

**TECHNICAL MANUAL**

**LOADING AND STOWAGE**

**OF MILITARY AMMUNITION**

**AND EXPLOSIVES ABOARD**

**BREKBUK MERCHANT SHIPS**

Approved for public release; distribution is unlimited.

TECHNICAL MANUAL  
No. 55-607  
NAVY PUBLICATION  
NAVSEA OP 3221 REV 2



HEADQUARTERS  
DEPARTMENTS OF THE ARMY  
AND THE NAVY  
WASHINGTON, DC, 27 December 1988

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**\*This manual supersedes TM 55-607, NAVSEA OP 3221 Rev 1 September 1976**

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## CHAPTER 1 INTRODUCTION

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### 1-1. Purpose and Scope

This manual provides an operational reference guide for loading military munitions and explosives aboard breakbulk merchant ships. Only breakbulk stowage methods are discussed. Container loading procedures are described by specific outloading drawings prepared by the Services. The text provides general guidance for military and civilian personnel engaged in loading, blocking, and bracing military explosives cargo for ocean movement by ships in conformance with the Code of Federal Regulations (CFR), Title 46, Part 146 (46 CFR146).

### 1-2. Report of Publication Improvements

Users of this publication are encouraged to recommend changes and submit comments for its improvement. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment, to ensure understanding and complete evaluation. Comments should be prepared on DA Form 2028 (Recommended Changes to Publications and Blank Forms) or in a letter and forwarded to the Commander, Military Traffic Management Command, ATTN: MT-SA, 5611 Columbia Pike, Falls Church, VA 22041-5050, or the Commander, Naval Weapons Station Earle, ATTN: Naval Weapons Handling Laboratory, Colts Neck, New Jersey 07722. All proposed changes will be evaluated and approved by both commands.

### 1-3. Application and Intended Use

The information in this publication is intended for personnel, at shiploading activities, who are concerned with loading and shoring military explosives onboard merchant ships. Particular emphasis is placed on dunnaging, with text and illustrations directed to the requirements of blockers and bracers. Additional information concerning associated functions, such as cargo planning, equipment and material scheduling, inspection, and labor requirements, is sufficiently detailed to describe the complete environment of shiploading and cargo stowage. When used in conjunction with applicable Federal and military regulations, this manual will provide ammunition terminals with a synopsis of user-tested procedures for the safe securing of breakbulk ammunition and explosives. Shiploading drawings, as listed in the Department of the Army Pamphlet 310-24, are available for the stowage and shoring of US Army guided missile and large rocket components in accordance with approved methods and procedures. References are contained in appendix A.

### 1-4. Compliance With Federal Regulations

Procedures in this manual comply with requirements established in 46CFR146-29. These regulations prescribe the responsibilities of shippers and carriers of military explosives and hazardous materials and provide for their enforcement. Figure 1-1 shows a typical merchant ship being loaded with military ammunition and explosives.

### 1-5. Compliance by Navy Activities

Navy activities are required by OPNAV 8023.22A to comply with OP 3221/TM 55-607.

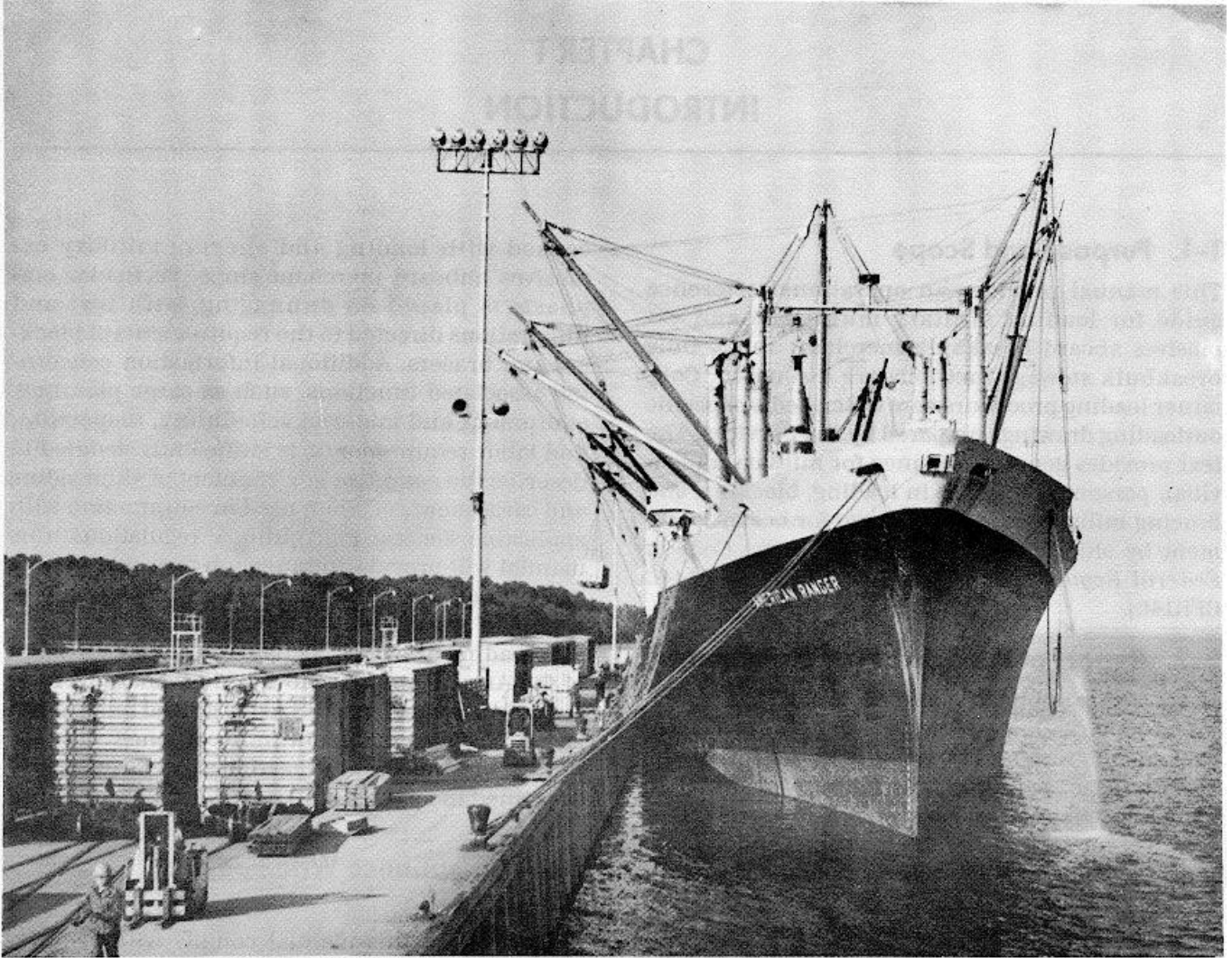


Figure 1-1 Military cargo being loaded aboard merchant-type ship.

**CHAPTER 2**  
**PERMITS, CERTIFICATES, INSPECTIONS, AND ACCEPTANCE**

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**2-1. General**

The hazardous properties of military explosives cargo require strict compliance with the accepted standards for packaging, marking, loading, and securing of dangerous cargoes. This chapter provides a summary of procedures for certification, inspections, and acceptance as required by 46CFR146 and local regulations.

**2-2. Permit for Handling Military Explosives**

Authorization to load, handle, or discharge military explosives and lethal chemicals, except Coast Guard Class I, on any vessel at a United States port must be obtained from the District Commander of the US Coast Guard, Captain of the Port, or other officer designated by the District Commander. Specific policies concerning permits for handling military explosives are defined by 46CFR146.29-13(a) and (b).

**2-3. Certification of Cargo**

Subject to the Code of Federal Regulations, the shipper is responsible for the preparation of any hazardous material offered for transportation by water. The following certification will be shown on the shipping paper and signed by the shipper: "This is to certify that the above-named articles are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation, according to the applicable regulations of the Department of Transportation."

**2-4. Inspections and Acceptance**

a. Prior to commencement of the actual loading operation, all hatches and compartments in which military explosives cargo is to be carried will be thoroughly inspected by cargo operations personnel and qualified station inspectors. All defects and/or substandard conditions will be corrected prior to the loading operation in the affected hatch or compartment. A Coast Guard explosives loading detail (ELD) may be assigned to a vessel being worked at a Navy or Army depot, arsenal, ocean terminal, or other similar facility, unless the Commanding Officer of the facility declines the detail. However, staff directives or instructions issued by the individual Services can require mandatory acceptance of Coast Guard inspection details by the explosives terminal or station. When no Coast Guard ELD is assigned and in attendance, safe operations will be enforced by explosives-qualified inspectors from the port or station.

b. As the loading of each compartment is completed, the adequacy and acceptance of the stowage will be approved by authorized station personnel and inspectors and by an authorized ship's officer. Final acceptance of completed cargo stowage will be certified by the ship's master or his authorized representative. A cargo stowage inspection record may be used for this purpose, a sample of which is shown in figure 2-1.

FINAL HOLD INSPECTION, ACCEPTANCE AND CERTIFICATION OF SHIPS  
LOADED WITH MILITARY EXPLOSIVES AND HAZARDOUS MUNITIONS

SHIP		ACTIVITY		PIER	BERTH
SS AMERICAN KNIGHT		3CD UNWPNSTALONG		1	2
DATE AND TIME OF ARRIVAL			DATE AND TIME LOADING STARTED	DATE AND TIME LOADING COMPLETED	
1030 HRS 10 AUG 74			0800 11 AUG 74	1530 14 AUG 74	
SIGNATURES					
DATE	TIME	HOLD & DECK	SHIP'S BLOCKER & BRACER SUPERVISOR	SHIP'S OFFICER	STATION/COAST GUARD INSPECTOR
11 AUG 74	1300	#1 3RD	Bill Smith	John Andrews	Paul Wood, LT, USCG
12	0900	3RD	Bill Smith	John Andrews	Paul Wood
12 AUG 74	1200	MAIN	Bill Smith	John Andrews	Paul Wood
11 AUG 74	1500	#2 IN. BOTTOM	E White	G. Jones 2/0	Paul Wood, LT, USCG
12 AUG 74	1300	3RD	E White	G. Jones 2/0	Paul Wood
12 AUG 74	0930	2ND	E White	G. Jones 2/0	Paul Wood
13 AUG 74	0900	MAIN	E White	G. Jones 2/0	Paul Wood
		#3			
		#4			
12 AUG 74	1100	#5	Bill Smith	G. Jones 2/0	James Adams LTJG
12 AUG 74	1545	3RD	Bill Smith	G. Jones 2/0	James Adams LTJG
13 AUG 74	1200	2ND	Bill Smith	G. Jones 2/0	James Adams LTJG
14 AUG 74	0945	MAIN	Bill Smith	G. Jones 2/0	James Adams LTJG
13 AUG 74	1115	#6 16' FLAT	Bill Smith	John Andrews	Paul Wood, LT, USCG
13 AUG 74	1330	26' FLAT	Bill Smith	John Andrews	Paul Wood
14 AUG 74	0830	2ND	Bill Smith	John Andrews	Paul Wood
14 AUG 74	1300	MAIN	Bill Smith	John Andrews	Paul Wood
		#7			
		SPECIAL STOW.			
		SPECIAL STOW.			
		SPECIAL STOW.			
		SPECIAL STOW.			
		SPECIAL STOW.			

HOLDS MARKED WITH ASTERISK \* CONTAIN SECURITY ITEMS

CERTIFICATION OF FINAL INSPECTION

THE LOADING WAS CARRIED OUT IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS AND THE STOWAGE HAS BEEN INSPECTED AND ACCEPTED AS SATISFACTORY. NO DAMAGE OR PILFERAGE NOTED.

(SIGNATURE) Thomas Parker SHIP SUPERVISOR  
 (SIGNATURE) Paul Wood STATION/COAST GUARD INSPECTOR  
 (SIGNATURE) Bill Smith BLOCKER AND BRACER FOREMAN

THE STOWAGE HAS BEEN INSPECTED BY ME OR MY REPRESENTATIVE AND IS ACCEPTED AS SATISFACTORY. NO APPARENT DAMAGE OR PILFERAGE NOTED.  
 DATE 14 Aug 1974 (SIGNATURE) John Andrews

Figure 2-1 Typical cargo stowage inspection record.

Should a dispute arise about the adequacy of the stowage, the matter should be referred to the Military Sealift Command (MSC) representative, the MSC Office, or the MSC Area Commander as appropriate.

## **2-5. Standard Feedback Forms and Systems**

Cargo stowage is inspected and the cargo condition reported during and upon completion of the voyage.

a. SF 364 (Report of Discrepancy) (fig 2-2) will be prepared by the military load inspector, Coast TM 55-607/NAVSEA OP 3221 Rev 2 Guard inspector, or ship's master to report unsatisfactory conditions noted in received cargo, including item damage or loss resulting from improper packaging. Any deficiency in packaging involving ammunition, explosives, and other hazardous materials must be reported, whether or not damage or other unsatisfactory condition has resulted. SF 364 must be filed in any instance of improper identification or marking of items, packages, containers, or unitized loads of ammunition, explosives, or hazardous materials. Joint Regulation AR 700-58/NAVSUPINST 4030-29/AFR 71-13/ MCO P4030.29A/DSAR 4145.8 prescribes use of SF Form 364 and provides instructions for preparing, routing, and taking corrective action.



<b>REPORT OF DISCREPANCY (ROD)</b>				1. DATE OF PREPARATION 6 May 88		2. REPORT NUMBER				
<input checked="" type="checkbox"/> SHIPPING <input type="checkbox"/> PACKAGING										
3. TO (Name and address, include ZIP Code) Chief, Storage Branch U. S. Army Garrison, Honshu APO Seattle 98764				4. FROM (Name and address, include ZIP Code) Water Terminal Branch U. S. Army Garrison, Honshu APO Seattle 98760						
5a. SHIPPER'S NAME Ordnance Ammo Depot Songhwan Ni, Korea APO San Francisco 96271				5b. NUMBER AND DATE OF INVOICE A33333 1 May 88		6. TRANSPORTATION DOCUMENT NUMBER (GBL, Waybill, TCN, etc.) AX38541				
7a. SHIPPER'S NUMBER (Purchase Order/shipment, Contract, etc.) N/A		7b. OFFICE ADMINISTERING CONTRACT N/A		8. REQUISITIONER'S NUMBER (Requisition, Purchase Request, etc.) 123xx125						
9. SHIPMENT, BILLING, AND RECEIPT DATA						10. DISCREPANCY DATA		11. ACTION CODE		
NSN/PART NUMBER AND NOMENCLATURE (a)			UNIT OF ISSUE (b)	QUANTITY SHIPPED/BILLED (c)	QUANTITY RECEIVED (d)	QUANTITY (a)	UNIT PRICE (b)	TOTAL COST (c)	CODE <sup>1</sup> (d)	AC <sup>2</sup> TION CODE
1315-00-0279-CJ30			1	2	50	50	\$1.00	\$50.00	Z	D

SAMPLE

12. REMARKS (Continue on separate sheet of paper if necessary)

Five pallets of propellant charge were found in damaged condition in Hatch No. 2 Lt of SS Green Lake during discharge operations at Hiro Port, Japan, on 7 Jul 87. Vessel sailed from Pusan, Korea. Damaged 5 pallets were delivered to storage branch, Dir. of Ammo., USAGH, on 8 Jul 87 via barge No. 74.

1 DISCREPANCY CODES		2 ACTION CODES
<b>CONDITION OF MATERIAL</b> C1 - In condition other than that indicated on release/receipt document C2 - Expired shelf life C3 - Damaged parcel post shipment <b>SUPPLY DOCUMENTATION</b> D1 - Not received D2 - Illegible or mutilated D3 - Incomplete improper or without authority (Only when receipt cannot be properly processed) <b>MISDIRECTED MATERIAL</b> M1 - Addressed to wrong activity <b>OVERAGE/DUPLICATE SHIPMENTS</b> O1 - Quantity in excess of that on receipt document O2 - Quantity in excess of that requested (Other than unit of issue pack) O3 - Quantity duplicates shipment <b>PACKING DISCREPANCY</b> P1 - Improper preservation P2 - Improper packing P3 - Improper marking P4 - Improper utilization	<b>PRODUCT QUALITY DEFICIENCIES</b> Q1 - Deficient material (Applicable to Grant Aid and FMS shipments only) <b>SHORTAGE OF MATERIAL</b> S1 - Quantity less than that on receipt document S2 - Quantity less than that requested (Other than unit of issue pack) S3 - Non-receipt of parcel post shipments <b>ITEM TECHNICAL DATA MARKINGS (i.e., Name Plates, Log Books, Operating Handbooks, Special Instructions, etc.)</b> T1 - Missing T2 - Illegible or mutilated T3 - Precautionary operational markings missing T4 - Inspection data missing or incomplete T5 - Serviceability operating data missing or incomplete T6 - Warranty data missing <b>WRONG ITEM (Identify requested item as a separate copy in Item 9 above)</b> W1 - Incorrect item received W2 - Unacceptable substitute <b>OTHER DISCREPANCIES</b> Z1 - See remarks	1A - Disposition instructions requested (Reply on reverse) 1B - Material being retained (See remarks) 1C - Supporting supply documentation requested 1D - Material still required expedite shipment (Not applicable to FMS) 1E - Local purchase material to be returned at supplier's expense unless disposition instructions to the contrary are received within 15 days (Reply on reverse) (Not applicable to FMS) 1F - Replacement shipment requested (Not applicable to FMS) 1G - Reshipment not required. Item to be re-requisitioned. 1H - No action required. Information only 1Z - Other action requested (See remarks)

13. FUNDING AND ACCOUNTING DATA

N/A

14a. TYPED OR PRINTED NAME, TITLE, AND PHONE NUMBER OF PREPARING OFFICIAL Mr. James Hoover, ITO 927-4646	14b. SIGNATURE
---	----------------

15. DISTRIBUTION ADDRESSEES FOR COPIES

- 2 - Chief, Storage Br. USAGH
- 1 - ORD Ammo Depot, Songhwan Ni, Korea

Figure 2-2. Report of Discrepancy (ROD) (SF 364) (Sheet 1 of 2).

