Determining Type and Quantity of Tiedown Devices Required

Determination of the types and quantities of tiedown devices to be used in restraining cargo should be based on the following considerations:

a. Appropriate strength rating to afford adequate restraint with the minimum number of devices.

b. Like types and lengths of tiedown devices should be used for a given direction of restraint.

c. Units of general cargo may be grouped and effectively restrained by cargo nets. Concentrated cargo units within such a grouping must rest on the cargo floor and be individually restrained by appropriate tiedown devices.

d. Tiedowns should be attached in a symmetrical pattern by using corresponding fittings on each side of the cargo floor centerline.

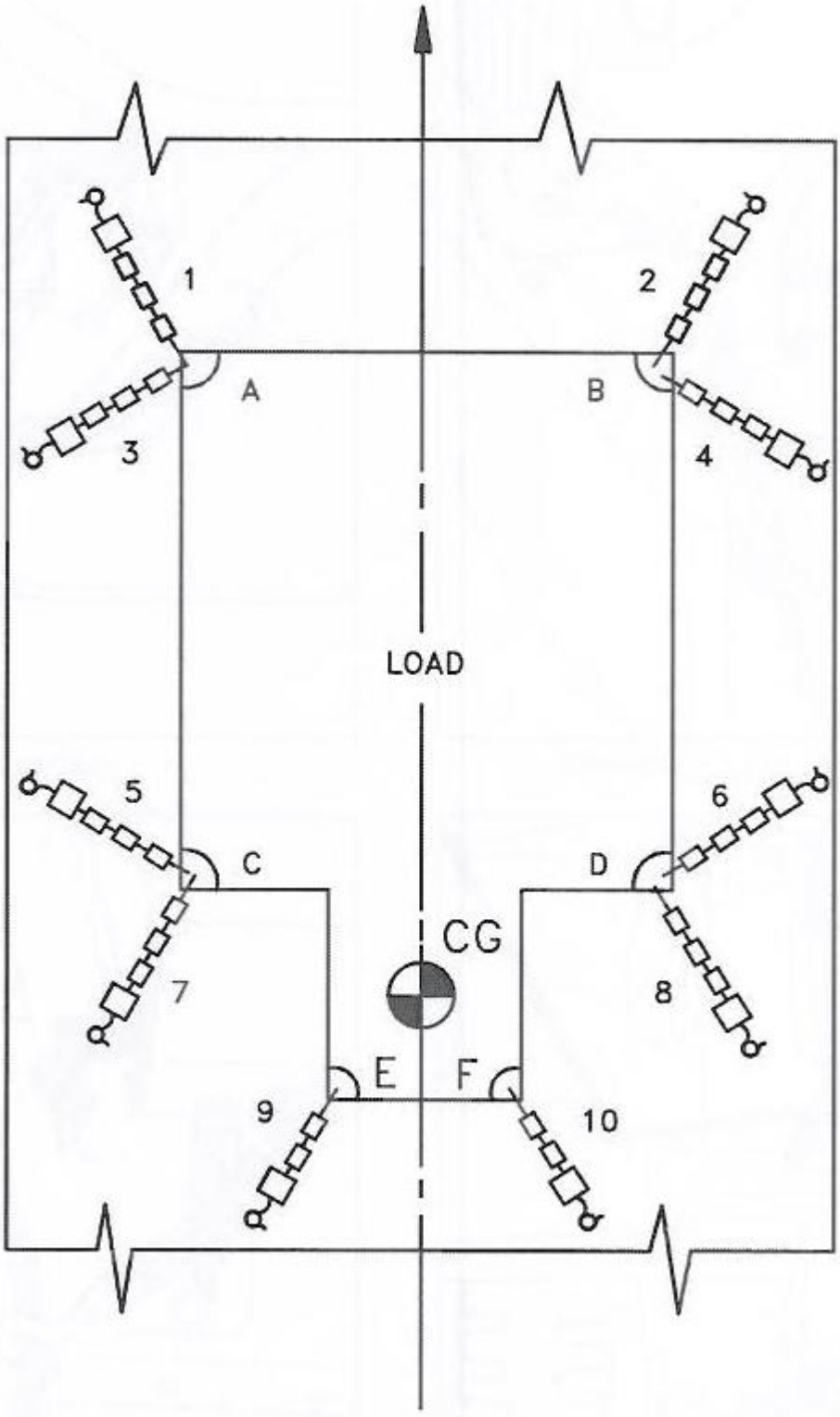
e. Tiedown devices must be securely attached to the cargo and all slack removed so that any tendency toward motion is immediately restrained.

