH®

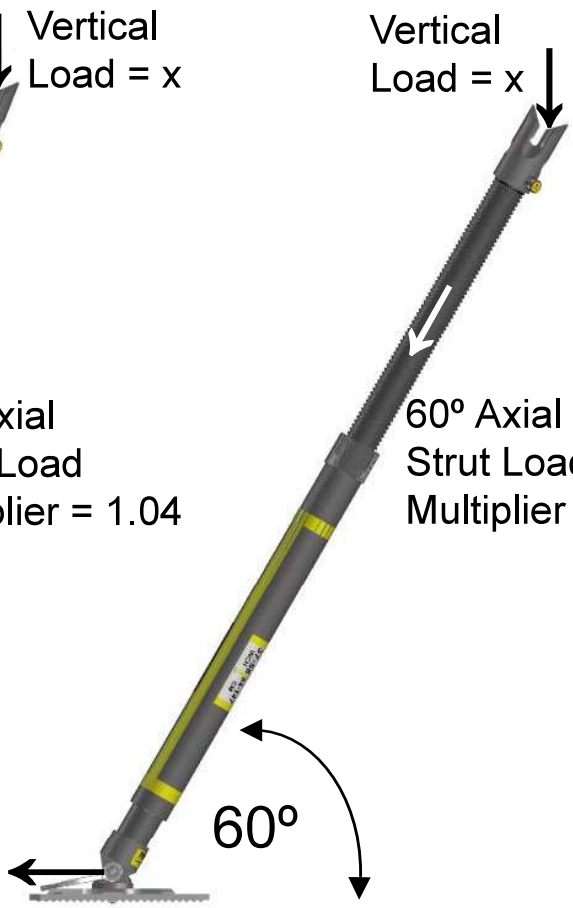
RescueStrut Multipliers

(Vertical Load) x (Axial Load Multiplier) = Axial Load

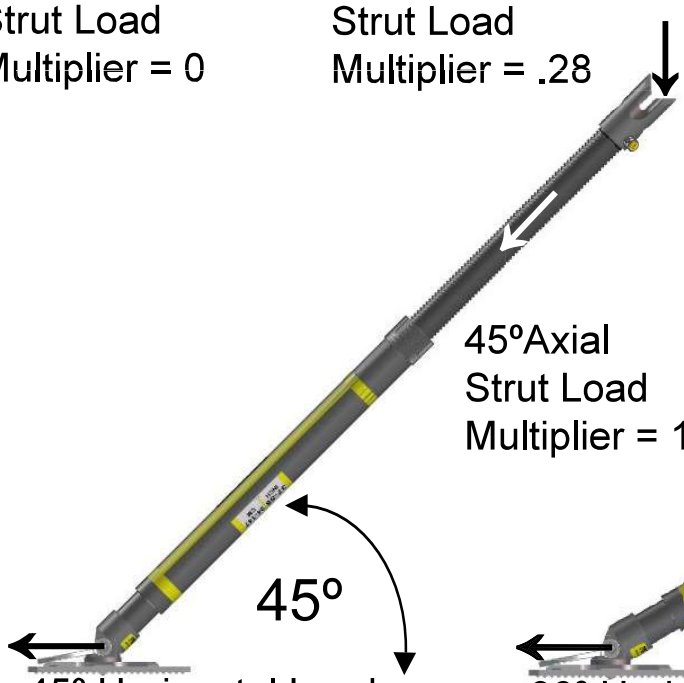
(Vertical Load) x (Horizontal Load Multiplier) = Horizontal Load

90º Horizontal
Strut Load
Multiplier = 0

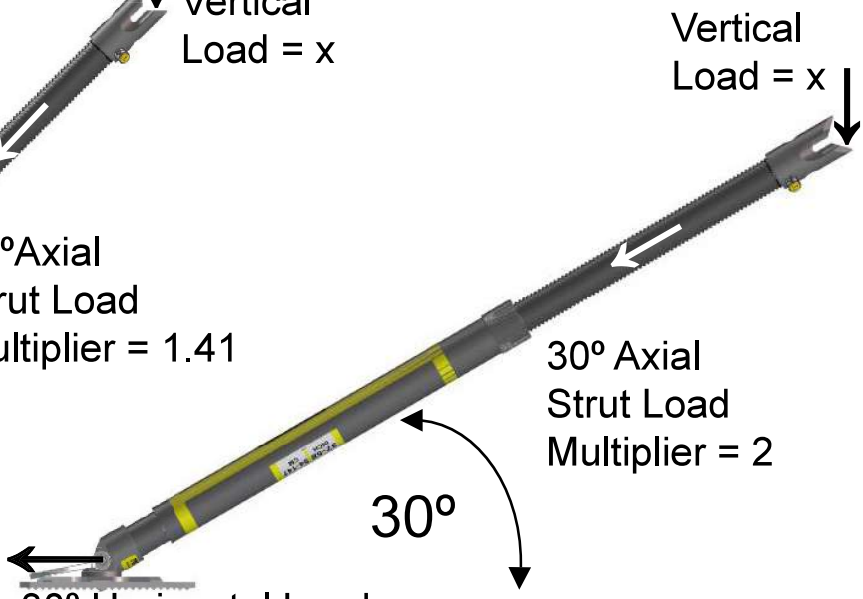
75º Horizontal
Strut Load
Multiplier = .28



60º Horizontal Load Multiplier = .58



45º Horizontal Load
Multiplier = 1



30º Horizontal Load
Multiplier = 1.73