16. FROM:  Same As #4	17. DISTRIBUTION ADDRESSEES FOR COPIES  Same As #5
-----------------------------	--

18. TO:  Same As #3	Use window envelope to mail this document. Insert name and address, including ZIP Code, starting one typing space below the left dot. Each address line must NOT extend beyond right dot. Address must not exceed four single space typing lines.
---------------------------	---

19. IN ACCORDANCE WITH NOTICE OF DISCREPANCY ON FACE OF THIS FORM:

Fold here → a. MATERIAL HAS BEEN <input checked="" type="checkbox"/> WILL BE <input type="checkbox"/> SHIPPED c. <input type="checkbox"/> AN ADJUSTMENT IN BILLING HAS BEEN/WILL BE PROCESSED AS A: <input type="checkbox"/> CREDIT <input type="checkbox"/> DEBIT f. <input type="checkbox"/> AN ADJUSTMENT IN BILLING FOR THE REPORTED DISCREPANCY WILL NOT BE PROCESSED FOR THE FOLLOWING REASON WHICH IS CITED IN THE INDICATED REGULATION.	DOCUMENT NUMBER AX38541	b. <input type="checkbox"/> NO RECORD OF SHIPMENT. RESUBMIT REPORT TO PROPER OFFICE UNDER APPROPRIATE REGULATION. d. <input checked="" type="checkbox"/> INVOICE/BILL ATTACHED e. <input checked="" type="checkbox"/> PROOF OF DELIVERY (Parcel Post Shipments) OR EVIDENCE OF SHIPMENT ENCLOSED.
(1) REASON FOR NOT PROCESSING (a) DISCREPANCY WAS NOT REPORTED WITHIN THE TIME FRAMES ALLOWED AND/OR (b) DOLLAR VALUE DOES NOT MEET THE CRITERIA PRESCRIBED IN THE REGULATION OR AGREEMENT INDICATED IN 19f(2)	(2) PRESCRIBING REGULATION (a) CHAPTER 5 OF THE GSA HANDBOOK. DISCREPANCIES OR DEFICIENCIES IN GSA OR DOD SHIPMENTS, MATERIAL, OR BILLINGS (FPMR 101-26.8) (b) CHAP. 2 AND/OR 7 OF DOD 4000.25-7-M, MILITARY STANDARD BILLING SYSTEM (MILSBILLS) AND/OR DD 1513, U.S. DOD OFFER AND ACCEPTANCE, AS APPLICABLE.	

20. THE FOLLOWING DISPOSITION IS TO BE MADE OF THE REFERENCED MATERIAL:

a. <input type="checkbox"/> PROCESS FOR DISPOSAL IN ACCORDANCE WITH SERVICE/AGENCY DIRECTIVES. c. <input type="checkbox"/> RETAIN MATERIAL AT NO CHARGE. e. <input type="checkbox"/> SHIP MATERIAL (Specify location): (1) <input type="checkbox"/> GBL APPROPRIATION CHARGEABLE: (2) <input type="checkbox"/> CHARGES COLLECT-VIA: <input type="checkbox"/> FREIGHT <input type="checkbox"/> EXPRESS <input type="checkbox"/> PARCEL POST (3) <input type="checkbox"/> PARCEL POST LABEL ATTACHED (4) <input type="checkbox"/> FREIGHT PREPAID	b. <input checked="" type="checkbox"/> REPRESENTATIVE WILL CALL FOR DISCUSSION CONCERNING DISPOSITION IN: d. <input type="checkbox"/> MATERIAL WILL BE PICKED UP IN:	DAYS 15 DAYS
f. <input type="checkbox"/> OTHER (Specify)		

21. <input type="checkbox"/> IF MATERIAL IS STILL REQUIRED, SUBMIT NEW REQUISITION	22. <input checked="" type="checkbox"/> REPLACEMENT WITH SATISFACTORY MATERIAL WILL BE MADE ON OR BEFORE:	DATE 15 May 88
--	---	-------------------

23. REMARKS (Continue on separate sheet of paper if necessary)  
N/A

24a. TYPED OR PRINTED NAME AND PHONE NUMBER OF PREPARING OFFICIAL Mr. James Hoover, ITO 927-4646	24b. SIGNATURE	24c. DATE 1 May 88
---	----------------	-----------------------

Figure 2-2. Report of Discrepancy (ROD) (SF 364) (Sheet 2 of 2).

b. Details of improper loading, stowing, handling, blocking and bracing, and lashing are reported by the discharging activity on Standard Form 361 (Transportation Discrepancy Report) (fig 2-3). Joint Regulation AR 55-38/NAVSUPINST 4610.33A/AFM 75-18/MCO P4610.19B/DSAR 4500.15 provides details for preparation and disposition of the Standard Form 361.





c. Cargo Outturn Advisory and Reconciliation Message (CORM)

(1) The CORM includes specified forms and formats with supporting documentary evidence, reports, and photographs and( provides a source of information for maintaining shipper services' property accountability records. Also, it constitutes the basic source of' information for the Military Sealift Command (MSC) to:

- (a) Administer ocean cargo loss and damage prevention programs.
- (b) Assess ship responsibility and commercial carrier liability for all changes in the quantity and condition of cargo that occurred while the cargo was in the custody of the ship.
- (c) Evaluate the performance of MSC ships and its contractors' ships.

(2) The CORM applies only to shipments moved in lift capability provided or arranged by MSC. It reports cargo discrepancies in the form of overages, shortages, apparent pilferage's, and damages that occur while the cargo is in the custody of ocean carriers, their agents, or the ships. The term Discrepancy in Shipment Cargo Outturn Reporting System (DISCORS) includes the complete array of formats that are the CORM Message, the CORM Reconciliation/Reply, and the formal Discrepancy in Shipment Cargo Outturn Report; this, for ammunition and explosives shipments, includes DD Form 470, and SF 361. These reports are described briefly as follows: (a) CORM Message. The CORM Message is the initial action in the DISCORS. It reports to the Military Sealift Command, to the loading activity, TM 55-607/NAVSEA OP 3221 Rev 2 and to other selected addressees that the cargo has been discharged and that changes in the quantity and condition of cargo as manifested have or have not occurred while in the custody of the ocean carrier.

(b) CORM Reconciliation. The CORM Reconciliation is a message report forwarded, by the discharge activity, to the loading port and other ports on the ship's itinerary. This report advises of overages and/or shortages and requests verification to reconcile the discharge tally.

(c) Discrepancy in Shipment Cargo Outturn Report. The Cargo Outturn Report (DD Form 470) is illustrated in figure 2-4 and, with the Transportation Discrepancy Report (SF 361), constitutes a statement of all changes in quantity and condition of the ammunition or explosives that occurred while in the custody of the carriers, their agents, or the vessels. DD Form 470 identifies the ship and the loading and discharging ports and activities. DD Form 470 and SF 361 list those unreconciled changes in the form of overages, shortages, apparent pilferage's, and damages as such changes appear from a comparison between the cargo manifested and the cargo as tallied at the time and place of discharge from the vessel. Effective 1 July 1975, DISCORS provisions were incorporate(1 into Joint Regulation AR 55-38/NA4610.33A/AFM 75-18/MCO P4610.19B/l)SAR 4500.15, Reporting of Transportation Discrepancies in Shipment. This regulation provides necessary details for report preparation and( disposition under the DISCORS system.

<b>CARGO OUTTURN REPORT</b>	1. PREPARING ACTIVITY (Name and address) (Include ZIP Code) CHIEF, DOCUMENTATION BRANCH US ARMY TRANS ACTIVITY, THAILAND APO SAN FRANCISCO 96232				2. NAME OF SHIP SS. AMERICAN KNIGHT		3. VOYAGE DOCUMENT NO. A-2618		PAGE NO. 1	
	4. SHIP STATUS <input type="checkbox"/> USNS <input type="checkbox"/> USS <input type="checkbox"/> GAA		COMMERCIAL <input type="checkbox"/> VOYAGE CHARTER <input checked="" type="checkbox"/> TIME CHARTER <input type="checkbox"/> SHIPPING CONTRACT <input type="checkbox"/> BERTH TERM		5. LOADING PORT 1N4 SOUTHPORT		6. LOADING ACTIVITY CO MOTSU SOUTHPORT NC		7. DISCHARGING PORT RA4	
8. DISCHARGING ACTIVITY SAME AS BLOCK#1		9. DISCHARGE				10. CARGO DISCHARGED BY:		11. UNLOADING COST CHARGEABLE TO		
		COMMENCED		COMPLETED		<input checked="" type="checkbox"/> MILITARY OR CONTRACT PERSONNEL <input type="checkbox"/> SHIP OPERATOR OR HIS AGENT <input type="checkbox"/> RECIPIENT GOVERNMENT (MAP/AID shipment)		<input type="checkbox"/> SHIP <input checked="" type="checkbox"/> CARGO		
		DATE	HOUR	DATE	HOUR					
		3-1-75	1900	5-1-75	0430					
12. LIST OF ENCLOSURES IN SUPPORT OF REPORT		13. DISCREPANCY (Explain in detail, state apparent cause; indicate action taken or recommended)								
		<p>ALL THE OVERAGES WERE DELIVERED TO ULTIMATE CONSIGNEE.</p> <p><b>SAMPLE</b></p>								
<b>IMPORTANT: ATTACH TO THIS REPORT ALL SUPPORTING EVIDENCE IN THE FORM OF SWORN STATEMENTS, AFFIDAVITS, EXTRACTS OF SHIP'S ROUGH LOG, PHOTOGRAPHS, ETC.</b>		I HEREBY CERTIFY THAT ALL ITEMS OF PROPERTY, DISCHARGED FROM THE ABOVE INDICATED SHIP, IN WHICH DISCREPANCY EXISTS BETWEEN QUANTITY OR CONDITION AS MANIFESTED AND QUANTITY OR CONDITION AS TALLIED AT TIME AND PLACE OF DISCHARGE FROM SHIP, ARE INCLUDED IN THIS REPORT;				AND THAT ALL ITEMS NOT APPEARING IN THIS REPORT WERE RECEIVED AS MANIFESTED IN APPARENT GOOD ORDER AND CONDITION; AND THAT THIS REPORT IS TRUE TO THE BEST OF MY KNOWLEDGE AND BELIEF.				
		TYPED NAME AND GRADE OR RANK OF CERTIFYING OFFICER		TITLE		SIGNATURE		DATE		
		ROBERT J. SMITH, CPT, TC		CHIEF, DOCUMENTATION BRANCH		<i>Robert J. Smith</i>		20 JAN 75		

DD FORM 470  
1 APR 66

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

Figure 2-4. Cargo Outturn Report (DD Form 470)

d. Feedback concerning the loading/stowage procedures used for military explosives is important if dunnaging procedures are to be improved continually. The reporting system prescribed by DISCORS is concerned primarily with discrete deficiencies noted after loss or damage has occurred. Figure 2-5 illustrates a typical feedback report that can be used for evaluating loading and dunnaging pro TM 55-607/NAVSEA OP 3221 Rev 2 procedures regardless of whether or not loss, damage, or deficiency has occurred. It is recommended that the report be provided the ship's master by the responsible loading activity. Copies should be furnished the responsible military command, the station or terminal commander, the Military Sealift Command, and the responsible Coast Guard or military loading inspector.



CARGO AMMUNITION  
STOWAGE EVALUATION SHEET

VESSEL SS NEVERSAIL DATE DEPARTED May 16, 1974  
 OUTLOADING ACTIVITY MOT SUNNYPOINT NC DATE ARRIVED May 27, 1974  
 DESTINATION(S) Zeebrugge, Belgium

1. COMMENTS ON LOADING/STOWAGE PROCEDURES AND EVALUATION OF STOWAGE AT TIME OF DEPARTURE.  
 Loading/stowage proceeded smoothly, utilizing the block stowage technique. Stow was tight and secure. No unshored voids or deficiencies were noted.
2. EVALUATION OF STOWAGE DURING VOYAGE.  
 No comment. Fine weather throughout voyage.
3. EVALUATION OF OFFLOADING PROCEDURES AT DESTINATION.  
 Offloading proceeded normally in all holds. However, an access ladder in No. 1 lower hold was not shored properly and cargo was resting against it.
4. RECOMMENDATIONS TO IMPROVE STOWAGE AND HANDLING PROCEDURES.  
 Use of access ladders as load-bearing structures is not acceptable. Recommend ladders be shored in such manner that all cargo weight is transmitted by the dunnage to stronger ship's structures.

SAMPLE

May 28, 1974  
DATE

John M. Withers  
MASTER OF VESSEL

Figure 2-5. Typical ammunition stowage evaluation sheet.

## CHAPTER 3 PRELOAD REQUIREMENTS

### 3-1. General

Proper securing of explosives represents only one phase of a detailed plan formulated to ensure safe passage of the ship. An adequately secured stow is dependent on the availability of personnel, equipment, and materials in a sequence predetermined by the stowage plan. Preload inspections must be performed to be sure that the condition of the ship is satisfactory for receipt of the intended cargo. This chapter emphasizes the relationship between securing and effective preload planning.

### 3-2. Preloading Inspection

a. A preloading inspection of the ship will be conducted by the US Coast Guard to determine its adequacy for transporting explosives. If Coast Guard inspectors are not available, the inspection will be accomplished by a qualified inspector from the ammunition port. The master or other person in charge of the ship will be required to examine and verify the adequacy, condition, and working order of all working equipment before loading or discharge and to monitor the condition of equipment during operations. Inspections of cargo working equipment apply both to the ship's equipment and to that of the contract labor or Civil Service stevedores. Magazines, decks, hatches, and holds must be prepared for handling military explosives as specified by 46CFR146.29-73.

b. An inspection will be conducted by qualified station personnel to determine bulkheading and decking requirements in the holds. Previously chartered ships will not normally require as extensive preload bulkheads or decking as those being utilized for the first time. The ship is also inspected to ensure that all compartments and holds are swept or hosed clean of rubbish, discarded dunnage, or residue of the previous cargo; that all decks, gangways and hatches where cargo is handled are swept clear of loose material or debris; that the ship's fire hoses, valves, and couplings are in working order; that the ship's cargo-handling gear is test-certified to be in safe working condition; that all tween-deck hatch covers are present and undamaged; and that all sweatboards are in place and undamaged.

### 3-3. Planning

Comprehensive planning prior to the arrival of the ship is the most important function contributing to an effective shiploading operation. Preload planning includes, but is not limited to, the following:

- a. Development of a preliminary stowage plan from booked cargo.
- b. Preparation of estimates of materials from knowledge of ship condition and booked cargo.
- c. Ordering of materials handling equipment and necessary gear.
- d. Ordering required personnel to supervise, load, dunnage, inspect, and document loading operations.
- e. Scheduling and control of cargo flow during loading in accordance with the stowage plan.

### 3-4. Cargo Stowage Plan

a. The practical utilization of the stowage area aboard the ship is dependent on several factors, including the following:

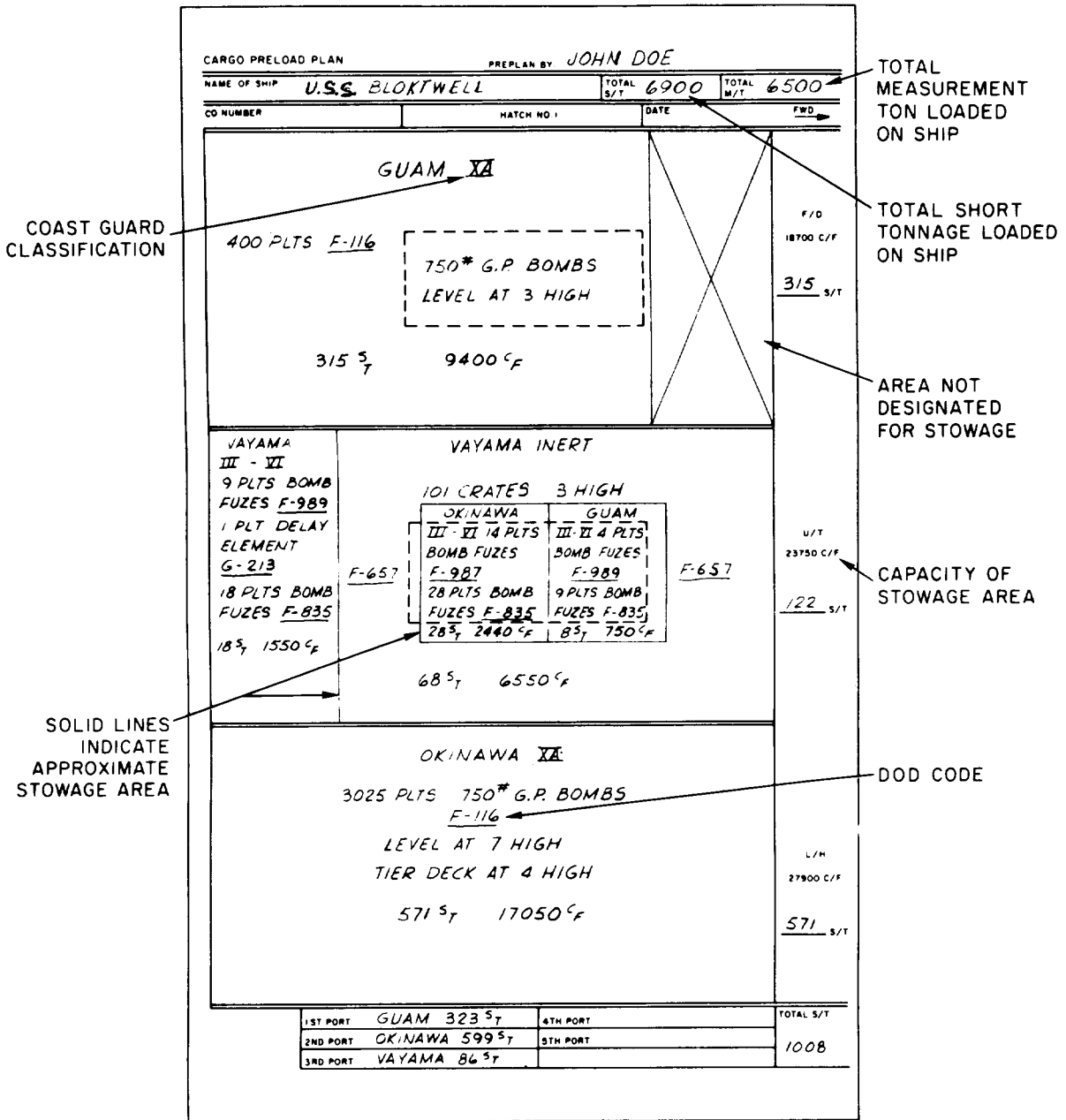
- (1) Compliance with Coast Guard compatibility charts for military explosives and munitions.
- (2) Effect of the cargo weight upon structural and stability parameters of the ship.
- (3) Number and sequence of parts of discharge.

b. The format of stowage plans for the preliminary loading activity and individual planner may differ depending on local policy, but all should include the following:

- (1) Identify the commodity by DOD Indicator Code (DODIC) and short nomenclature.
- (2) Denote the number of loads comprising the stowage and the height to which they may be tiered.
- (3) Locate the stowage area.
- (4) Show the Coast Guard classification of the commodity.
- (5) Indicate the offloading ports.
- (6) Denote the weight and cube of each stowage.