f. A symmetrical tiedown arrangement must be used whenever possible.

g. Use nylon tiedown devices on crates, boxes, and other large units that might crush easily.

h. Do not use nylon devices over sharp edges.

i. Use steel tiedown devices on heavy objects that have attachment lugs or a hard surface for chains to go around.



GENERAL RULES FOR APPLYING TIEDOWNS (SEE FIGURE 4B-8)

The following general conditions should be met when restraining a load:

a. Always compute the number of tiedown chains required. Apply aft restraint (tiedowns 1, 2, 5, and 6) in the opposite direction but at the same angle as forward restraint (tiedowns 3, 4, 7, and 8). Use the same attachment point (points A, B, C, or D) on the cargo for attaching a forward and an aft restraint chain if possible.

b. Always attach an even number of tiedowns (4 chains, or 6 chains, or 8 chains, etc.) in pairs (1 and 2, 3 and 4, 5 and 6, 7 and 8) for forward or for aft restraint. The tiedown chains should be attached in a symmetrical pattern by connecting to opposite fittings (A opposite B, C opposite D, E opposite F) across the cargo floor centerline.

c. If the center of gravity is remote from the geometric center of the load as in Figure 4B-8, add an additional tiedown (tiedowns 9 and 10) on each side of the load so the center of gravity is between a pair of tiedowns.

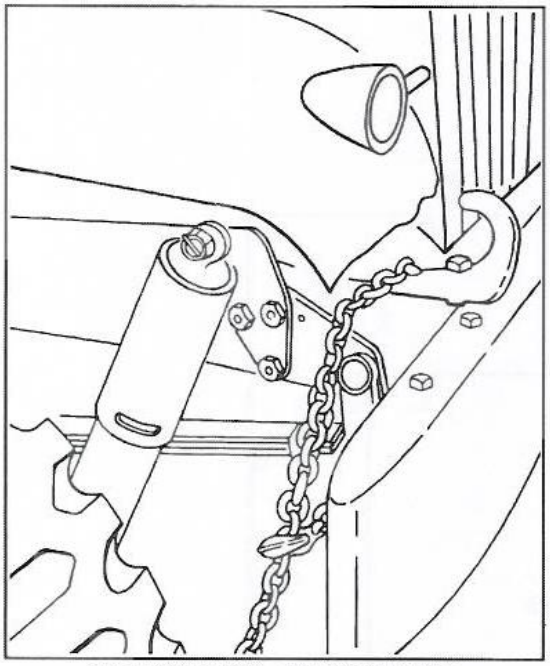
d. Vehicles must be secured using points on the frame of the vehicles. Use sufficient devices to

restrain the total weight of the vehicle. On Spring-mounted vehicles do not attach more than half the total number of tiedowns required in any given direction to the axles of vehicles. Figure 4B-9 shows some vehicle attachment points and methods of attaching tiedown chains.

