TRAINER GUIDANCE

Line Item 1.7 *Identify types of shoring*

Prerequisites:	A. Complete the Air Freight DL Course // Aircraft Loading // Cargo Assembly and Transportation.
Training References:	A. DTR Part II, Chapter 208, Packing and Handling, Para I.; B. AFI 24-605,Vol 2, 3.4; C. AFI 24-602,Vol 2, 2.16.8; D. TO 1C-17A-9-WA-1, Section IVB, 4B60-82 E. TO 1C-130-9-WA-1, TO 1C10(K)A-9, Section IV, 4-44/4-50 F. TO 1C-130A-9, Section 4, 4A-4 TO 1C-135-9, Section IV, 4-4 – 4-9 G. TO 1C-46 Section VI XXXX
Additional Supporting References:	Access to the Air Transport Test Loading Activity (ATTLA) database.
Training Support Material:	Examples of cargo that contain need for calculations to determine requirement of shoring.
Specific Techniques:	Trainers will annotate with TBA once trainee is capable of identifying purpose and application of shoring. Additionally, trainees must be able to properly determine if presented is correct and adequate for mission requirements.
Criterion Objective:	**A. Upon completion of training, trainee will be able to:** 1. Determine type(s) of shoring as required. 2. Determine calculations for shoring requirements. 3. Understand the effects of shoring.
NOTES to Trainer:	This lesson plan is designed for hands-on training (demonstration-performance). Aerial port missions are inherently different from station to station; training sessions may or may not easily lend themselves to hands-on training. Therefore, it is imperative that trainers demonstrate, document and verify training using a variety of hands-on and scenario-based techniques to achieve the desired proficiency prior to signing the Task Evaluation Checklist (TEC). Prior to accomplishing the practical application of this lesson, ensure the trainee has the necessary PPE; i.e., gloves, steel-toed boots, hearing protection, and reflective gear during hours of darkness. Use caution while maneuvering around the Mechanized Material Handling System (MMHS), if applicable. Brief the trainee to remain aware of vehicles/Material Handling Equipment (MHE) operating in the warehouse/pallet grid yard. Additionally, remind the trainee to remove all rings and exposed jewelry.

TASK STEPS

Line Item 1.7 *Identify types of shoring*

Learning Objective 1 *Determine types of shoring:*

A. Terms and definitions:

1. **ATTLA:** Air Transport Test Loading Activity (ATTLA) is a database which provides instructions on how to prepare and transport equipment on US Air Force aircraft to Aircraft loadmasters/Air Transportation personnel and other persons requiring movement of equipment.

2. **Shoring:** Shoring refers to the protection of the conveyance (normally aircraft) by using materials to respond to floor limitations (pounds per square inch [PSI]) or clearance limits. Standard sized lumber and plywood are both used to shore aircraft loads. Shoring is used to protect the aircraft floor, distribute the cargo load over a larger area of aircraft floor (and substructure), and, on occasion, to reduce the ramp-angle during vehicle loading (see Military Standard 1791, Designing for Internal Aerial Delivery In Fixed Wing Aircraft). The shipper is responsible for any required shoring when not provided by the APOE or airlift unit. Equipment will be designed to minimize the requirements for shoring to limit the logistics burden during air movement and minimize the volume of solid waste generated. The shipper is responsible for any required specialized shoring IAW technical order shipment instructions when not provided by the APOE or airlift unit. The following types of shoring may be required for airlift:
3. **Approach shoring (step-up shoring):** Approach shoring is used to reduce the ramp angle that a vehicle must traverse during aircraft on/offloading. Reduction of the ramp angle becomes necessary to avoid interference problems where there are minimal underside, overhead, or overhang clearances. Approach shoring requires large amounts of lumber.
4. **Floor protection shoring:** Shoring that is required to protect the aircraft ramps and cargo compartment floor from damage during on/offloading and flight of tracked vehicles or vehicles with wheels that have lugs, cleats, studs, metal rolling surfaces, or small diameters.
5. **Parking shoring:** Shoring that is required under the wheels or tracks of vehicular cargo prior to loading to reduce PSI exertion on the aircraft floor by increasing the wheel or track contact area.
6. **Rolling shoring:** Shoring that is required to distribute weight on the cargo floor during on/offloading.
7. **Sleeper shoring:** Sleeper shoring is used to prevent the movement of a vehicle due to gust and flight maneuver load conditions where tires or suspension system cannot withstand these loads without failure or depression producing slack in tie-down devices. This type of shoring is placed between the aircraft floor and a structural part of the vehicle (e.g., frame).
8. **Contact Area:** Amount of cargo actually contacting the cargo floor (in square inches). Determined by multiplying Length (L) x Width (W) = contact area. Round off to the tenth position and never increase, even if there are remainders in the hundredth position (29.48 rounds off to 29.4). If there are any numbers after the tenth position, they are dropped off.
9. **Pound per square inch:** The amount of weight exerted, per square inch, for a piece of cargo on the aircraft floor. The strength of the cargo floor is measured in pounds per square inch (PSI). When determining shoring requirements, always consult the FLIGHT columns in the -9. FLIGHT PSI limits are always less than those for loading and

offloading. The weight of the cargo must be in pounds. The cargo's contact area must be in square inches.