Figure 3-1 is a typical cargo preload plan for the holds serviced through hatch number 1. A typical preplan of an entire ship is shown in figure 3-2. The preload plans provide graphic information for each hold of the ship, with bird's-eye views of the

tween-deck holds and profile views of the lower holds and deep tanks. It is evident that the cargo preload plan is extremely useful to personnel concerned with load emplacement and dunnaging, since it provides the intended stowage scheme. The stowage plans illustrated by figures 3-1 and 3-2 are presented for informational purposes only and may vary with loading activities or by Services.



LEGEND

- <sup>C</sup><sub>F</sub> - CUBIC FEET
- <sup>S</sup><sub>T</sub> - SHORT TON (2000 POUNDS)
- <sup>M</sup><sub>T</sub> MEASUREMENT OR VOLUME TON, UNIT OF MEASUREMENT IS 40 CUBIC FEET
- F/O - FOCSLE DECK
- U/T - UPPER TWEEN
- L/H - LOWER HOLD
- PLTS - PALLETIZED UNIT LOADS

Figure 3-1 Typical preliminary cargo stowage plan for a single hatch.

ON DECK AFT  
 1ST VIII (A-MAP) (24) 1 PLT BLAST CAP #CU.  
 2ND VIII (A-MAP) (10) 1 PLT BLAST CAP #CU.

SS NOON DAY  
 AS 01  
 A# 1228  
 DESTINATIONS: 1ST - RG3 - DAMANG  
 2ND - RG4 - QUI NHON  
 TOTAL TO BE LOADED: 5647 LT 7388 MT  
 PLANSMAN: J.W. WALTON  
 DATE PREPARED: 3 MAR 71

TOTAL L/T & M/T PER PORT OF DISCHARGE  
 3899 LT 5275 MT  
 1748 LT 2113 MT  
 5647 LT 7388 MT  
 TOTAL L/T & M/T

NOTE: BLOCK STOW ALL CARGO FOR ALL SERVICES  
 LOAD BY LOT NUMBERS, SEPARATE LOTS WITH TAPE

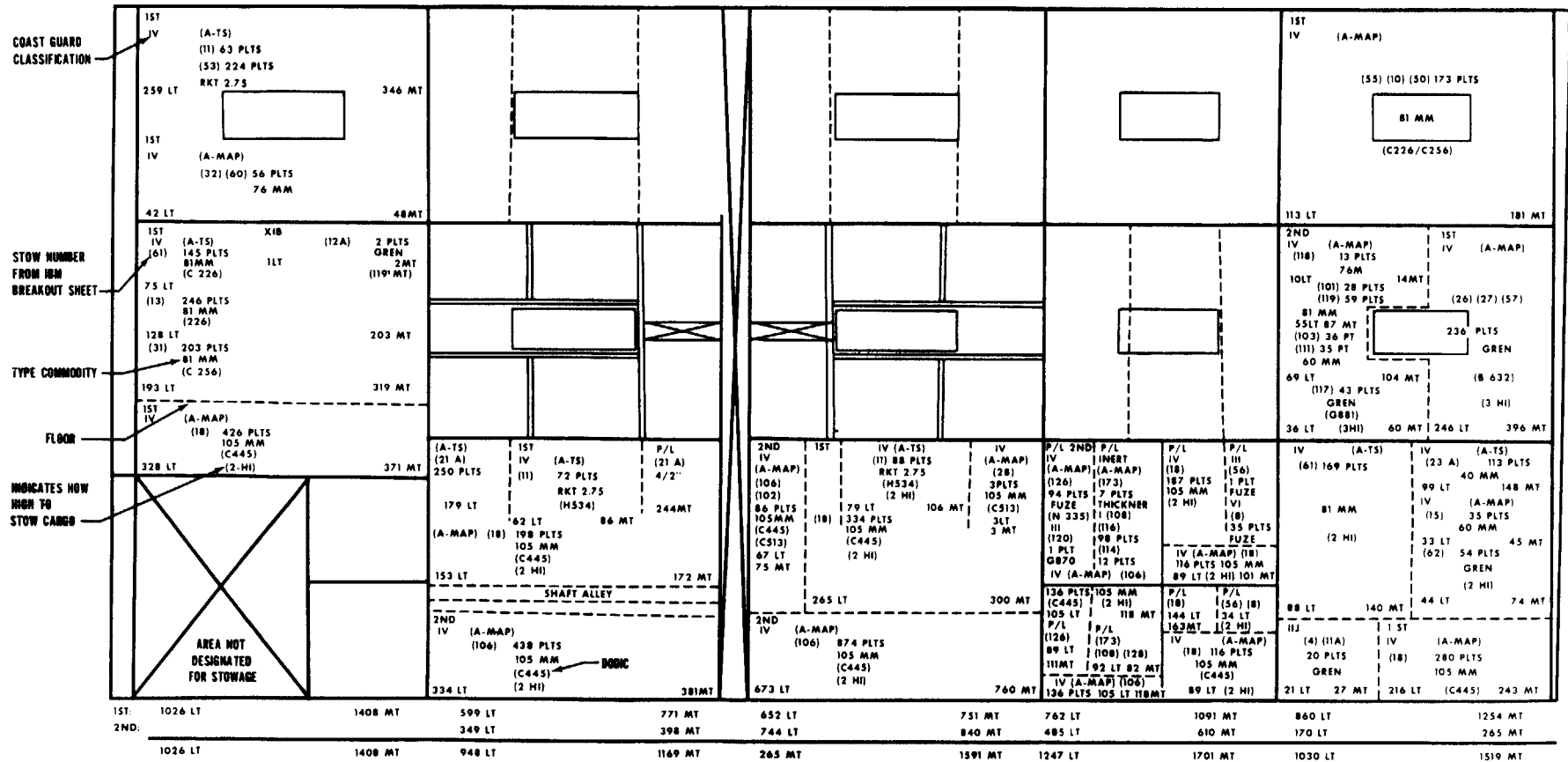
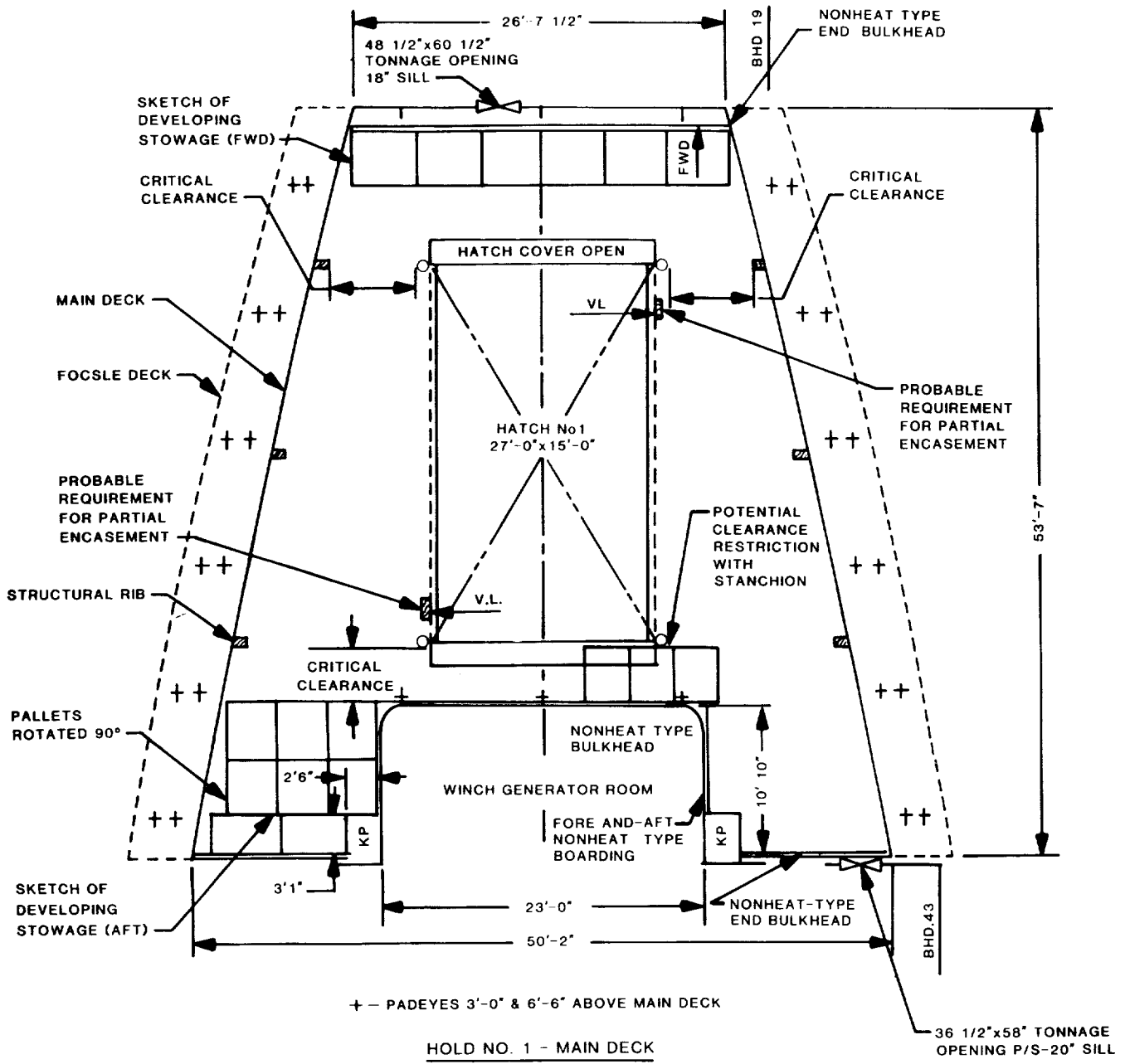


Figure 3-2. Typical preplan for an entire ship.

c. Changes in the stowage plan may occur for several reasons, such as unavailability of cargo at the time needed or substitutions of cargo. As the ship is loaded, such changes are recorded until loading is complete. All changes must be approved by the same Coast Guard agency who issued the loading permit. Since cargo changes can affect the ship's stability, changes must also be coordinated with the ship's master.

d. An additional example of effective preload planning is shown in figure 3-3. The compartment diagram illustrated provides basic dimensional data for hold number 1, main deck, of a Maritime Administration Design C4-S-57a cargo ship. These diagrams are provided in Ship's Loading Characteristics Pamphlets available through the Military Sealift Command. In addition to providing detailed diagrams for each hold and compartment, the pamphlets list general ship's characteristics, including a summary of cargo-handling gear and dry cargo capacity. As shown in the illustration, the diagrams are very useful in preload planning to determine the general stowage arrangement and note potential problem areas before actual commencement of operations. Significant time is required during loading to measure the cargo space and adjust stowage plans, based on the clearances, hull curvature, TM 55-607/NAVSEA OP 3221 Rev 2 and obstructions encountered. While there is no substitute for onsite judgment by experienced personnel, many time-consuming problems can be noted and corrective action planned during preparation of the preplan. For example, the limited deck area available port and starboard of the winch generator room might require rotation of the unit load (usually rectangular in configuration) to maximize space utilization and bring the stow flush with the forward face of the generator room. Critical clearances between end bulkheads and stanchions or between ribs and stanchions, as shown, may permit stowage of unit loads only if bulkheads or encasement structures are constructed to proper dimensions; hence, special attention must be given these areas by blocker and bracer/carpenter crews. Requirements for encasement, such as for vertical ladders or stanchions, can be recognized in advance and completed, at least partially, when loading operations begin. By use of these scaled diagrams, it would not be uncommon for the planner to estimate exactly the number of pallets stowable in a given compartment. By reducing onsite delays in loading operations, the loading diagrams can save the ammunition terminal both time and dunnage materials.



HEIGHT TO GIRDER  
 HEIGHT TO HATCH COVER  
 MINIMUM CLEARANCE  
 BOOMS  
 SQUARE FEET  
 CUBIC FEET  
 MAXIMUM DECK LOADING  
 HATCH OPENING OVERHEAD  
 SCALE

7'-10 7/8" AFT - 7'-10 3/8" FWD  
 TWO 10 TON  
 1824  
 17399  
 DECK 400 LBS/SQ.FT.-HATCH 414 LBS/SQ.FT.  
 27'-0"x16'-0"  
 3/32" EQUALS ONE FOOT

Figure 3-3. Use of compartment diagram during preload planning.

### **3-5. Estimation of Requirements for Materials and Personnel**

a. Lumber Requirements. To ensure that the proper quantity and size of lumber are available during the loading operation, an estimate of materials required must be made, based on the type of cargo, hull configuration, and prestow plan. Such TM 55-607/NAVSEA OP 3221 Rev 2 estimates are of value in optimizing lumber usage and in evaluating excess or inadequate securing procedures. Any additions or deletions to the basic securing estimate should be documented for future reference. Figure 3-4 shows a typical estimate sheet used at military ocean terminals, ammunition depots, and weapon stations for estimating lumber requirements.



MATERIALS ESTIMATING SHEET

Date 5/30/74  
 Location (pier) 4

**AMERICAN KNIGHT**  
 Vessel Name & Voyage No.

Estimator Joseph P. Price

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NEW LUMBER	RECLAIMED LUMBER
<u>800</u> BMF 1 x <u>10</u>	BMF 1 x _____
BMF 4/4 Hardwood _____	BMF 4/4 Hardwood _____
BMF 2x3 _____	BMF 2x3 _____
<u>4202</u> BMF 2x4	BMF 2x4 _____
<u>1564</u> BMF 2x6	BMF 2x6 _____
BMF 2x8 _____	BMF 2x8 _____
<u>14138</u> BMF 2x10	BMF 2x10 _____
<u>1228</u> BMF 2x12	<u>1872</u> BMF 2x12
BMF 4x4x8 _____	<u>4032</u> BMF 4x4 _____
<u>7372</u> BMF 4x4 (8-FT, PRECUT)	BMF _____
<u>4268</u> BMF 4x4 (RANDOM LENGTH)	BMF _____
BMF _____	BMF _____

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EQUIPMENT

\*Wire Rope 1/2 In 3000 Ft

Shkls 3/4 In 75 Ea

Trnbkls 3/4x18 In 75 Ea

\*Clips 1/2 In 250 Ea

Deck Box N/A Ea

Roofing Tacks - Lbs

Felt Paper 2 Rolls

NAILS 300 Lbs 16D

Nails \_\_\_\_\_ Lbs 20D

Nails 150 Lbs 12D

Nails 90 Lbs 10D

Nails \_\_\_\_\_ Lbs \_\_\_\_\_

---

EQUIPMENT SIZES

Wire Rope (5/8) (3/4) (1/2) (7/8)

Shkls (7/8) (3/4)

Trnbkls (3/4 x 18) (1 x 18)

Clips (5/8) (3/4) (1/2) (7/8)

\*Sizes must be identical

---

ACC of U.S. Government \_\_\_\_\_

\_\_\_\_\_ ACC of Vessel Operator \_\_\_\_\_

\_\_\_\_\_ ACC of MAAG POD \_\_\_\_\_

\_\_\_\_\_ ACC of Recipient Country \_\_\_\_\_

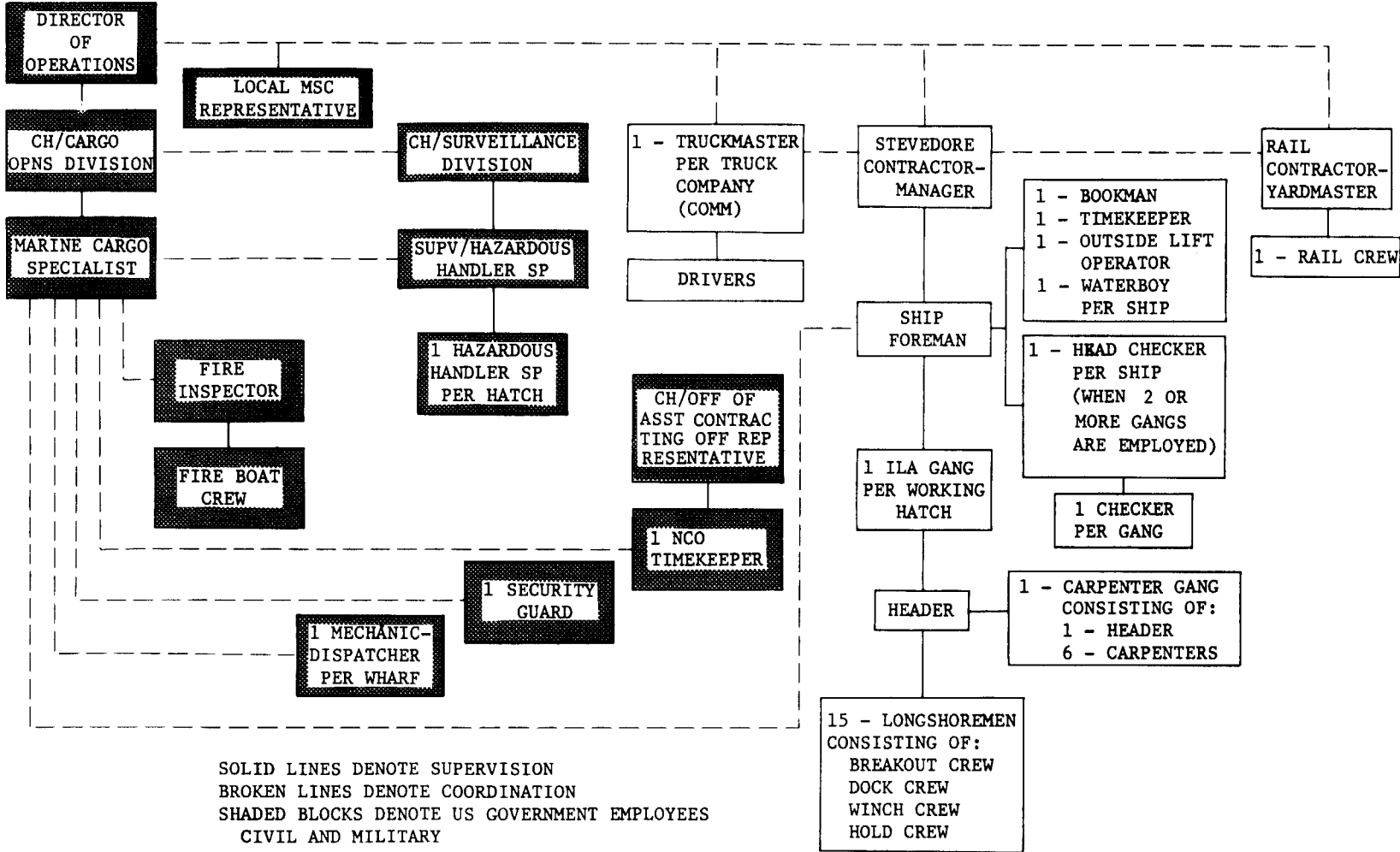
(FF Ships only-MSMS CGO)

Figure 3-4. Typical materials estimate sheet.

b. **Equipment Requirements.** The type and quantity of handling equipment required for loading is determined daily for each ship by cargo operations or cargo planning personnel, based on local terminology at the activity. In either case, the groups are qualified to schedule, dispatch, and control ship-loading operations. After loading is begun, a running account of the progress of loading is provided to the above-referenced personnel to permit quick-reaction changes to be made in case of switched cargo or delayed receipt of cargo by the loading activity. Changes, however, must be approved by the same Coast Guard agent who approved the loading permit.

c. **Personnel Requirements.** Military ammunition shiploading activities generally use either contract labor or Civil Service loading forces in their daily operations. The organization and position responsibilities of each system are similar but require separate consideration for clarity, as follows: (1) Typical contract labor loading force. A civilian stevedore contractor is employed to provide the labor force necessary to load, discharge, handle, and secure explosives aboard ship. The contractor employs a working staff and employs longshoremen, carpenters, and checkers from union locals. Cargo documentation, cargo planning, and stevedore supervision are accomplished by both military and Civil Service personnel. A typical contract labor loading force is shown in figure 3-5. The function and size of contract longshoreman gangs vary with the loading or discharge activity, but generally 75 to 100 longshoremen (three to four gangs) are required for each ship being worked. Each gang generally consists of 16 longshoremen, seven carpenters, one checker, and one outside life operator.