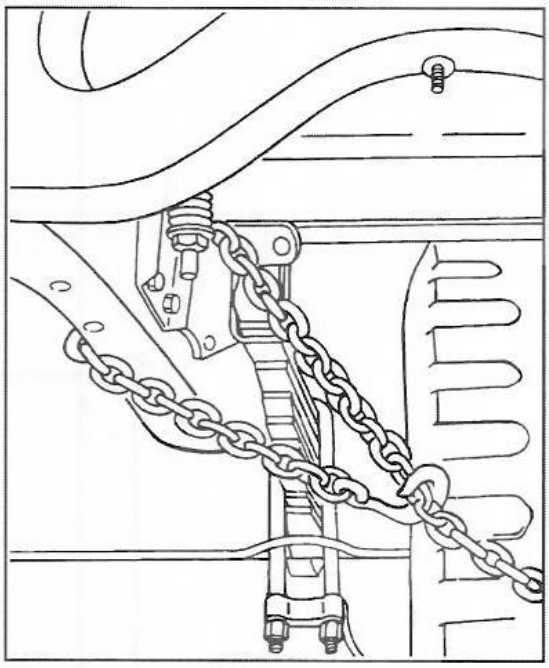
CAUTION

Inspect the back side of axles and structures for the presence of hydraulic lines and/or electrical cables. Tiedown chains must be routed to prevent damage to the hydraulic lines and/or electrical cables.

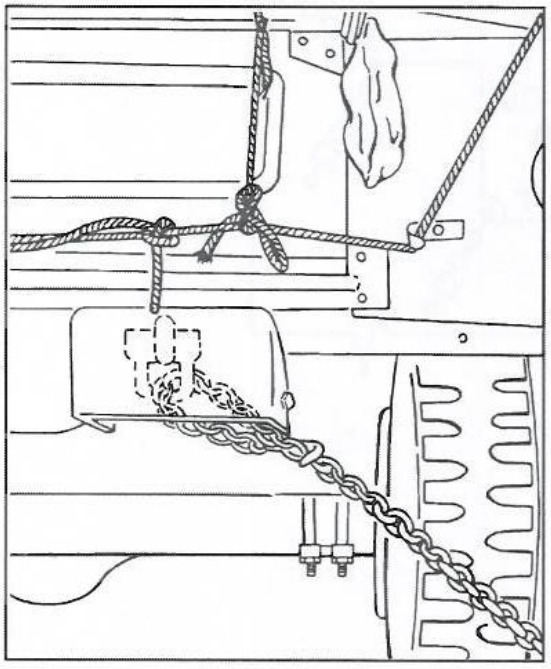
e. Nylon tiedown devices may be used to secure lightweight vehicles.