10. **PSI Computation:** Divide the contact area into the weight to get the PSI. For PSI, round off to the tenth position and always increase to the next highest tenth if there is any remainder in the hundredths position (32.52 rounds off to 32.6). If there is any number after the tenth position, round up.

Learning Objective 2 *Determine calculation for shoring requirements:*

A. Formulas: The trainer will explain and demonstrate each shoring formula. There are six different formulas used to determine shoring requirements. Different types of items have different methods to determine the contact area. The contact area is determined first. Then, the contact area is used to determine the PSI exerted in the floor.

1. Squared/Rectangle Boxes: (Length X Width = Contact Area). 1. Example: A box has dimensions of 24" by 30". That makes the contact area 720 square inches (24" X 30"). If the contact area is not a whole number, drop off any number after the tenth position. Do this even if the remainder is .09! (CONTACT AREA = DROP OFF past the tenth position). Following this rule creates a safety margin, because if you underestimate the area, the calculated PSI will be on the high side for an even bigger safety margin.
   a). Divide weight of box by the contact area to get the PSI. Round off to the tenths position and always increase to the next highest tenth if there is a remainder in the hundredths position (PSI=ROUND UP).
   b). Determine strength of the floor (target PSI) where cargo will be positioned. The maximum floor pressure for each part of the aircraft is listed in the aircraft's -9 T.O. When you are load planning, always consult the FLIGHT columns. FLIGHT PSI limits are always less than those for loading and offloading.
   c). Determine if the maximum PSI for the cargo location in the aircraft will be exceeded. If PSI is exceeded, shoring is required to spread the contact area over a larger area. Example: Cargo loaded on the treadways has loading limit of 125 PSI, but the flight limit is only 50 PSI. If the cargo PSI exceeds 50 PSI and will be located on the treadways during flight, shoring is required.

B. Skidded Cargo: (Length of Skid x Width of Skid x Numbers of Skids = Contact Area).

1. Example: Each skid is 10" long and 3" wide. There are three skids, so the contact area of this item is 90 square inches (10" X 3 "X 3 skids = 90 square inches). (CONTACT AREA = DROP OFF past the tenth position).
2. Determine PSI for a skidded box. Divide the weight of the box by the contact area to get the PSI. Round off to the tenths position and always increase to the next highest tenth if there is a remainder in the hundredths position (PSI=ROUND UP).
3. Determine strength of the floor (target PSI) where cargo will be positioned. The maximum floor pressure for each part of the aircraft is listed in the aircraft's -9 T.O.

When load planning, always consult the FLIGHT columns. FLIGHT PSI limits are always less than those for loading and offloading.

4. Determine if the maximum PSI for the cargo location in the aircraft will be exceeded. If PSI is exceeded, shoring is required to spread the contact area over a larger area. Example: Cargo loaded on the treadways has loading limit of 125 PSI, but the flight limit is only 50 PSI. If the cargo PSI exceeds 50 PSI and will be located on the treadways during flight, shoring is required.

C. Drums without Rims: (Diameter Squared x 0.785 = Contact Area).

1. Example: Diameter of a drum without a rim is 22". To get the contact area, multiply 22" X 22" X .785 = 379.94 square inches. Then, round down to 379.9, which would be used in the PSI calculation. (CONTACT AREA = DROP OFF past the tenth position).
2. Determine PSI for a drum without rims. Divide weight of the drum by the contact area. Round off to the tenths position and always increase to the next highest tenth if there is a remainder in the hundredths position (PSI=ROUND UP).
3. Determine strength of the floor (target PSI) where cargo will be positioned. The maximum floor pressure for each part of the aircraft is listed in the aircraft's -9 T.O. When load planning, always consult the FLIGHT columns. FLIGHT PSI limits are always less than those for loading and offloading.
4. Determine if the maximum PSI for the cargo location in the aircraft will be exceeded. If PSI is exceeded, shoring is required to spread the contact area over a larger area. Example: Cargo loaded on the treadways has loading limit of 125 PSI, but the flight limit is only 50 PSI. If the cargo PSI exceeds 50 PSI and will be located on the treadways during flight, shoring is required.