LOADING FORCE FOR ONE BERTH



(2) Typical Civil Service loading force. The function and size of Civil Service crews also vary with the loading activity, but generally from 100 to 125 direct-labor personnel are required for each ship. Of this number, approximately 15 are fixed and are relatively unaffected by the number of ships to be loaded. Crew assignments are based on the schedule prepared by the cargo planning personnel. A typical loading force would include a general foreman, with a ship foreman, a head checker, and a cargo coordinator reporting to him. Below this level, personnel are assigned by hatches, with each hatch having a loading gang reporting to a TM 55-607/NAVSEA OP 3221 Rev 2 leader. Each gang consists of a dock, winch, and hold crew. The basic dock crew includes a checker, two forklift truck operators, and two hookers. Normally, one utility person is also present for miscellaneous dunnaging tasks as required on the dock or in the hold. The winch crew has a winch operator and a signal man. The hold crew consists of two forklift truck operators, one hooker, and at least four blockers and bracers. Requirements for additional manpower can be met by changing crew sizes daily based on information received from daily progress reports. A Civil Service loading force is shown in figure 3-6.

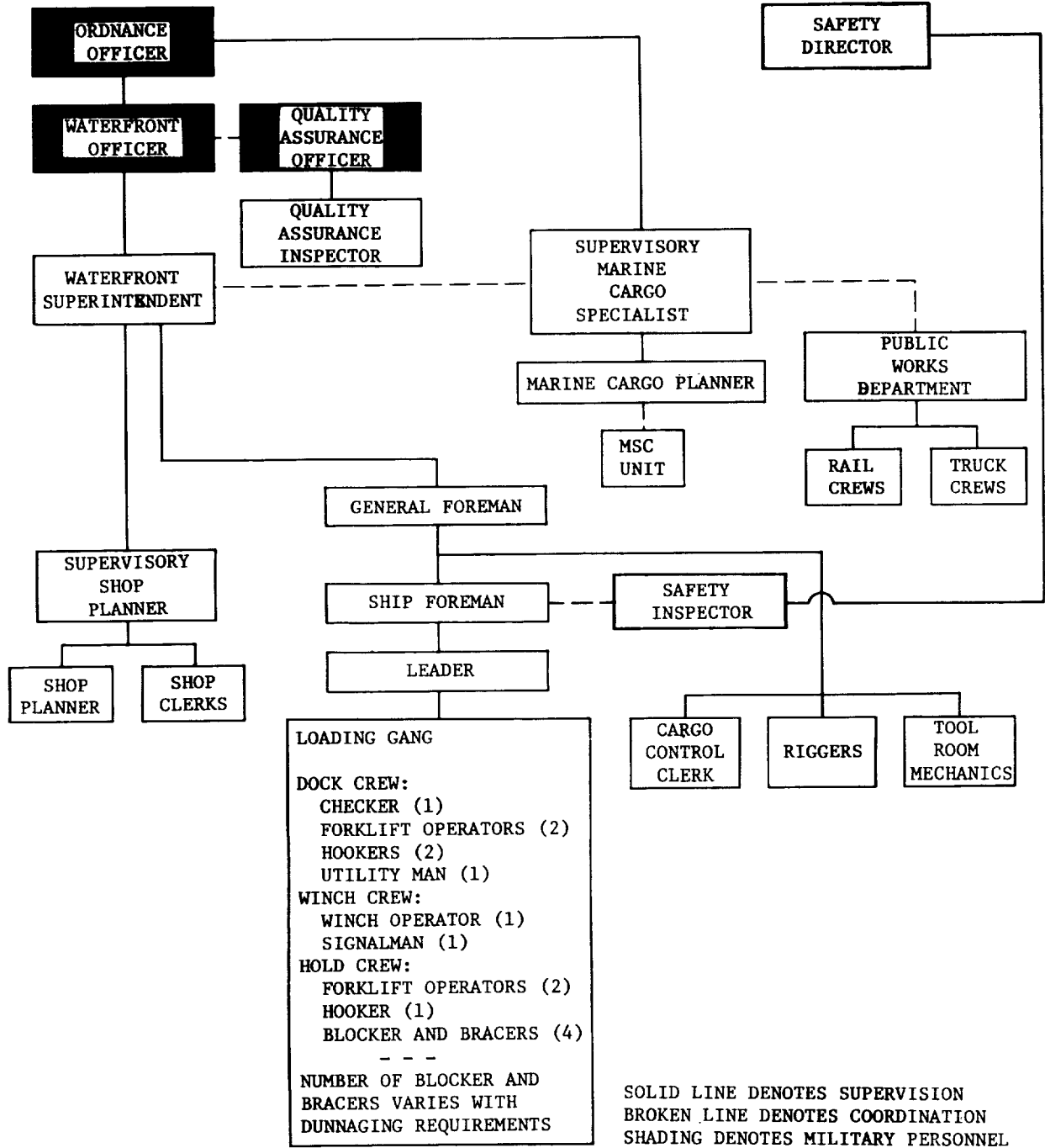


Figure 3-6. Organization of a typical Civil Service loading force.

**CHAPTER 4**  
**BASIC REQUIREMENTS FOR CARGO LOADING AND SECURING**

4-1. General Loading Procedures

a. General requirements for loading or unloading military explosives and other cargo are specified by 46CFR146.29-45. The loading operation is performed in two phases: transfer of the cargo from railcars or trucks to the dock and transfer from dock to ship. Railcars or trucks are subjected to visual inspections en route to the loading area to ensure that the cargo has not been damaged in transit. After the railcar or truck has been opened and its contents inspected, cargo is transferred by forklift truck to designated spotting points for each hatch, as shown in figure 4-1. When military explosives are to be handled, loaded, or unloaded by mechanical means, equipment specified for the various classes of explosives in 46CFR146.09 and 46CFR146.29-100 will be used. Handling and slinging procedures are specified by 46CFR146.29-39.

In addition, cargo handling gear and operations will be in accordance with the longshoring regulations of 29CFR1918. Naval activities must inspect and test ship's cargo gear in accordance with NAVSEAINST 8023.A.

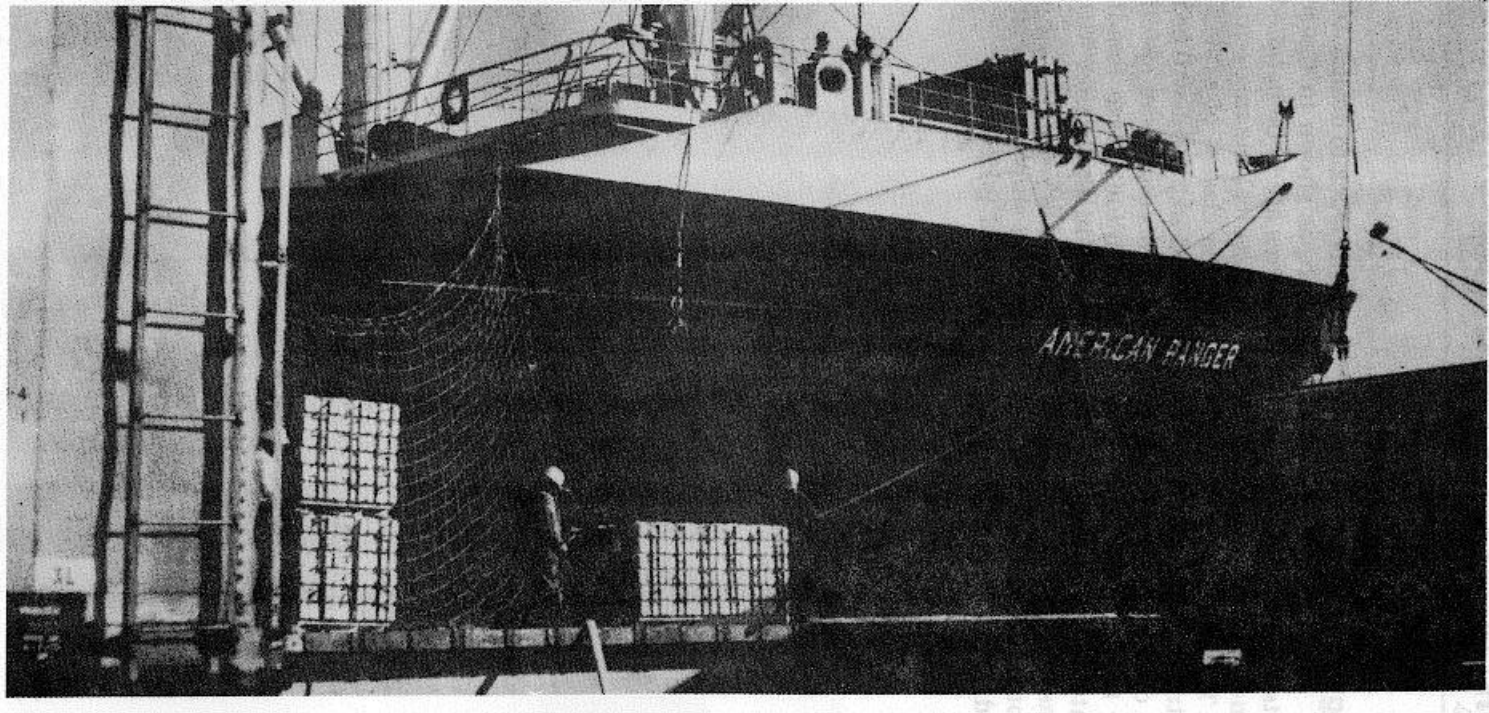


Figure 4-1. Explosives spotted for loading.

b. Explosives positioned for hoisting are given a final visual inspection to detect deficiencies in strapping or packaging. All metal strapping should be tight and the items comprising the unit load should be undamaged. Broken or loose banding of palletized explosives requires that the defective pallet be removed, isolated, and corrected prior to loading. A typical banding defect is illustrated in figure 4-2. Defects in banding must be reported immediately to the supervising authority for evaluation of the banding and possible correction by onsite rebanding. If damage to the commodity is evident, the load should be transferred immediately to an area away from normal loading activity to await further disposition. Navy unit loads are palletized in accordance with MIL-STD's-1332,-1333, and -1324. For Army unit loads, see MIL,-ST-1660.



Figure 42. Unit load isolated because of defective banding.



**WARNING**

**The following conditions require the immediate rejection of an explosives item for transportation or stowage onboard any vessel:**

- (1) Container failure or evidence of leaking of liquid components.
- (2) Unusual appearance of the container, such as dampness, mold, or stains, which indicate internal defects in the absorbent material.
- (3) Defective ammunition and/or packaging. Explosives cargo that indicates any of the above must be immediately removed from the loading area, isolated, and processed in accordance with safety regulations.

c. At the spotting location, riggers/hookers will place the appropriate sling on the load and check pallet balance and construction for lift capability. To eliminate excessive drift, slings will be as short as practicable when military ammunition or explosives are handled. Cargo safety hook (MK2 MOD 0) is required to be used at all Navy activities. When the sling is attached to the load and secured to the hook, the signalman will signal the winchman to hoist the load (fig 4-3). Weight per draft will not exceed the limits specified by 46CFR146.29-41 or as further restricted by command direction. The draft should be lifted in a single, smooth motion, clearing the rail and hatch coaming by at least 3 feet. If activity within the hold restricts the lowering of the load, the load must be returned to the dock or lowered within 6 inches of the ship's deck until loading resumes.

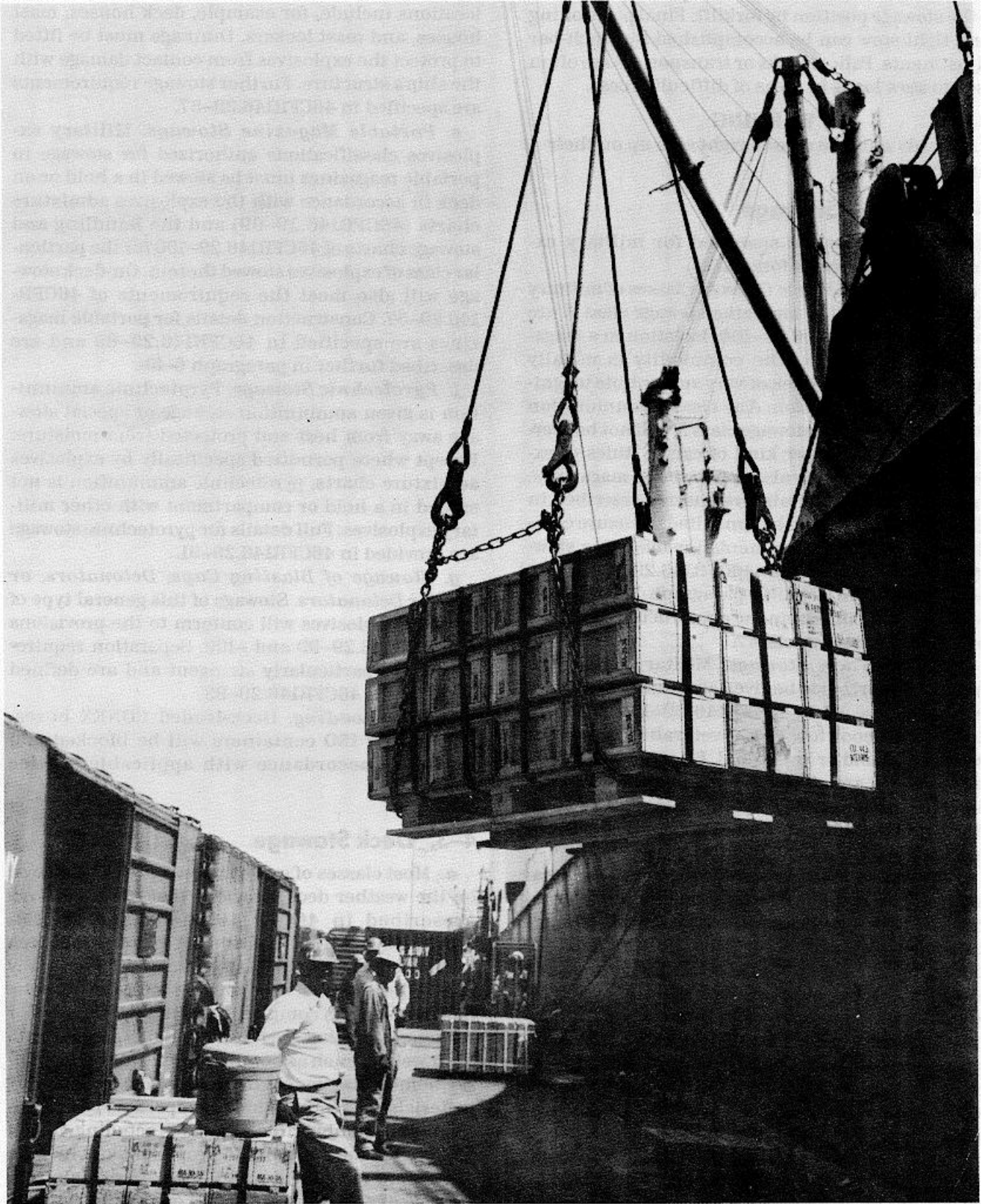


Figure 4-3. Typical lift of palletized cargo.

d. The load is moved from the square of the hatch to the stowage position by forklift. Final positioning for a tight stow can be accomplished by pinch-bar adjustments. Pallet trucks or transporters are often used to stow loads in areas of difficult access.

**WARNING**

**All loads must be stowed right side up on their pallets or skids.**

**4-2. Types of Stowage**

The types of stowage specified for military explosives are termed as follows:

a. Magazine Stowage Class A. Classes of military explosives requiring magazine stowage class A are specified in 46CFR146.29-100. Isolation in a magazine is necessary as the commodity is usually highly sensitive to shock or very susceptible to ignition by spark or friction. Any class of ammunition requiring magazine stowage class A will not be overstowed with any other kind of cargo. Rules of explosives compatibility also apply within magazines, and the explosives admixture charts prescribed in 46CFR146.29-99 must be consulted to ensure compliance. Specific requirements for magazine stowage class A are defined by 46CFR146.29-81 and are also described in detail in paragraph 7-8. Figures 7-26 and 7-27 illustrate the construction required for magazine stowage class A.

b. Ammunition Stowage. Military explosives that are authorized to be given ammunition stowage in accordance with 46CFR146.29-100 must be stowed in a cool location, preferably in a lower tween-deck hold or lower hold. Priorities for selecting locations are similar to those used for magazines and are specified by 46CFR146.29-75. Further details of ammunition stowage are described in 46CFR146.29-83.

c. Chemical Ammunition Stowage. Chemical ammunition or bulk chemical agents that are authorized to be given chemical ammunition stowage in accordance with 46CFR146.29-100 must be given protection at least equivalent to that required for ammunition stowage, described above; however, stowage in a deep tank or lower hold is preferred. Because of the hazards associated with leakage, precautions must be taken during the dunnaging operation to seal the pump suction, hatch covers, and ventilators in accordance with procedures specified by 46CFR146.29-85.

d. Special Stowage. Classes of military explosives that are authorized for special stowage by 46CFR146.20-100 can be stowed in a ventilated space, protected from the elements, that does not contain vessel stores or machinery or equipment used during the navigation of the vessel and that 44 can be closed off from traffic while at sea. Such locations include, for example, deck houses, mast houses, and mast lockers. Dunnage must be fitted to protect the explosives from contact damage with the ship's structure. Further stowage requirements are specified in 46CFR146.29-87.

e. Portable Magazine Stowage. Military explosives classifications authorized for stowage in portable magazines must be stowed in a hold or on deck in accordance with the explosives admixture charts (46CFR146.29-99) and the handling and stowage charts of 46CFR146.29-100 for the particular class of explosives stowed therein. On-deck stowage will also meet the requirements of 46CFR146.29-57. Construction details for portable magazines are specified in 46CFR146.29-89 and are described further in paragraph 6-8b.

f. Pyrotechnic Stowage. Pyrotechnic ammunition is given ammunition stowage or special stowage away from heat and protected from moisture. Except where permitted specifically by explosives admixture charts, pyrotechnic ammunition is not stowed in a hold or compartment with other military explosives. Full details for pyrotechnic stowage are provided in 46CFR146.29-91 g. Stowage of Blasting Caps, Detonators, or Primer Detonators. Stowage of this general type of military explosives will conform to the provisions of 46CFR146.29-99 and -100. Separation requirements are particularly stringent and are defined explicitly in 46CFR,146.29-93.

h. Deck Loading. Deck-loaded CONEX boxes, MILVAN, or ISO containers will be blocked and braced in accordance with applicable service drawings.