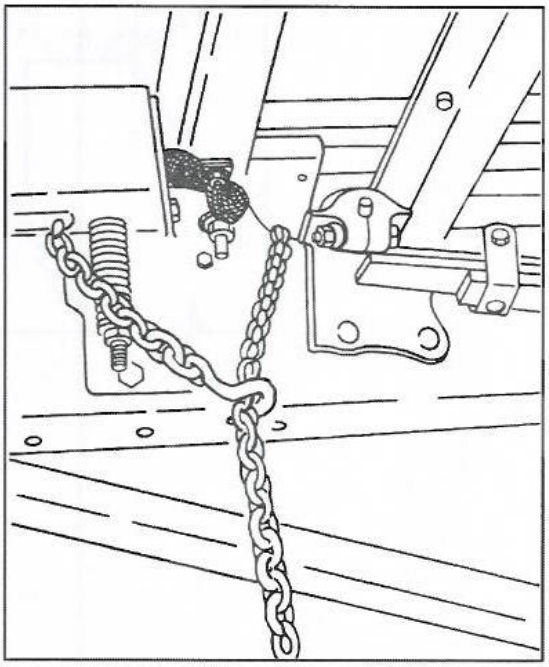
AROUND FRAME, AFT OF BUMPER



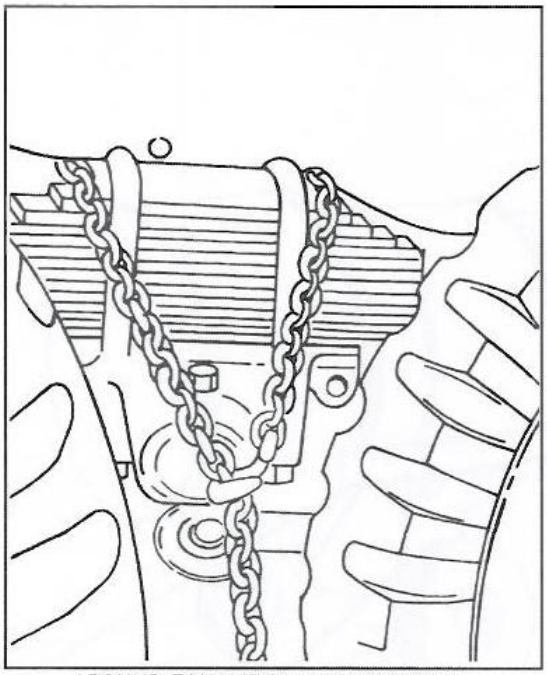
AROUND FRAME



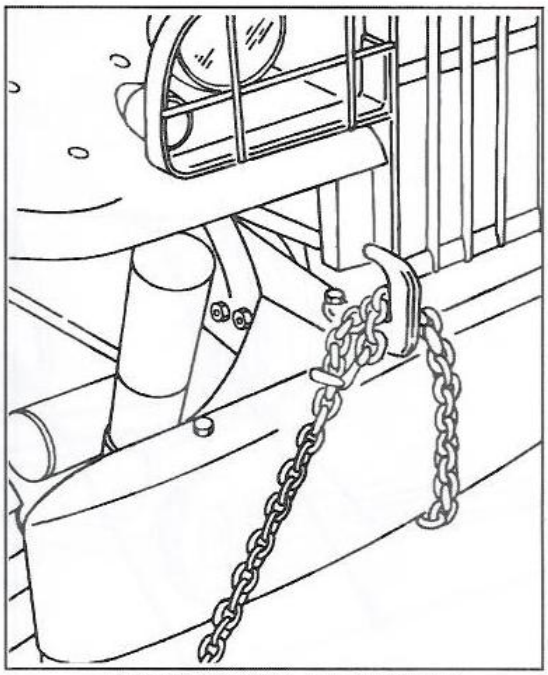
AROUND REAR LIFTING CLEVISES



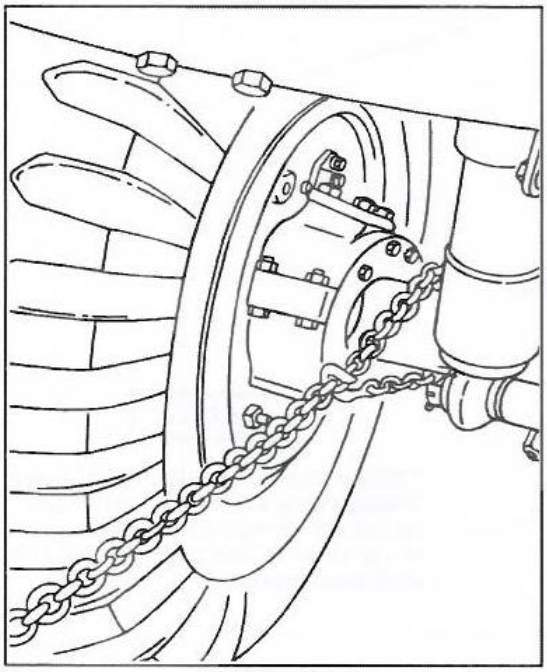
OVER FRAME AND UNDER CROSSMEMBER



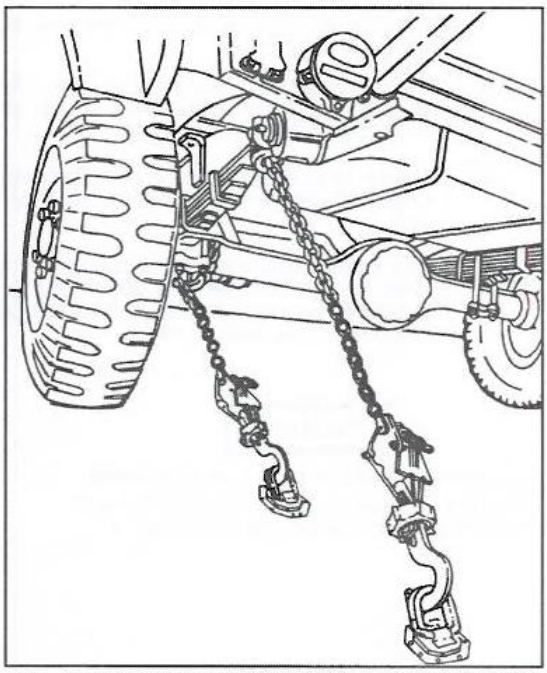
AROUND EQUALIZER TRUNNION BAR
AND OVER SPRING