D. Drums with Rim: [(Outside Rim Diameter Squared – Inside Rim Diameter Squared) x 0.785 = Contact Area.]

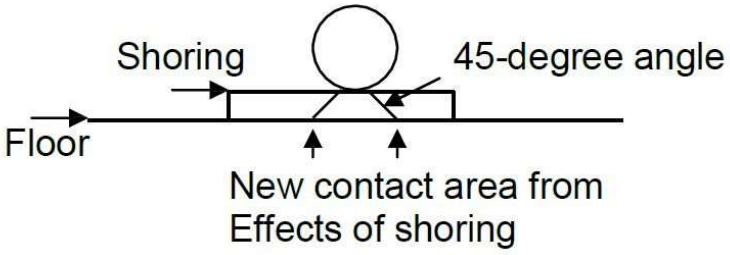
1. Example: To calculate the contact area of the drum, you must first measure the Outside Diameter (OD) and the Inside Diameter (ID). Calculate contact area of a drum with a 24" OD and a 22" ID: (24 X 24) - (22 X 22) X .785 = 72.22. Simplified formula: (OD squared - ID squared) X .785 = contact area.
2. Determine PSI for a drum with rims. Divide weight of drum by the contact area to get the PSI. Round off to the tenth position and always increase to the next highest tenth if there is a remainder in the hundredths position (PSI=ROUND UP).
3. Determine strength of the floor (target PSI) where cargo will be positioned. The maximum floor pressure for each part of the aircraft is listed in the aircraft's -9 T.O. When load planning, always consult the FLIGHT columns. FLIGHT PSI limits are always less than those for loading and offloading.
4. Determine if the maximum PSI for the cargo location in the aircraft will be exceeded. If PSI is exceeded, shoring is required to spread the contact area over a larger area. Example: Cargo loaded on the treadways has a loading limit of 125 PSI, but the flight limit is only 50 PSI. If the cargo PSI exceeds 50 PSI and will be located on the treadways during flight, shoring is required.

E. Pneumatic Tires: (0.785 x Length of Pad x Width of Pad = Pad "contact" Area).

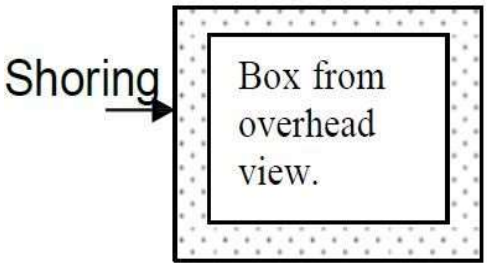
1. Example: 0.785 X 6" (length touching floor) X 8" (width of the tire) = Pad (contact) area of 37.68 square inches (DROP OFF past the tenth position) to 37.6 inches to be used in the PSI calculations.
2. Determine the wheel load. Divide the axle weight by the number of wheels to receive the wheel load.
3. Once the wheel load is determined, determine PSI. Divide the wheel load by the pad area to get the PSI. Round off to the tenth position and always increase to the next highest tenth if there is a remainder in the hundredth position. (PSI=ROUND UP).
4. Determine strength of the floor (target PSI) where cargo will be positioned. The maximum floor pressure for each part of the aircraft is listed in the aircraft's -9 T.O. When load planning, always consult the FLIGHT columns. FLIGHT PSI limits are always less than those are for loading and offloading.
5. Determine if the maximum PSI for the cargo location in the aircraft will be exceeded. If PSI is exceeded, shoring is required to spread the contact area over a larger area. Example: Cargo loaded on the treadways has a loading limit of 125 PSI, but the flight limit is only 50 PSI. If the cargo PSI exceeds 50 PSI and will be located on the treadways during flight, shoring is required.

Learning Objective 2 *Understand the effects of shoring requirements:*

A. Plane of angle effect is the typical plane of 45 degrees outward from the base of the cargo where it meets the shoring. The contact area can be increased because of the 45-degree angle from the upper surface of the shoring down to the cargo floor. Shoring will only increase the area of contact by an amount approximately equal to the thickness on all sides of the object it supports. Example: 2" thick shoring would increase length of area by 4" total. To obtain this result you must ensure the width and length of shoring used equals the thickness of it.



1. *Example*: **A 6" by 8" rectangle** box has a contact area of 48". When positioned on a ½" piece of shoring, its contact area changes to 7" by 9", for a new contact area of 63".



2. *Example*: **A box with 6** 2” X 3” **skids** has a contact area of 36” (L x W x number of skids). If placed on a ½” piece of shoring, the new computation would be 3” x 4” x 6 skids = 72 square inches of contact area.

3. *Example*: **A drum without a rim** is 20” in diameter, which computes to a contact area of 314” (20” x 20” x 0.785 = 314 square inches). If placed on a ½” piece of shoring, the diameter would change to 21” and the new contact area would be 346.185” rounded off to 346.1 square inches.

4. *Example*: **A drum with a rim** has an OD of 15” and an ID of 14.5”. This computes to a contact area of 11.578 (drop off to 11.5 inches). (OD squared – ID squared) X 0.785 = contact area of a rimmed drum. If this drum is put on a ½” piece of shoring, the OD would change to 16” and the ID would change to 13.5”. The contact area will change to 57.893 square inches (rounded off to 57.8).

NOTE: Be sure to include weight of shoring when determining the cargo center of balance (CB).