**4-3. Deck Stowage**

a. Most classes of explosives cargo can be stowed on the weather deck, provided that the conditions prescribed in 46CFR146.29-57 and 46CFR146.29-59 are met. Typical cargo stowed on deck includes the following: last-on first-off loads in way of hatch; items that are too large to fit through the hatches, such as completely assembled missiles or rockets; items that are relatively bulky compared to their weight, such as bomb fins and empty incendiary bombs; flammable liquids, solids, or oxidizing materials: corrosive liquids; compressed gases, poisons, and combustible liquids (including rocket engines containing a liquid propellant and fuels in containers for guided missiles and rockets). Deck stowage of a dangerous item above a hold containing military explosives will not be undertaken unless specifically authorized by 46CFR146.20-100 and the sections referenced above.

b. The dockside handling procedures for cargo to be stowed on deck are the same as those previously described for cargo stowed in the hold. Often, however, the cargo is positioned on deck with the hoisting gear and then manually stowed. Proper emplacement of cargo is as significant for a tight stow on deck as it is in the hold, and to achieve this end, the unit loads should abut one another as much as possible.

#### **4-4. General Types of Explosive Loads**

The explosives loaded aboard merchant ships can be classed generally as rectangular or round. For stowing and securing purposes, loads are more specifically grouped as follows:

- a. *Rectangular Unit Loads.* Items unitized on wood pallets, metal pallets, or skids (fig 4-4).
- b. *Round, Single-Item Loads.* Large items loaded individually (fig 4-5).
- c. *Overhanging Unit Loads* (fig 4-6).
- d. *Single Containers and Unitized Loads of Containers* (fig 4-7).

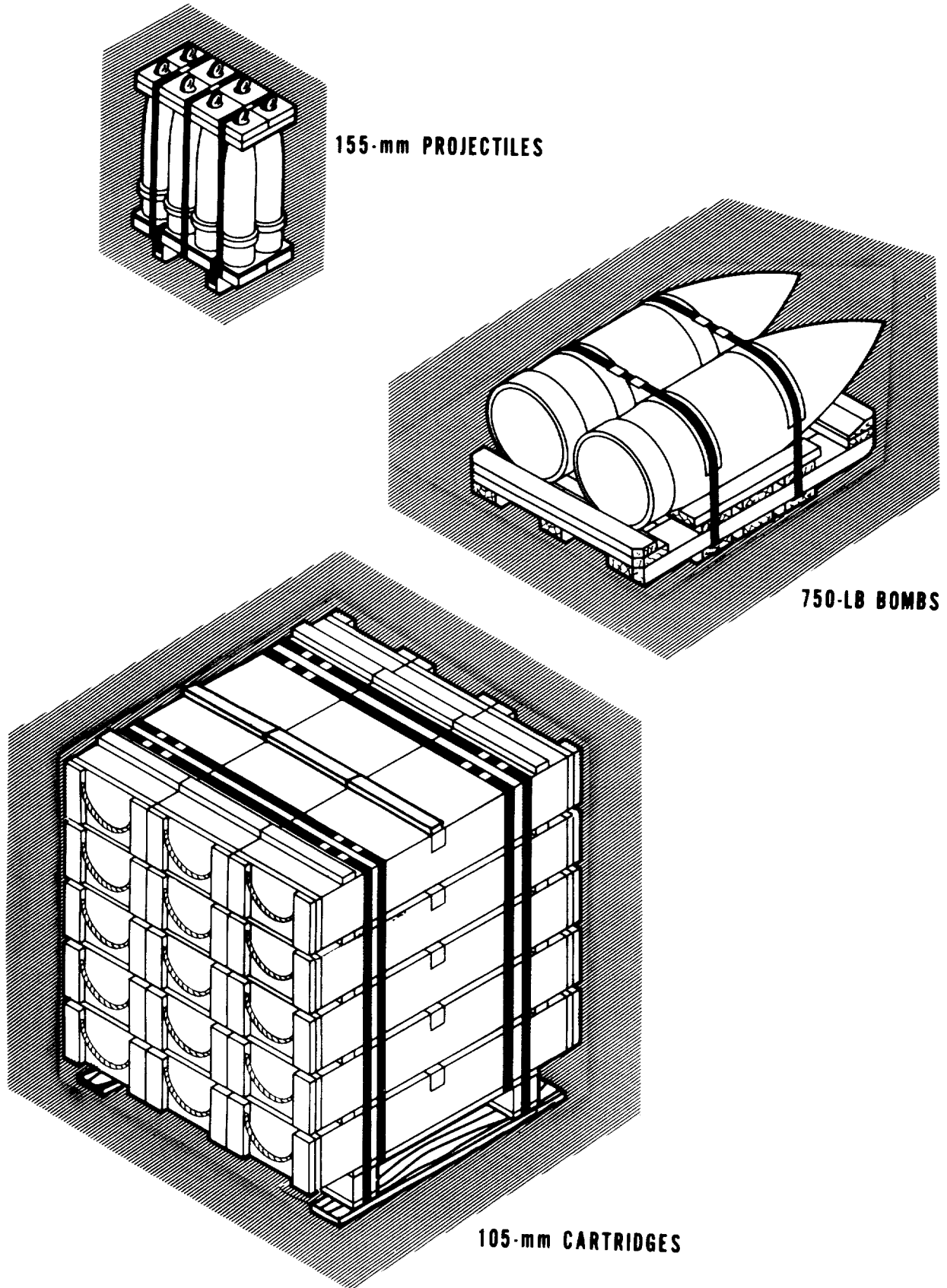


Figure 4-4. Typical palletized unit loads.

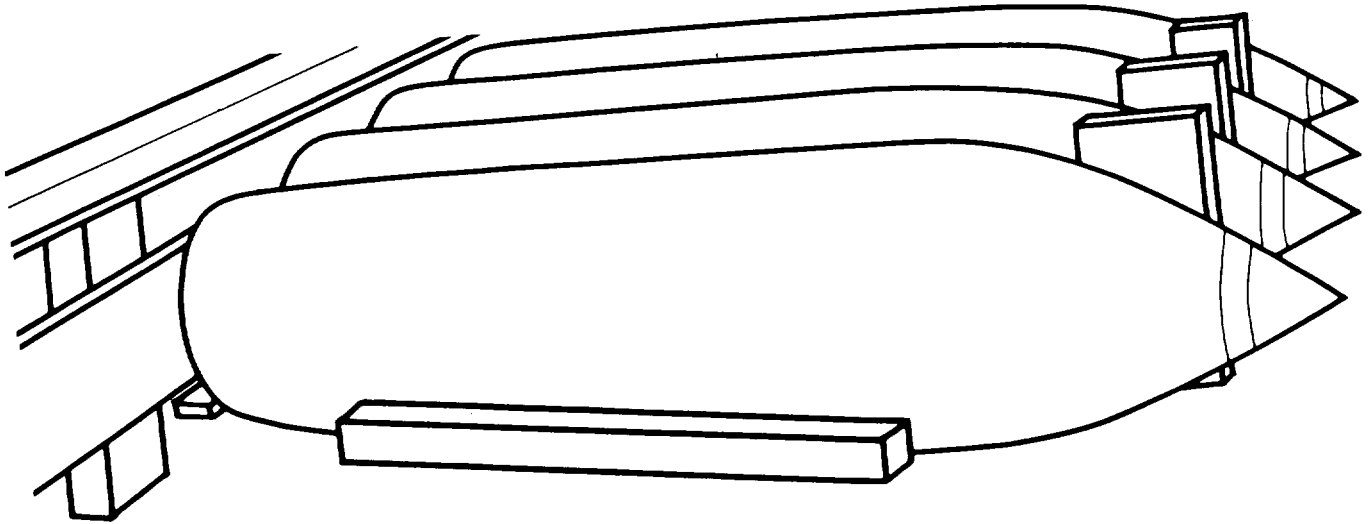


Figure 4-5. Round, single-item load (3,000-pound bombs).

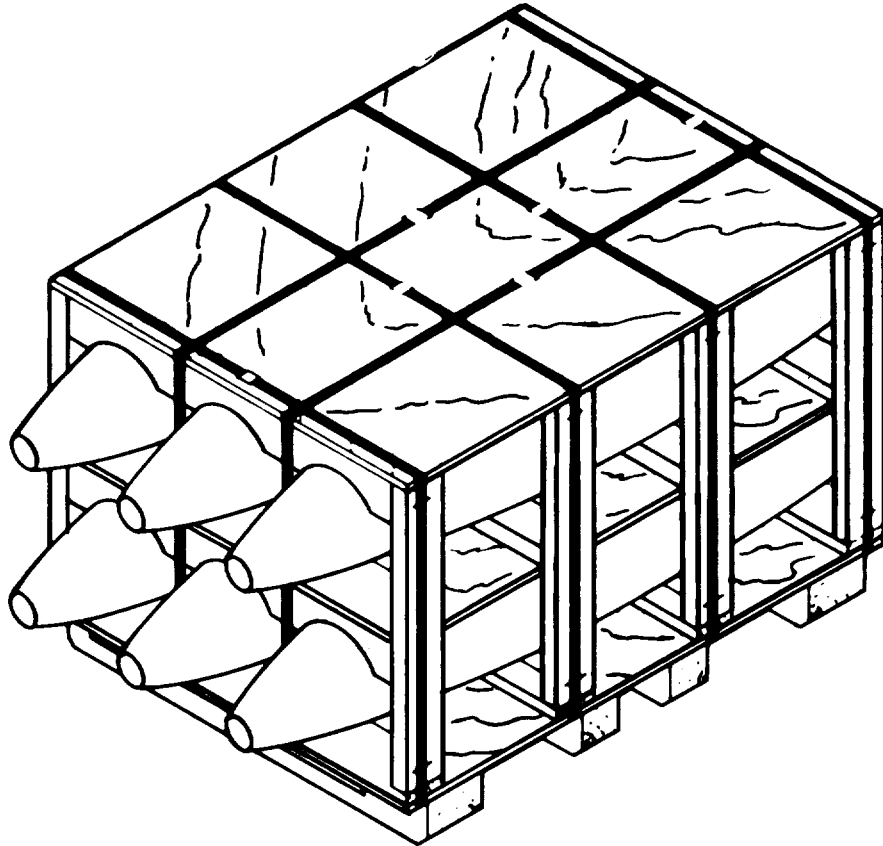


Figure 4-6. Unit load with overhang (500-pound bombs).

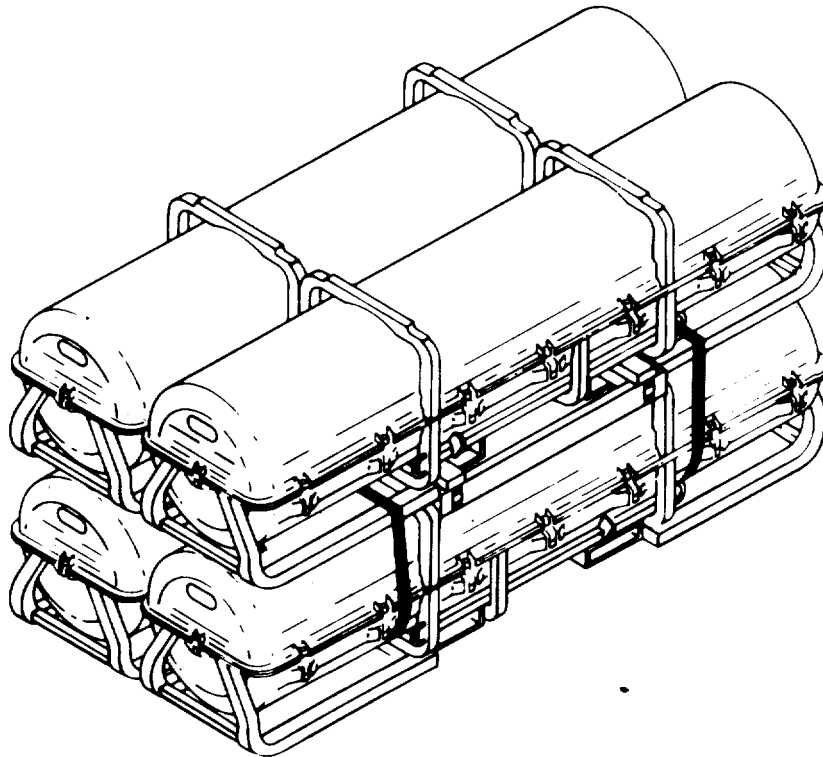


Figure 4-7. Unitized load for containers (CBU-55/B).

#### 4-5. General Stowage Procedures

Explosives are dunnaged below decks by use of either of the following equivalent methods:

*a. Block Stowage.* Loads are stowed in the form of a tight block between parallel securing structures constructed at both sides of the hold, or they are confined by other loads or wooden bulkheads if warranted by the size of the load. Block-stow techniques are advantageous in that undesirable void areas within the stow are minimized. The blockstow technique is described fully in chapter 8.

*b. Sweatboard-to-Sweatboard Stowage.* This technique requires that loads stowed along the sides of the hull be made to bear against strip sheathing and be parallel with the ship's center line. Therefore, unless the hull's angle fore and aft (chamber) at this particular stowplace is parallel to the ship's center line and the vertical angle of the hull (sheer) is perpendicular to the deck, only one corner of the load is brought to bear at the strip sheathing. A tight stow is achieved, provided that longitudinal movement is blocked and that subsequent loads comprising the complete stow are placed so that each row of unit loads bears against both the strip sheathing and its neighboring row. A more detailed description of this method of stowing is provided in chapter 8.

#### 4-6. Use of Power-Operated Industrial Trucks

Army activities should refer to 46CFR146.9-15 to determine the proper equipment necessary for safe loading operations. All Navy activities are required to comply with NAVSEASYSCOM OP 4098, "Handling Ammunition, Explosives, and Hazardous Materials with Industrial Materials Handling Equipment (MHE)."

## CHAPTER 5 APPROVED MATERIALS AND SPECIFICATIONS

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### 5-1. General

a. The basic specification requirements for securing materials are developed from 46CFR146, which defines the basic structures and materials. It does not, however, provide sufficient details for procurement purposes, and there is no single specification that spells out the total requirements for the physical composition of dunnaging materials to be used in loading military explosives aboard merchant ships. Each type of securing material used is covered by individual specifications of either Government or commercial origin.

b. Since a primary purpose of this publication is to standardize securing practices and procedures, there must first be some degree of standardization in the dunnaging materials used. For this reason, reference publications are cited in the material descriptions to serve as guides in obtaining or recognizing securing materials that have proved to meet the requirements of availability, utility, strength, and reasonable cost. The referenced publications also form the basis for a set of common terms and definitions that are needed to clarify local terminologies, which have developed because of the widely dispersed geographical locations of material users and producers. This is particularly true in the case of lumber and plywood, where such parameters as quality, species of wood, and sizes are established in grading rules issued by lumber manufacturers' associations or their affiliated inspection services; in the commercial standards issued by the Bureau of Foreign and Domestic Commerce of the US Department of Commerce; and in Federal Government specifications issued by the Federal Supply Board (formerly Federal Specifications Board). The latter covers Government purchases in governmental and military specifications formulated and issued for specific products by the Department of Defense. Should the user of this publication require a more detailed knowledge of the specific dunnaging material than is provided herein, the referenced publications will also serve this purpose.

c. The following descriptions cover all the materials specified for use in dunnaging by the regulations in 46CFR146, as well as other materials not directly specified but commonly used in complying with the requirements of applicable regulations. Materials specified by regulation that are considered the ship's responsibility are not discussed; that is, sweatboards, Ys-inch wire-mesh screening to cover ventilators in magazines, and blank flanges installed on the suction side of bilge pump manifolds for chemical ammunition storage.

### 5-2. Wood

a. *General Classification.* Native species of trees are classified generally as hardwoods or softwoods. Normally, softwood should be used for dunnaging because of its availability, utility, reasonable cost, ease of cutting and fastening, and adequate strength characteristics. This preference does not exclude the use of acceptable grades of hardwood in areas where local softwood is not available (a situation common to many oversea ports). Because of its relatively short duration of use, softwood is not preserved or fireproofed. Many species of softwood are available for securing explosives, and the species selected at a particular loading activity will vary based on availability and cost. Common commercial softwood species are listed in appendix B.

b. *Applicable Specifications.* Federal Specification MM-L-751, Softwood Lumber, covers the requirements for softwood used in shipboard dunnaging.

c. *Grades of Common Boards.* Five numerical grades of common boards are provided for in the American Lumber Standards (some lumber associations such as the West Coast Lumber Inspection Bureau (WCLIB) and the Western Wood Products Association (WWPA) grade common boards in only four grades: construction, standard, utility, and economy). Grade 1 is classed as suitable for better type construction and grade 2 for good standard construction. For sheathing and dunnaging ammunition, use grade 2 softened lumber (except where unavailable) that is sound and free from crossgrain knots, checks, or splints, which impair the strength of the lumber or interfere with adequate nailing. It is recognized that significant variations of quality can occur between like grades. Therefore, conservation by rated grade 3 lumber that meets the above quality standards may be used in place of grade 2.



d. *Grades of Planks, Scantlings, and Heavy Joists.*

(1) Planks, scantlings, and heavy joists of common-dimension lumber are graded in three numerical grades under the American Lumber Standard Grades (a fourth grade is provided under some association grading rules). Dimension lumber is graded mainly for strength, stiffness, and straightness. It is used mainly where stiffness is the controlling factor, as in joists or studs, where the size of the member is determined by common building practice rather than specifically designed to carry definite static (dead) or dynamic (live) loads. Grade 1 dimension lumber is a sound grade in which knots are allowed, depending on the size of the knots with relation to the size of the piece. Features such as pitch, torn grain, checks, and stains that do not materially affect the strength of the piece are not limited. Wane (bark, or lack of wood for any cause, on an edge or corner of a board or timber) is limited to provide good nailing on one side and two edges. This grade is used for joists and rafters in light framing and for less exacting items in heavier framing. It is also used as planking for platforms and other heavy-duty flooring where the wearing surface rather than load-carrying capacity is the important factor. Grade 2 dimension lumber permits coarse, sound knots to a limited extent, along with warped pieces and certain types of decay. It has fair nailing edges and other features that will not weaken the piece to an extent that will render it unfit for use.