AROUND BUMPER, AFT OF PINTLE



AROUND AXLE



MB–1 TIEDOWNS ATTACHED TO FLOOR FITTINGS

Cargo Restraint Load Factor

Cargo must be restrained so it will not shift due to loads resulting from dynamic forces encountered during flight and landing. The restraint must be adequate for the greatest load that may result. These loads are expressed in terms of cargo weight times the applicable load factor. If a cargo unit is subjected to a load equal to 1.5 times its weight, it must be restrained for a load factor of 1.5 to prevent it from shifting.

Counter forces applied to the cargo to prevent movement are identified by the direction in which the cargo would move if it were unrestrained. Forward restraint keeps the cargo from moving forward, aft restraint prevents the cargo from moving rearward, lateral restraint prevents side-to-side movement, and vertical restraint prevents the cargo from rising off the cargo floor.

Minimum Restraint Force

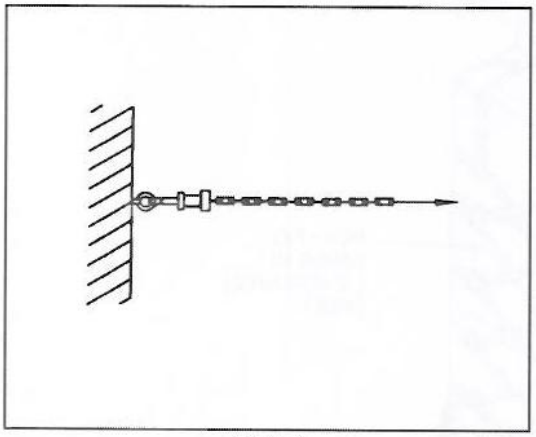
The minimum restraints used to prevent cargo movement in any direction are called restraint criteria. Expressed in units of the force of gravity, or load factor, minimum restraint criteria are as follows:

a. Forward – 3.0 g's

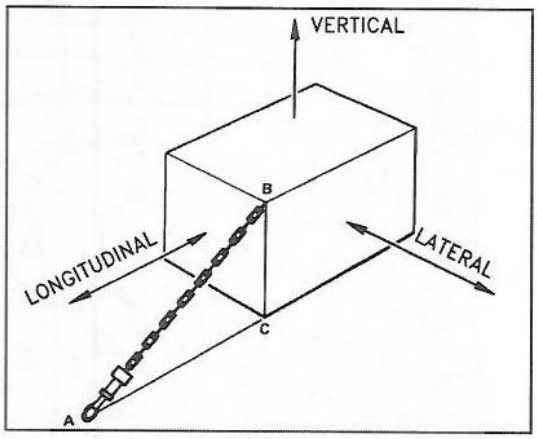
b. Aft – 1.5 g's

c. Lateral – 1.5 g's

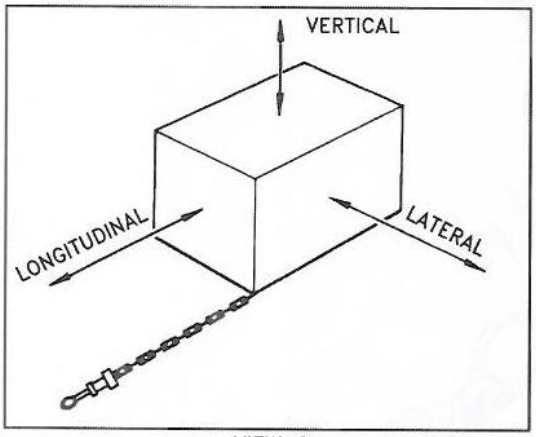
d. Vertical – 2.0 g's



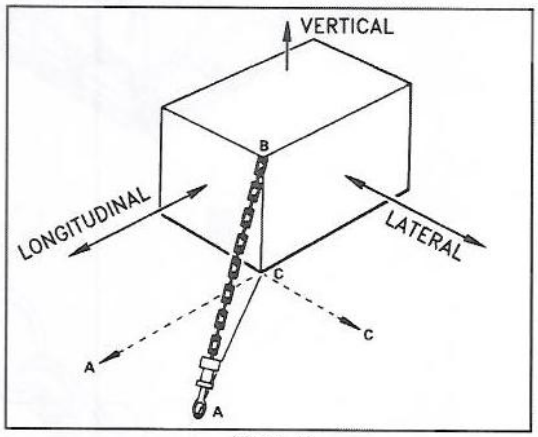
VIEW 1



VIEW 3



VIEW 2



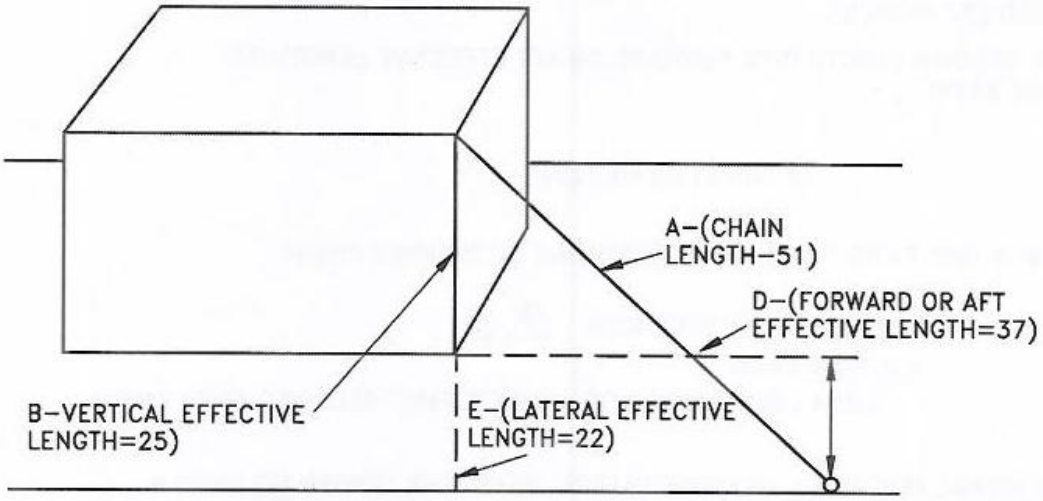
VIEW 4

Effect of Applying Restraint at Angles

Every tiedown device is rated to withstand a force exerted parallel to the tiedown device as shown in view 1 of Figure 4B-7. When one end of a device is secured to a fitting on the cargo floor, the longitudinal force will not be exerted parallel to the length of the device unless the device is attached to the cargo as shown in view 2. If so attached, all the rated strength will be available to prevent cargo from moving in the direction of the longitudinal arrow.

Because it is seldom practical to fasten a tiedown device as illustrated in views 1 and 2, tiedowns are usually attached at some point above the cargo floor as shown in view 3. When so attached, only part of the device is available to prevent

cargo longitudinal movement. Vertical restraint is provided, but no lateral restraint is provided. A compromise position as shown in view 4 generally provides restraint simultaneously in three directions: forward, vertical, and lateral. Aft restraint is obtained by attaching tiedowns symmetrically in pairs to the front of the cargo.



NOTE

THIS FIGURE ILLUSTRATES A METHOD OF DETERMINING RESTRAINT FOR CARGO TIEDOWN. AS ILLUSTRATED, TIEDOWN RATIOS CAN BE DETERMINED BY DIVIDING TIEDOWN LENGTH INTO EFFECTIVE LENGTH FOR DIRECTION IN WHICH RESTRAINT IS REQUIRED. THIS RATIO IS THEN MULTIPLIED BY THE STRENGTH OF THE CHAIN OR ATTACHMENT RING, WHICHEVER IS LESS, TO FIND THE RESTRAINT RECEIVED FROM THE TIEDOWN CHAIN.

EXAMPLE:

1. MEASURE LENGTH OF TIEDOWN CHAIN (A) FROM TIEDOWN FITTING TO ATTACHMENT POINT ON CARGO (51 INCHES).

2. MEASURE EFFECTIVE VERTICAL LENGTH (B) FROM ATTACHMENT POINT ON CARGO TO A POINT DIRECTLY BENEATH IT ON THE HORIZONTAL PLANE OF THE TIEDOWN FITTING (25 INCHES) (I.E. CARGO RESTING ON FLOOR AND TIEDOWN ATTACHMENT POINT ON DUAL RAIL OR SIDEWALL RING).

△3 3. DIVIDE TIEDOWN LENGTH INTO VERTICAL EFFECTIVE LENGTH TO DETERMINE RATIO.

$$25.00 \div 51.00 = 0.4901$$

4. MULTIPLY THIS RATIO TIMES RATED RESTRAINT OF TIEDOWN CHAIN.

10,000 CHAIN STRENGTH △1 △2
x 0.4901 RATIO
4,901 LBS VERTICAL RESTRAINT RECEIVED FROM CHAIN

5. FOR FORWARD OR AFT RESTRAINT, MEASURE FORWARD OR AFT EFFECTIVE LENGTH (D) FROM A POINT DIRECTLY BENEATH ATTACHMENT POINT ON THE CARGO ALONG A LONGITUDINAL AXIS TO A POINT LATERAL TO THE FITTING BEING USED (37 INCHES).

6. DIVIDE TIEDOWN LENGTH INTO FORWARD OR AFT EFFECTIVE LENGTH TO DETERMINE RATIO.

37.00÷51.00=0.7254

7. MULTIPLY THIS RATIO TIMES RATED RESTRAINT OF TIEDOWN CHAIN.

10,000 CHAIN STRENGTH ⚠1 ⚠2
x 0.7254 RATIO
7,254 LBS FORWARD OR AFT RESTRAINT RECEIVED FROM CHAIN

8. FOR LATERAL RESTRAINT, MEASURE LATERAL EFFECTIVE LENGTH (E) FROM A POINT DIRECTLY BENEATH THE ATTACHMENT POINT ON THE CARGO TO THE COLUMN OF TIEDOWN FITTINGS BEING USED (22 INCHES).

9. DIVIDE TIEDOWN LENGTH INTO LATERAL EFFECTIVE LENGTH TO DETERMINE RATIO.

22.00÷51.00=0.4313

10. MULTIPLY THIS RATIO TIMES RATED RESTRAINT OF TIEDOWN CHAIN.

10,000 CHAIN STRENGTH ⚠1 ⚠2
x 0.4313 RATIO
4,313 LBS LATERAL RESTRAINT RECEIVED FROM CHAIN

NOTE

⚠1 IF THE CHAIN IS ATTACHED TO A 463L PALLET RING, THE RATED RESTRAINT WOULD BE 7,500 POUNDS. THE RATIO WOULD BE MULTIPLIED BY 7,500, GIVING THE RESTRAINT RECEIVED.

⚠2 IF THE CHAIN IS ATTACHED TO THE 5000-POUND TIEDOWN RING ON THE CARGO RAMP OR SIDEWALLS, THE RATED RESTRAINT WOULD BE 5,000 POUNDS. THE RATIO WOULD MULTIPLIED BY 5,000 GIVING THE RESTRAINT RECEIVED.

⚠3 COMPUTE TIEDOWN RATIOS OUT TO FOUR DIGITS (E.G., 0.4456).