(2) Grade 3 in American Standards and grade 4 in some association grading rules normally admit to characteristic defects or size limitations that affect their utility for dunnaging. Therefore, grade 2 dimension is recommended for dunnaging (construction grades under WCLIB, WWPA standards) structures. Again, in situations where lower graded lumber meets the physical quality requirements set forth in this section, it may be used in place of grade 2. Conversely, in situations where local grade 2 lumber does not meet these quality standards, higher graded lumber must be procured.

e. *Reclaimed Lumber.* Lumber reclaimed as the result of a ship being discharged, and which satisfies the requirements described in this section, is acceptable for dunnage as long as all split ends and nails are removed.

f. *Regulation Lumber Sizes.* The regulations in 46CFR146 provide for minimum sizes of lumber used for dunnage. The regulations cite "commercial" sizes, which are the undressed nominal sizes. For additional information on lumber sizes, refer to appendix B. Table 5-1 summarizes the regulation lumber sizes and construction techniques as specified by 46CFR146 with alternate techniques that can be considered with special justification under the exemption procedures specified by 46CFR146.02-25 and 49CFR107.

g. *Green Lumber.* Thoroughly seasoned lumber (that is, either air or kiln dried) is preferred for dunnaging since it reduces the amount of dimensional change that the lumber may undergo as its moisture content varies in the ship's environment. Since the effect of the ship's environment on green lumber during the timespan of a voyage is not well documented, it is recommended that the usage of green lumber be restricted to situations in which seasoned lumber is unavailable.

### 5-3. Plywood

a. *General.* Although plywood has limited application in securing operations, it is permitted as sheathing for covering the interior of Class "A" magazines, and for decking and bulkheading in lieu of solid 2-inch boarding. In these applications, the regulations specify 3/4-inch plywood and also require that, when used for the interior of a magazine, one side be finished so as to form a smooth surface.

b. *Applicable Specifications.* Federal Specification NN-P-530, Flat Panel Plywood, covers the requirements for softwood plywood that conforms to the commercial standard for Douglas-fir plywood (CS45), for western softwood plywood (SC122), for pine plywood (ponderosa pine, sugar pine, and Idaho white pine), and for southern pine plywood (CS259). These publications provide the detailed requirements for plywood that is suitable for dunnaging within the Federal regulation requirements previously discussed. It is recommended that the softwood plywood used for dunnaging be an exterior type of grade BC or CC, five or seven-ply, procured in 4 by 8-foot sheets.

c. *Exterior Plywood.* Exterior plywood has a high degree of moisture resistance and retains its original form and strength when repeatedly wet and dried. The grades of exterior plywood that are commercially available (grades refer to the quality of veneer used for the faces and inner piles) are provided in appendix B along with additional commercial limitations that apply to the specific grades.

### 5-4. Nails

The nails used for fastening wood are common steel-wire nails, designated as type II, style 10, flathead, diamond-point, bright, zinc or cement coated, smooth, as designated in Federal Specification FF-N-105, *Nails, Wire, Brads, and Staples*. Generally, 8 penny (8d) nails are used for direct nailing of 1-inch lumber and 10 penny (10d) or 12

penny (12d) for nominal 2-inch lumber. Larger 16 penny (16d) nails are often used for toenailing joints of 4 by 4-inch stock, or for nailing 2-inch lumber to 4 by 4-inch or larger material.

#### **5-5. Strapping, Lashing, and Tiedown Gear**

Cargo stowed on deck is lashed down with preformed flexible steel cable (Specification MIL-C-5424 or MIL-C-18375) or flexible steel wire rope (Specification MS-17353 or MIL-W-24228). The cable or rope is tensioned by turnbuckles (Specification FF-T-791) attached to suitable lashing points on the ship's structure. The turned-over ends of the cable or rope are secured by steel clamps (Specification FF-C-450). Heavy items can be tied down with 1/2-inch wire strap (Specification QQ-S-790, *Round Steel Strapping*, or Specification QQ-S-781, *Flat Steel Strapping and Seals*), steel cable, or rope.

#### **5-6. Barrier Materials**

The interior of stowage structures constructed on the weather deck will be lined with 4-mil polyethylene sheets, or equal; waterproof barrier materials (Specifications MIL-B-81374A, MIL-B-13239D, or MIL-B-121D); or with approved commercial equivalents.

#### **5-7. Tools**

Tools, including lights and portable equipment used to load or unload military explosives, will conform to the requirements established by 46CFR146.29-35. Power tools may be used in constructing shoring but are not permitted in any compartment containing military explosives.

#### **NOTE**

**Use of alternate construction techniques that are not equal to or that exceed the requirements of 46CFR146 requires special justification and issuance of an exemption in accordance with 46CFR146.02-25 and 49CFR107.**

**Waivers may be required to use most of these alternate construction techniques.**

**Table 5-1 Comparison of Approved Construction Techniques with Alternate Methods.**

REGULATION NO.	APPROVED CONSTRUCTION TECHNIQUES AND MINIMUM LUMBER SIZES	ALTERNATE CONSTRUCTION TECHNIQUES FOR OTHER LUMBER SIZES
46CFR146.29-11 (c) (19)	<p>Division bulkheads, tween-deck compartments, or holds. Commercial 2-inch boards secured to 4- by 6-inch uprights spaced 30 inches or less center-to-center. Random-width boards fitted edge-to-edge and butt-to-butt.</p> <p>Division bulkheads, lower holds. Commercial 2-inch boards secured to 6- by 6-inch uprights spaced 24 inches or less on centers. Random-width boards fitted edge-to-edge and butt-to-butt.</p>	<p>Uprights can be constructed of 4- by 4-inch lumber when 4- by 6-inch lumber is not available. Spacing must be reduced to 24-inch centers to provide comparable rigidity. Uprights can be constructed of 4- by 4-inch lumber when 6- by 6-inch lumber is not available. Spacing must be reduced to 16-inch centers to provide comparable rigidity.</p>
46CFR146.29-11 (c) (20)	<p>Dunnage. Not less than 1-inch commercial thickness laid over tank tops, decks, or against bulkheads, frames, ladders, or used for filling voids, or fitted around cargo.</p>	<p>Use of less than 1-inch lumber for general dunnage is not permitted.</p>
46CFR146.29-11 (c) (36)	<p>Partition bulkhead. Commercial 1-inch lumber of widths not less than 4 inches, secured alternately on both sides of the uprights, and spaced not more than 6 inches apart. Uprights at least 2 by 4 inches and spaced not more than 30 inches apart.</p>	<p>Uprights can be constructed of 4- by 4-inch lumber when 2- by 4-inch lumber is not available. Upright spacing will not exceed 30 inches between centers.</p>
46CFR146.29-11 (c) (63)	<p>Type A dunnage floor. Two layers of commercial 1-inch lumber of widths not less than 4 inches and fitted as close as possible, edge-to-edge and butt-to-butt. The top course is laid crosswise to the lower course, or a single layer of 2-inch lumber of widths not less than 6 inches is fitted as close as possible, edge-to-edge and butt-to-butt. When 2-inch lumber is used over hatch boards, it will be laid fore and aft.</p>	<p>Alternate construction not permitted.</p>
46CFR146.29-11 (c) (64)	<p>Type B dunnage floor. One layer of commercial 1-inch lumber of widths not less than 4 inches fitted as close as possible, edge-to-edge and butt-to-butt.</p>	<p>Alternate construction not permitted.</p>
46CFR146.29-61 (b)	<p>Stowage with nondangerous cargo in same hold. When nondangerous cargo is to be stored adjacent to exterior magazine, use wooden cargo batten of not less than commercial 2- by 4-inch size, spaced not more than 12 inches, center-to-center, and fitted horizontally to the uprights that form the frame of magazine.</p>	<p>Alternate construction not permitted.</p>
46CFR146.29-75 (a) (7)	<p>Location of magazines and ammunition stowage. In insulated spaces normally comprising refrigerator spaces, pipes within compartment will be protected by horizontal cargo battens of a size not less than commercial 2 by 4 inches; spaced not more than 12 inches apart, center-to-center, and secured to 4- by 6-inch uprights spaced not more than 36 inches apart.</p>	<p>Minimum 4- by 4-inch uprights can be used when 4- by 6-inch stock is not available. Spacing of uprights must be reduced to 24 inches for comparable strength.</p>
46CFR146.29-75 (b)(1),(2),(3)	<p>Construction of magazine to stow ammunition adjacent to engine room, boiler room, or coal bunker bulkheads, or engine room or boiler room uptakes or casings. Construction of tight wooden temporary bulkhead at least 1 foot off the permanent bulkhead, uptakes, or casings, with the smooth side facing the stowage of the explosives or ammunition.</p> <p>When permanent bulkhead is smooth on cargo side, commercial 2-inch boarding secured by 4- by 6-inch uprights spaced not more than 30 inches apart on tween or shelter deck, or 6- by 6-inch uprights spaced not more than 24 inches apart in lower hold. A 2- by 6-inch bearer to carry the upright will be laid on the metal deck, and a 2- by 6-inch header will be fitted against the underside of the overhead to receive top of uprights. Suitable horizontal stringers will be fitted between temporary and permanent bulkheads at top and bottom, as well as intermediate stringers spaced a maximum of 5 feet apart.</p>	<p>Deviations not permitted.</p> <p>Minimum of 4- by 4-inch uprights can be used when 4- by 6-inch lumber is unavailable; however, upright spacing must not exceed 24 inches on tween decks or 16 inches in the lower holds. Headers and bearers are optional. Two- by four-inch spacers are wedged to overhead beams or ship's structures as required.</p>

Table 5-1. Continued.

REGULATION NO.	APPROVED CONSTRUCTION TECHNIQUES AND MINIMUM LUMBER SIZES	ALTERNATE CONSTRUCTION TECHNIQUES FOR OTHER LUMBER SIZES
46CFR146.29-81 (b)	<p>When permanent bulkhead stiffeners are on the cargo side, suitable uprights of not less than 2 by 4 inches may be installed against the permanent vertical stiffeners to provide the required 12 inches off the bulkhead. If the permanent stiffeners are over 30 inches apart, center-to-center, 2½-inch boarding will be used.</p> <p>Magazine Stowage A. Magazines constructed of steel have the whole interior thoroughly protected by wood dunnage of a minimum thickness of three-quarters inch.</p> <p>Metal stanchions within magazine will be boxed with wood of a thickness not less than three-quarters inch.</p> <p>When bare steel or tank tops are used for magazine floor, a wooden floor consisting of two layers of commercial 1-inch-thick lumber will be laid, with the top course laid crosswise to the lower course. When steel decks or tank tops are originally fitted with a wood floor or are ceiled, it will be necessary to fit one course of dunnage.</p> <p>All flooring formed by these methods will be laid with commercial 1-inch lumber of widths not less than 4 inches, fitted as close as possible, edge-to-edge and butt-to-butt.</p>	<p>When permanent stiffeners are over 30 inches apart, intermediate wood stiffeners are built at locations between permanent stiffeners so that 30-inch dimension is not exceeded and 21/-inch boarding not required. Proper 12-inch spacing can be achieved by laminating three 4- by 4-inch uprights and a single 2- by 4-inch piece. Boarding shall be 2- by 10- or 2- by 12-inch material.</p> <p>Deviation not permitted.</p> <p>Do.</p> <p>Do.</p> <p>Commercial 2-inch lumber not less than 6 inches wide can be used when available.</p>
46CFR146.29-81 (c)	<p>Magazines constructed of wood will have side and end bulkheads of commercial 1-inch lumber, of 3/4-inch tongue-and-groove sheathing, or of 3/4-inch plywood, secured to uprights of at least a 3- by 4-inch size; spaced not more than 18 inches apart; and secured at top, bottom, and center with horizontal bracing.</p> <p>When 3/4-inch plywood is used, uprights may be spaced on 24-inch centers. A 2- by 4-inch bearer and header will be used for the uprights. Tops of uprights fitted against channel beams may be wedged directly to the beam with 2- by 4-inch spacers fitted between.</p> <p>When a metal stanchion, post, or other obstruction is located within interior area of magazine, it must be completely covered with wood of the thickness of at least three-quarters inch secured in place with nails or screws.</p>	<p>Two- by four-inch bearers and headers not mandatory.</p>
46CFR146.29-89 (b)	<p>Portable Magazine Stowage. Portable magazines will be constructed of wood or metal, lined with wood of 3/4-inch minimum thickness.</p>	<p>Three-quarters inch minimum hold. Two-inch minimum on deck when material availability permits.</p>
46CFR146.29-89 (d)	<p>When constructed of wood, the scantlings will not be less than those required for a type "A" magazine in 46CFR146.29-81, with a close-fitting hinged cover or door with an effective means of securing.</p>	<p>Three- by four-inch minimum uprights; 4- by 4-inch preferred when available; spacing requirements unchanged.</p>
46CFR146.29-89 (g)	<p>When stowed on deck, the magazine will be protected from the direct rays of the sun and elements. (Ed note: that is, near or beneath a ship's structure, as opposed to being completely exposed on deck.) Runners, bearers, or other suitable means will be provided to elevate it a minimum of 4 inches from the deck.</p>	<p>Construct in accordance with minimum material specifications outlined for class "A" magazine. Use of 4-by 4-inch uprights preferred when available. Magazine shall be lined with clear or black polyethylene sheets of at least a 4-mil thickness or felt construction paper of at least 15-pound grade; 4- by 4-inch lumber will be used for the bottom runners to achieve the proper elevation from the deck.</p>
46CFR146.29-93 (d)	<p>Stowage of blasting caps, detonators, and primer detonators. When Class VIII ammunition is stowed over tween-deck hatch covers and military explosives are stowed in hold below, a single layer of 2-inch commercial lumber is required over tween-deck hatch cover.</p>	<p>Deviation not permitted.</p>

## CHAPTER 6 SECURING PROCESS

### 6-1. Introduction

Shifting cargo presents hazards, as the ship may be severely damaged by the physical impact or the actual detonation of the cargo. It is imperative that all precautions be taken to protect the cargo from mechanical shock, fire, high temperature, moisture, or any other hazards that could lead to a catastrophe. In transit, repairs to dunnaging or the resecurement of shifted cargo are difficult and dangerous; consequently, the dunnaging system must be designed to resist, without failure, maximum anticipated forces generated by the ship in response to the marine environment. This chapter describes the general theory for dunnaging marine cargo and the sequence in which stowage techniques are applied during shiploading.

### 6-2. Mechanics of Ship Motions

Ship motions cause the cargo to apply different loads against the dunnaging system. While the ship is underway, the cargo is subjected to six basic motions—roll, pitch, yaw, heave, sway, and surge as illustrated in figure 6-1. Combinations of these motions are common but difficult to describe. Ship vibrations caused by propeller and engine action also agitate the cargo continuously. For the purpose of this manual, loads due to ship motions will be described as either "static" or "dynamic."

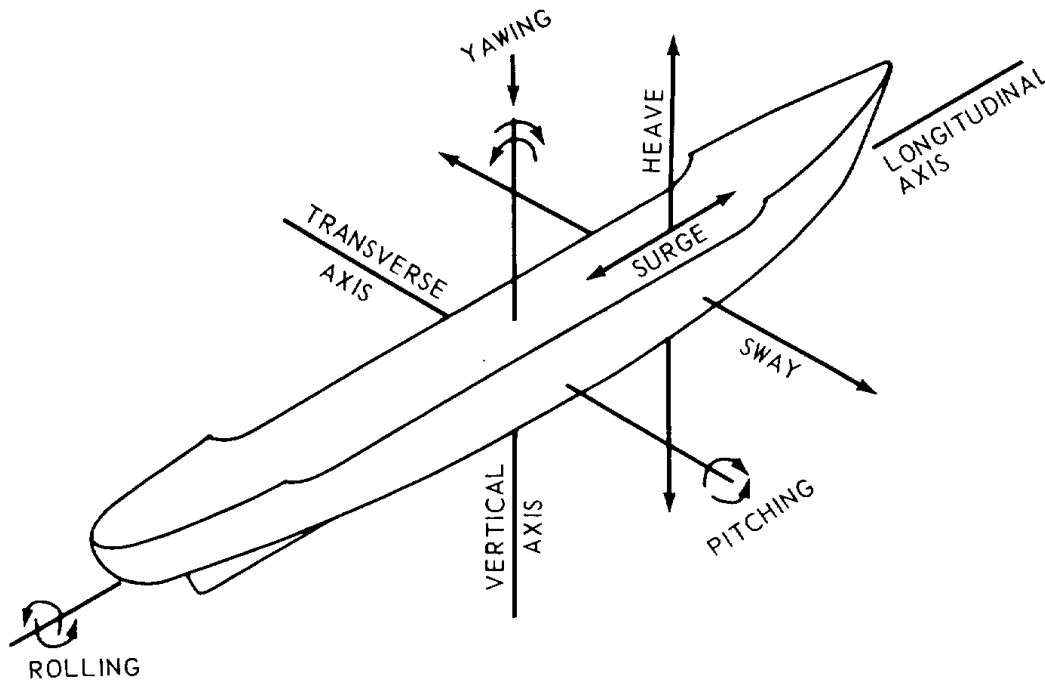


Figure 6-1. The six basic ship motions.

a. Static loads are exerted by the cargo while the ship is at rest. For example, cargo stowed on a ship at rest or underway in calm seas exerts only a downward vertical force equal to its weight, which is counteracted exactly by the upward support of the deck. Figure 6-2 illustrates the forces that act on the cargo when ship motions are negligible. The roll or pitch motion of the ship produces an inclination of the deck surface, as shown in figure 6-3. A portion of the item's weight shifts across the deck and tends to cause sliding in the direction of deck inclination. This potential motion is opposed by deck friction and the dunnaging structures. (Deck friction forces are discussed in paragraph 7-2b.) The item's weight rests against the dunnaging. Forces (loads) are greatest when the roll or pitch inclination of the ship reaches its maximum. Static loads can be significant during heavy rolls or when a "tender" ship is inclined for a relatively long period during recovery from a roll.

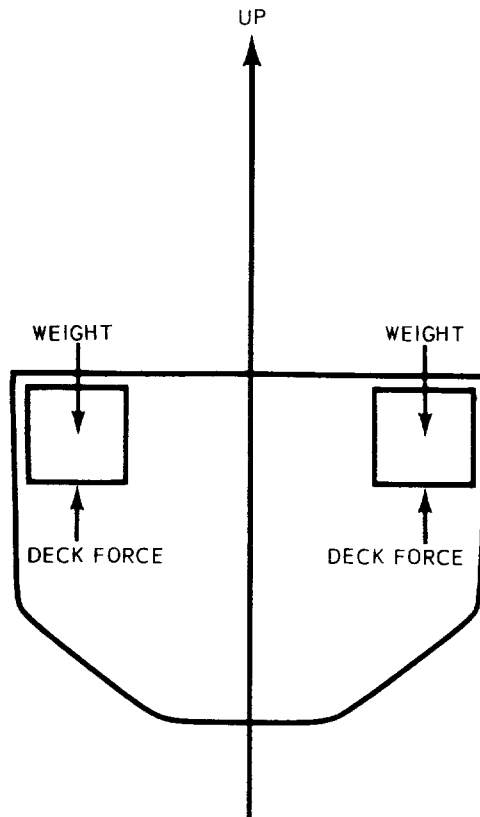
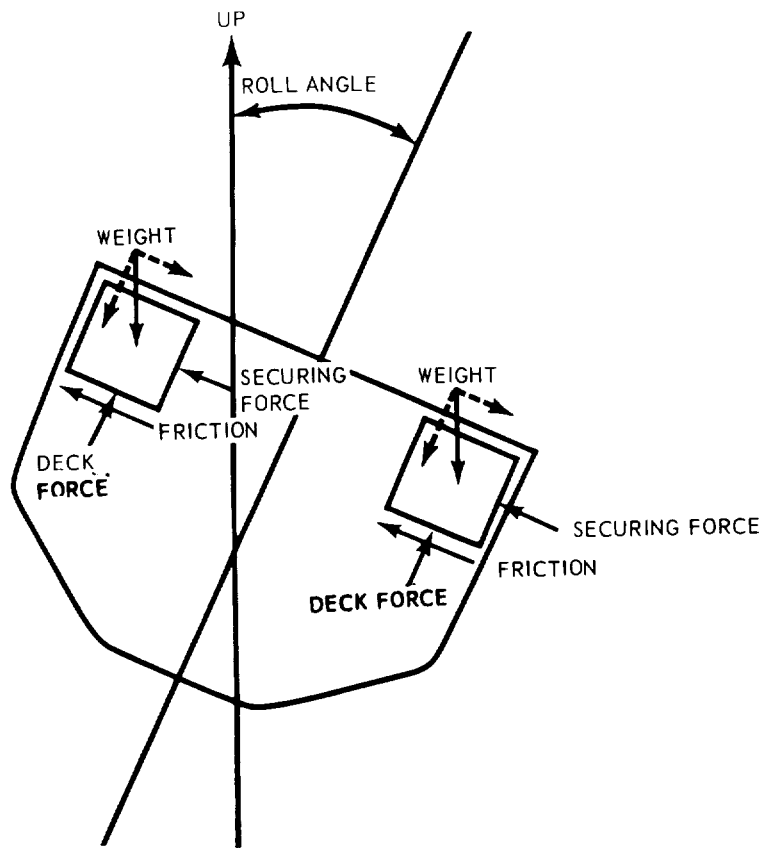
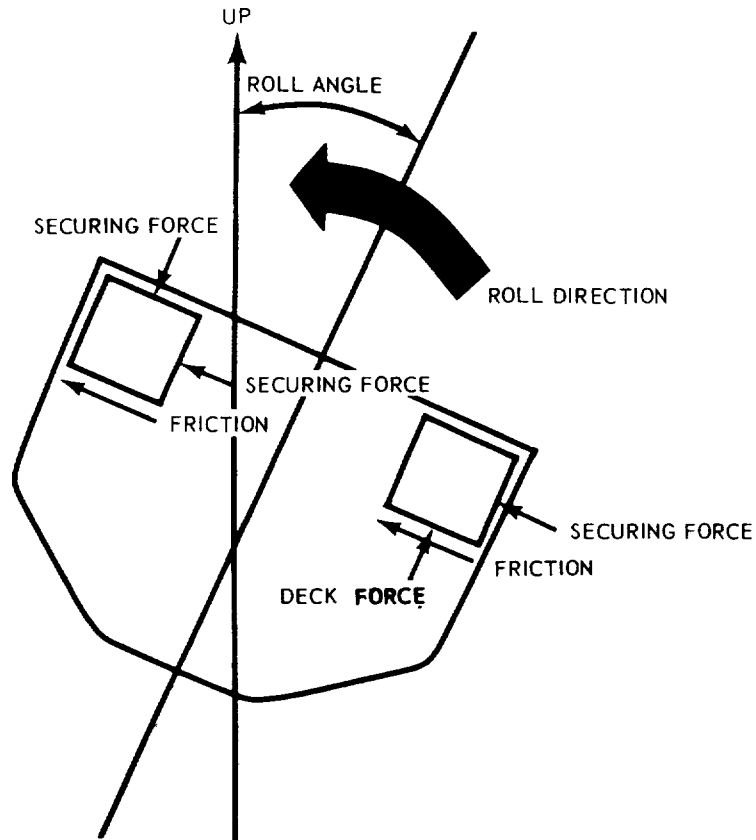


Figure 6-2. Static forces while ship is underway in calm seas.



**Figure 6-3. Static forces due to roll motion.**

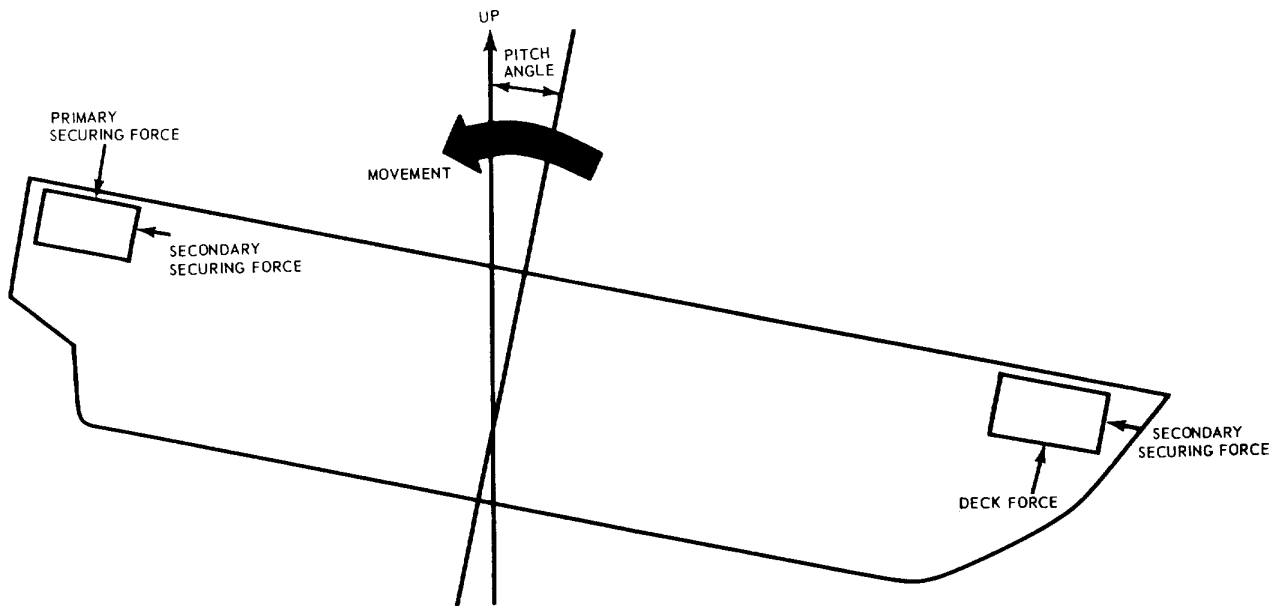
b. In shiploading, dynamic loads (forces) result mainly from the accelerations and decelerations of the roll, pitch, and yaw motions of a ship. The effects of such forces are indicated in figure 6-4. Dynamic forces are analogous to those experienced in an elevator and are most noticeable when the ship recovers from a roll; that is, changes roll direction. The change in roll direction obviously occurs at the point of maximum roll angle. As noted previously, the cross-deck component of the item's weight also exerts its maximum force on the dunnage structure at this point. Therefore, the total maximum force that is applied to the dunnaging structure is equal to the sum of the static and dynamic forces at the maximum roll angle. Both static and dynamic loads increase with roll angle; the dynamic forces also increase as the period (duration) of the roll becomes shorter for a given roll angle. Dynamic loads are more severe for "stiff" ships; that is, ships that demonstrate snap-roll recovery characteristics.



**Figure 6-4. Dynamic forces due to roll motion.**

c. The pitch motion produces acceleration forces that are significant in the vertical direction only. These forces can also have components that act across the deck, when the ship is rolled away from the vertical, thereby supplementing the roll forces. The main effects of pitching on securing structures are illustrated in figure 6-5.





**Figure 6-5. Dynamic forces due to pitch motion.**

d. The forces on cargo generated by the ship's rolling motion are considerably greater than those generated by the pitching motion. Although blocking and bracing must be provided to secure the cargo in all directions, the major consideration in the orientation and dunnaging of cargo is to ensure adequate resistance to roll forces. Other forces, such as those caused by slamming the hull in rough seas or cyclic vibrations of propulsion gear, must be considered for possible long-term detrimental effects on the cargo dunnaging structures.

**6-3. Fundamental Securing**

The general terms "securing" and "dunnaging" are used interchangeably to describe the procedures by which military explosives are effectively blocked, braced, and tommed aboard merchant-type ships to resist forces generated by vessel response to sea conditions. Securing includes not only the various wooden structures used in cargo securement, but also any straps or webs that are used to restrain cargo stowed in the holds and on the weather deck of a ship. To describe more specifically the process to obtain a secure stow, the terms "blocking" and "bracing" are commonly used. These terms are closely related, although each function is distinctly different.

a. *Blocking.* Blocking is the act of installing solid pieces of wood, or blocks, to a deck, bulkhead, or overhead in such a manner that these pieces bear directly against the cargo to prevent movement of the cargo horizontally. Blocking must be braced, shored, or tommed to be effective. Figures 6-6 and 6-7 illustrate the basic blocking techniques from which more complex securing structures are developed. Additional bracing would be required to secure the item adequately. In figure 6-6, 2 by 4-inch pieces of lumber are doubled, instead of the use of a single 4 by 4-inch piece to facilitate nailing and securement to the deck. The 2 by 6-inch contacting piece of blocking extends the full width of the unit load. Since blocking may be nailed directly to the wooden deck, the load may be secured in any location in the hold without the need for extending the blocking to permanent ship's structures for bracing. In figure 6-7, however, the metal deck precludes direct nailing; consequently, 4 by 4-inch lumber must be extended to the bulkhead to provide the necessary bracing.

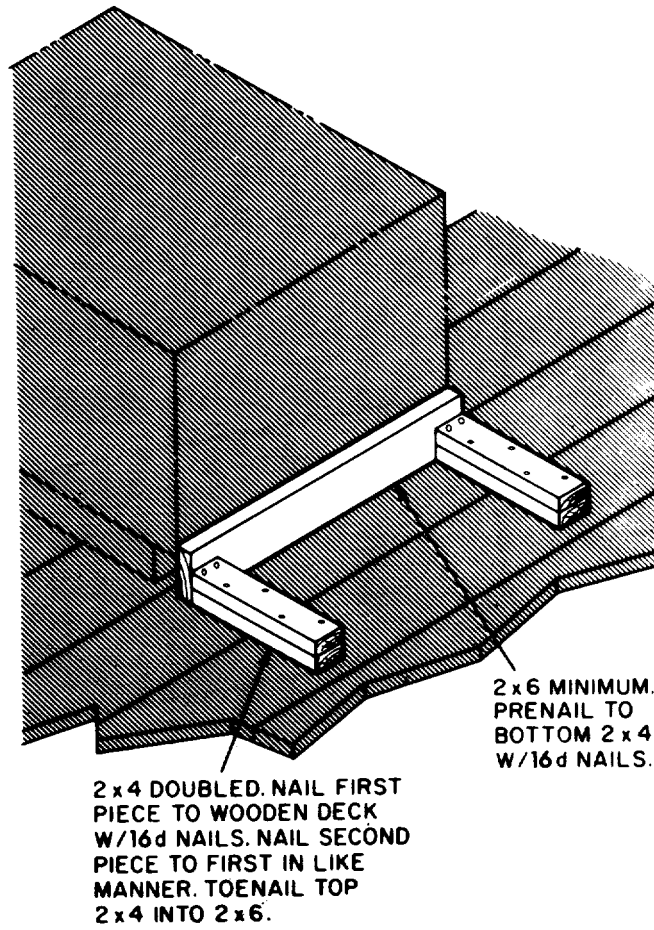
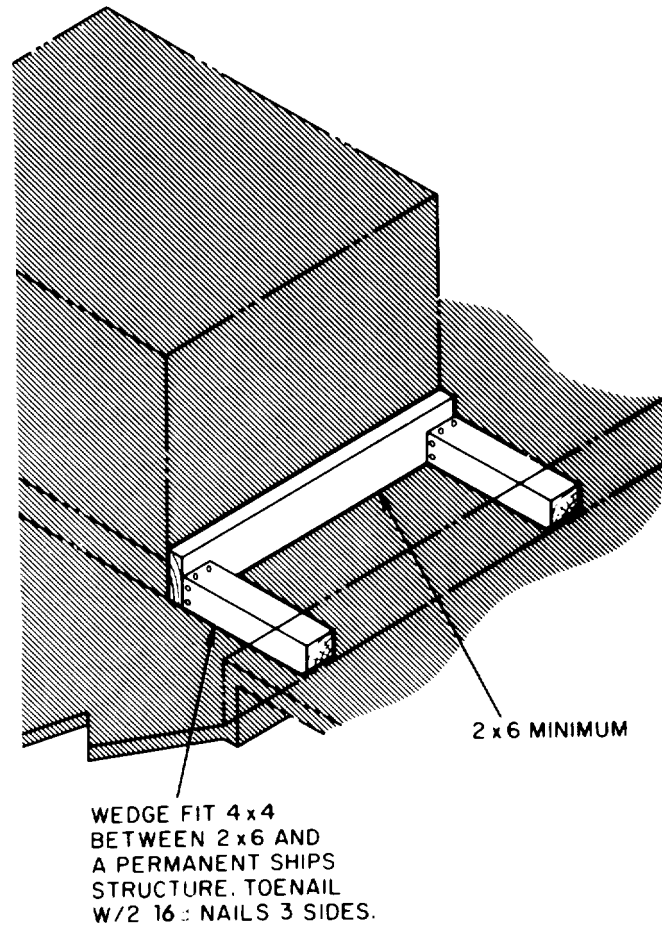


Figure 6-6. Basic blocking for wood deck.



**Figure 6-7. Basic blocking for metal deck.**

*b. Bracing.* Bracing is the act of installing a wood member or structure so that it extends from a deck, bulkhead, or overhead to the stow and strengthens the blocking by supporting it in a horizontal direction. Figures 6-8 and 6-9 illustrate basic methods of bracing. Kickers, relatively short lengths of lumber nailed horizontally, add rigidity to the uprights and braces. Kickers are either nailed to the deck or wedge fitted to a bulkhead. In both cases, it should be noted that the structure extends slightly higher than the unit load and along the full width.

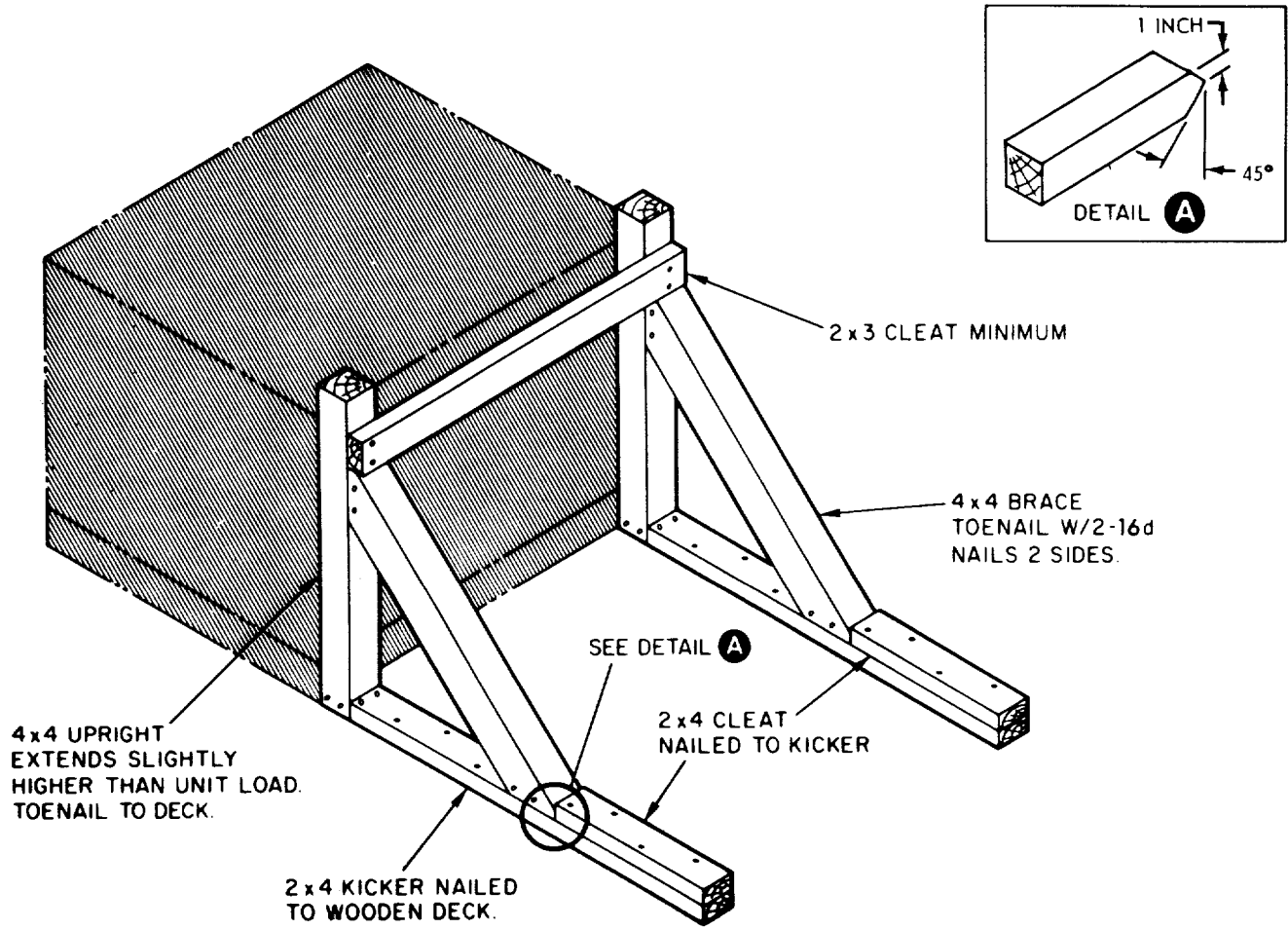
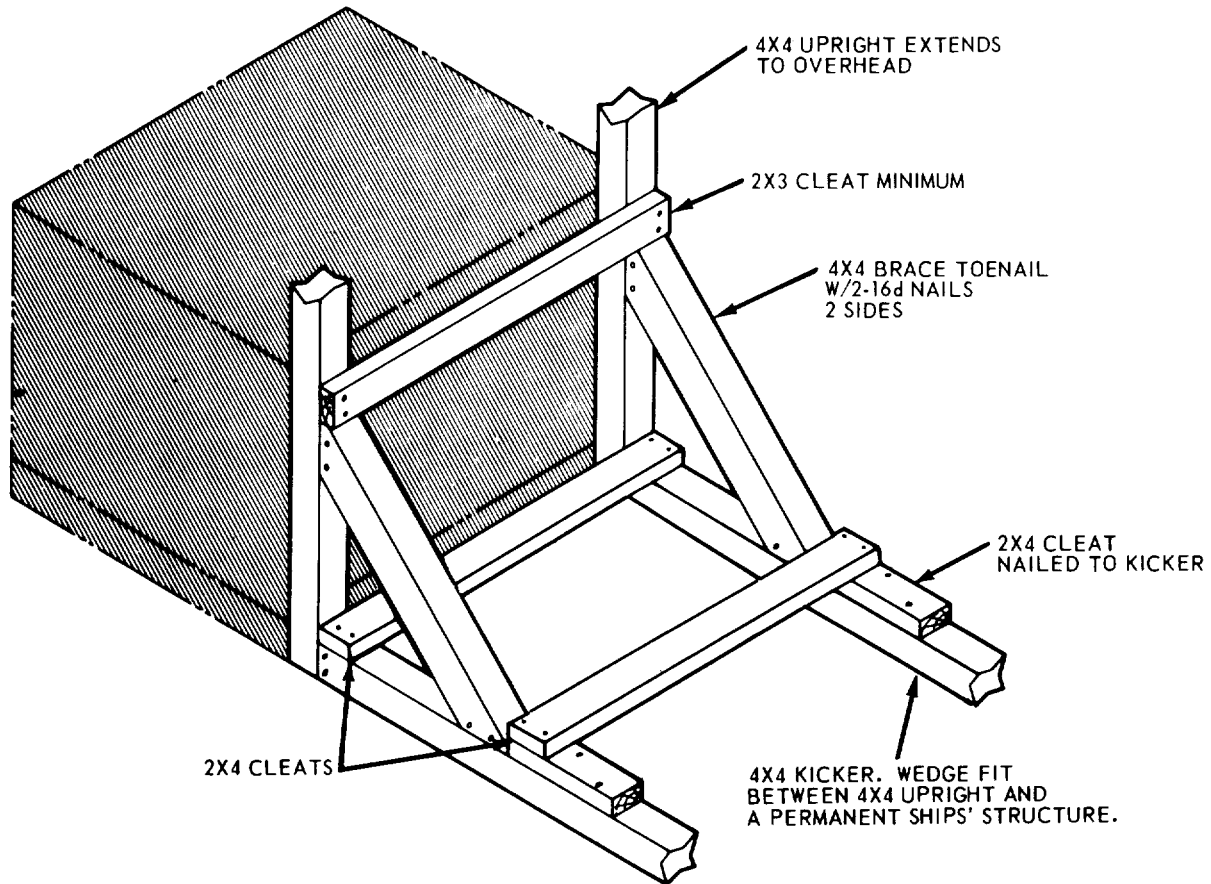


Figure 6-8. Basic bracing for wood deck.  
6-8



**Figure 6-9. Basic bracing for metal deck.**

c. *Shoring and Tomming.* Shoring, which includes blocking and bracing, is the process of securing cargo to prevent lateral movement by supporting cargo from the side, or to prevent downward movement by supporting cargo from below. Tomming is the securing of cargo to prevent upward movement. The cargo is secured by running lumber from an overhead ship's structure down to the cargo either vertically or at an angle.

**6-4. Preload Securing**

After the hold and cleaning have been inspected, as required for the loading of explosives cargo (figs 6-10 and 6-11), prestow preparation and loading are begun. Considering the stowage requirements of the type of cargo being loaded, pertinent structures such as heat or nonheat bulkheads, magazines, encasements, flooring, or sheathing are installed. Construction details for fundamental securing structures are specified in chapter 7.

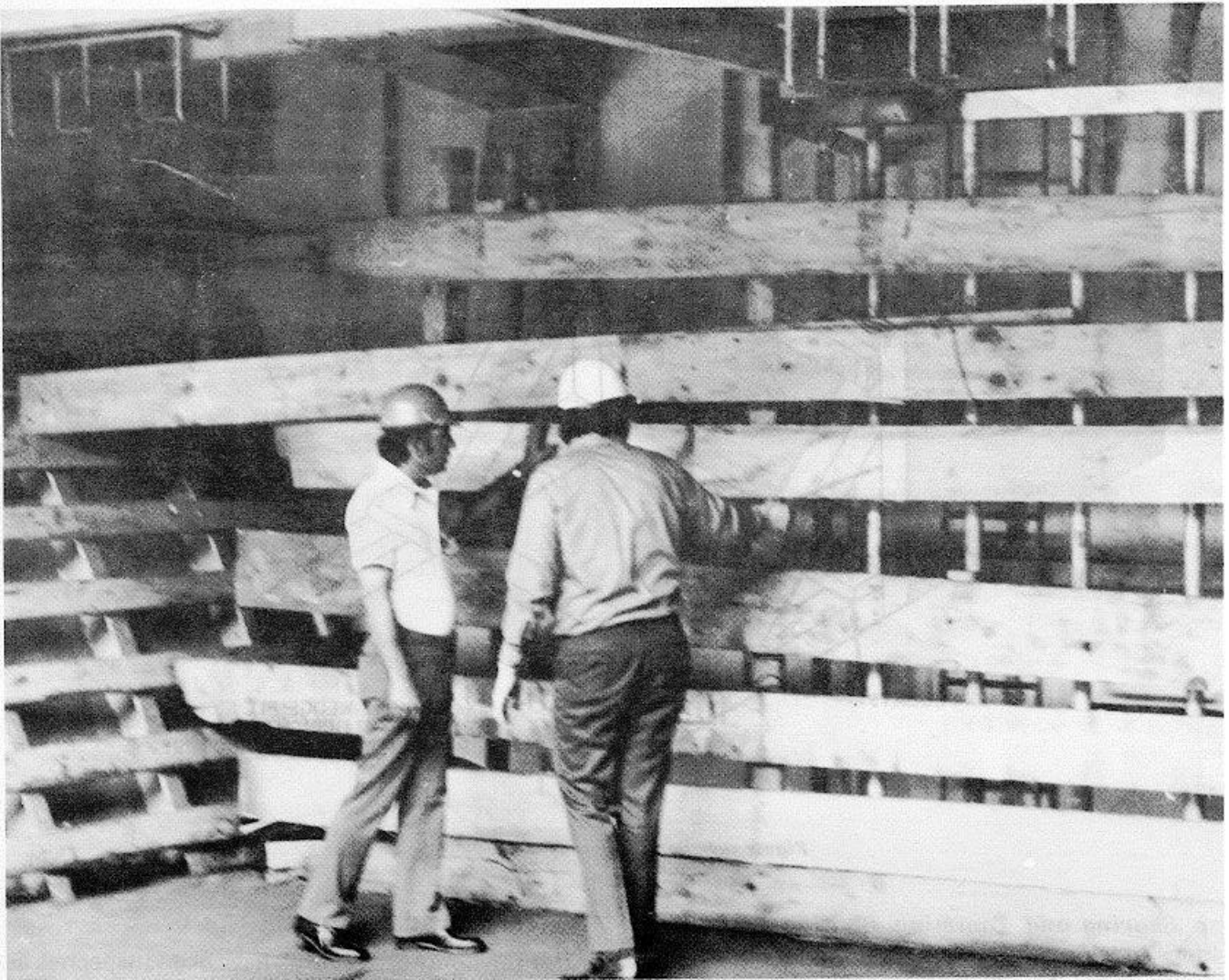
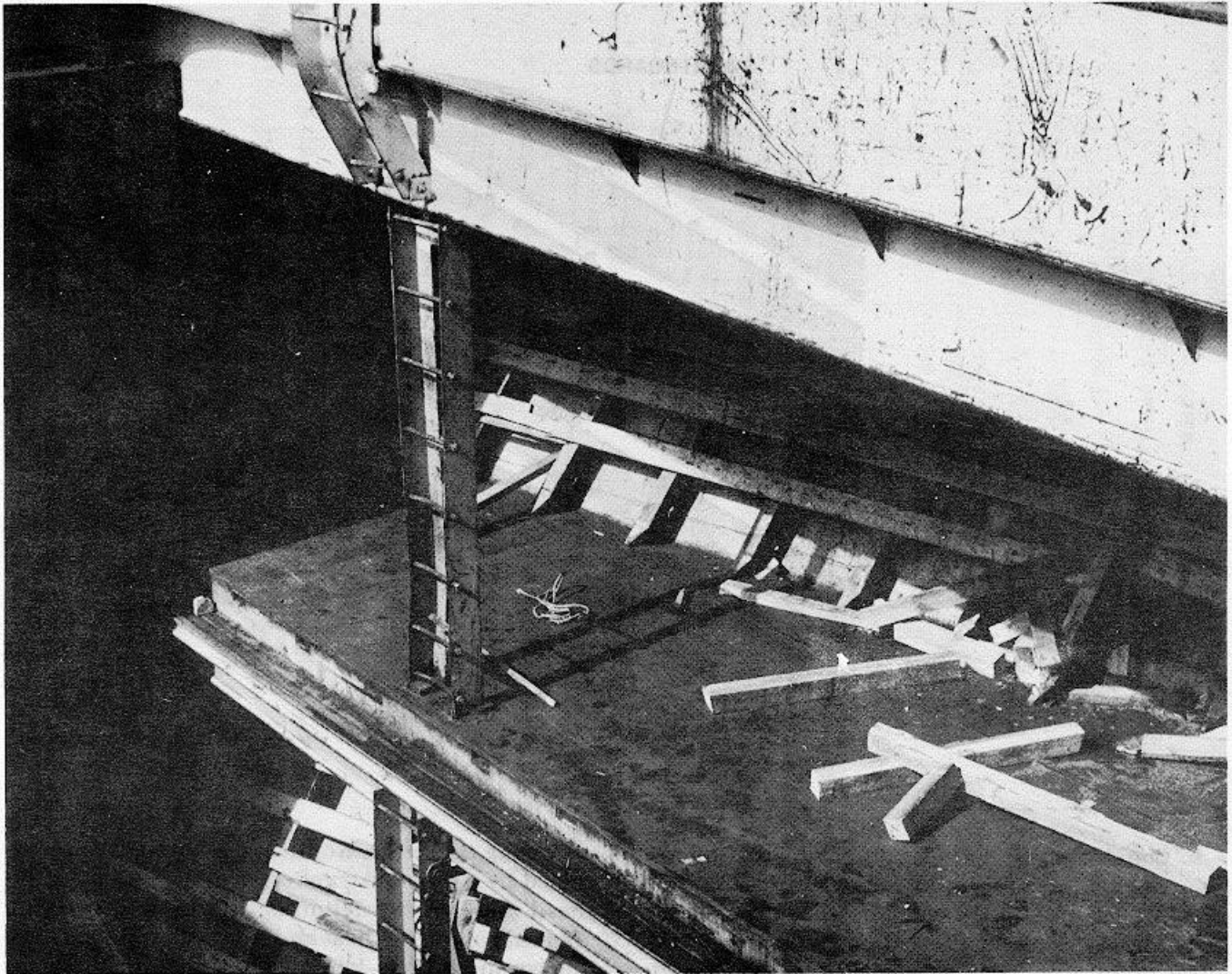
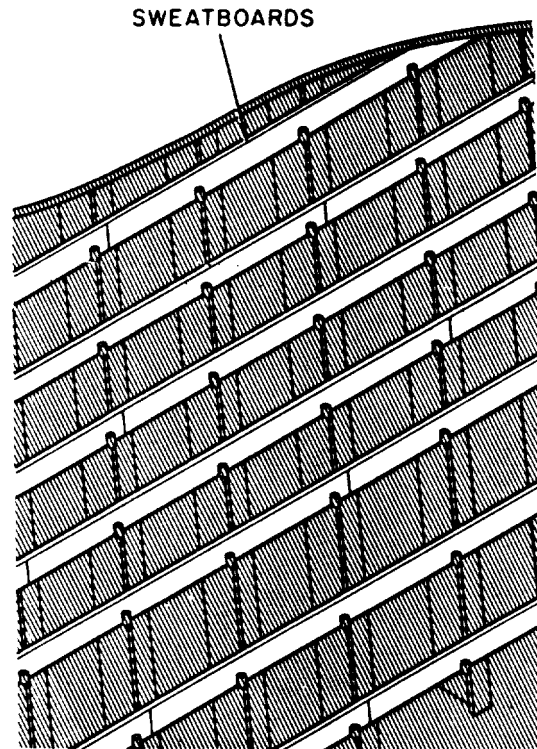


Figure 6-10. Preload inspection of existing securing structures.



**Figure 6-11 Compartment requiring preload cleanup.**

a. Sweatboards, or sweatbattens, are lengths of lumber, usually 2 by 6-inch pieces, installed in hangars or bolted over the ship's structural stiffener beams to prevent damage to the cargo or ship caused by contact with the ship's structure and hull (fig 6-12). Contact with condensation on the hull plate is also prevented; hence, origination of the term "sweatboard." Prior to cargo emplacement, all missing or damaged sweatboards should be replaced from the ship's stock, or with 2 by 6-inch lumber cut to the required length. Sweatboards bolted in position are more difficult to replace and require drilling holes to receive bolts mounted on the stiffener beams. Sweatboards are not generally used as load-bearing members in the block-stow technique but are used extensively as bearing surfaces for distributed loads transmitted through strip sheathing when the sweatboard-to-sweatboard method is employed (see chap 8).



**Figure 6-12. Hangar sweatboards.**

*b.* Considered next under preload securing are the requirements for bulkhead construction. Heat or nonheat bulkheads are constructed whenever loads must be stowed along the athwartship structural bulkheads. Heat bulkheads are tightly constructed to prevent radiated heat, such as heat from engineroom bulkheads, uptakes, or casing, from reaching the cargo. Nonheat bulkheads are recognized by open construction. A nonheat end bulkhead under construction is shown in figure 6-13. Typical completed heat and nonheat bulkheads are shown in figure 6-14. Full construction details for bulkheads are described in paragraphs 7-4 through 7-6.



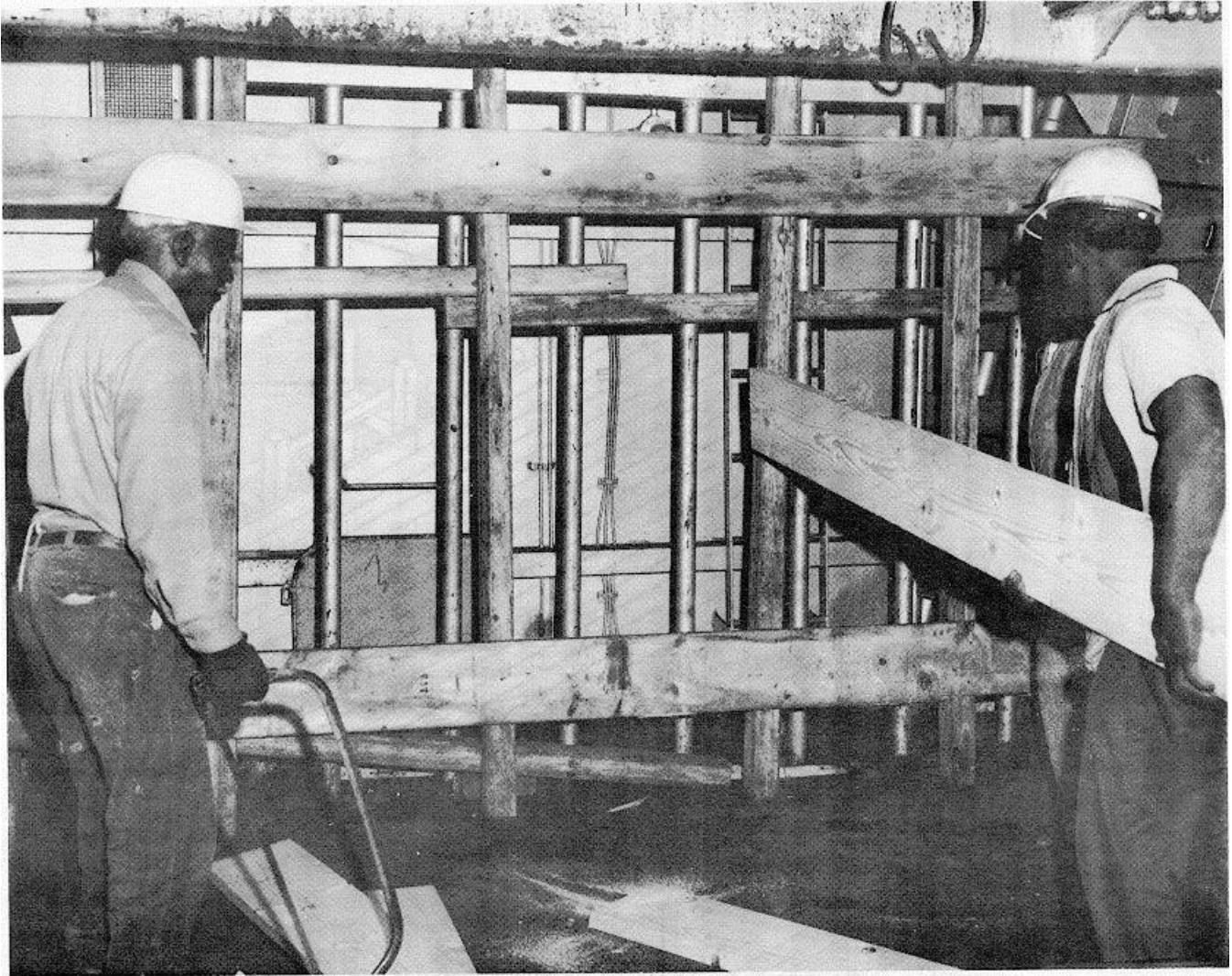


Figure 6-13. Nonheat end bulkhead under construction.  
6-13

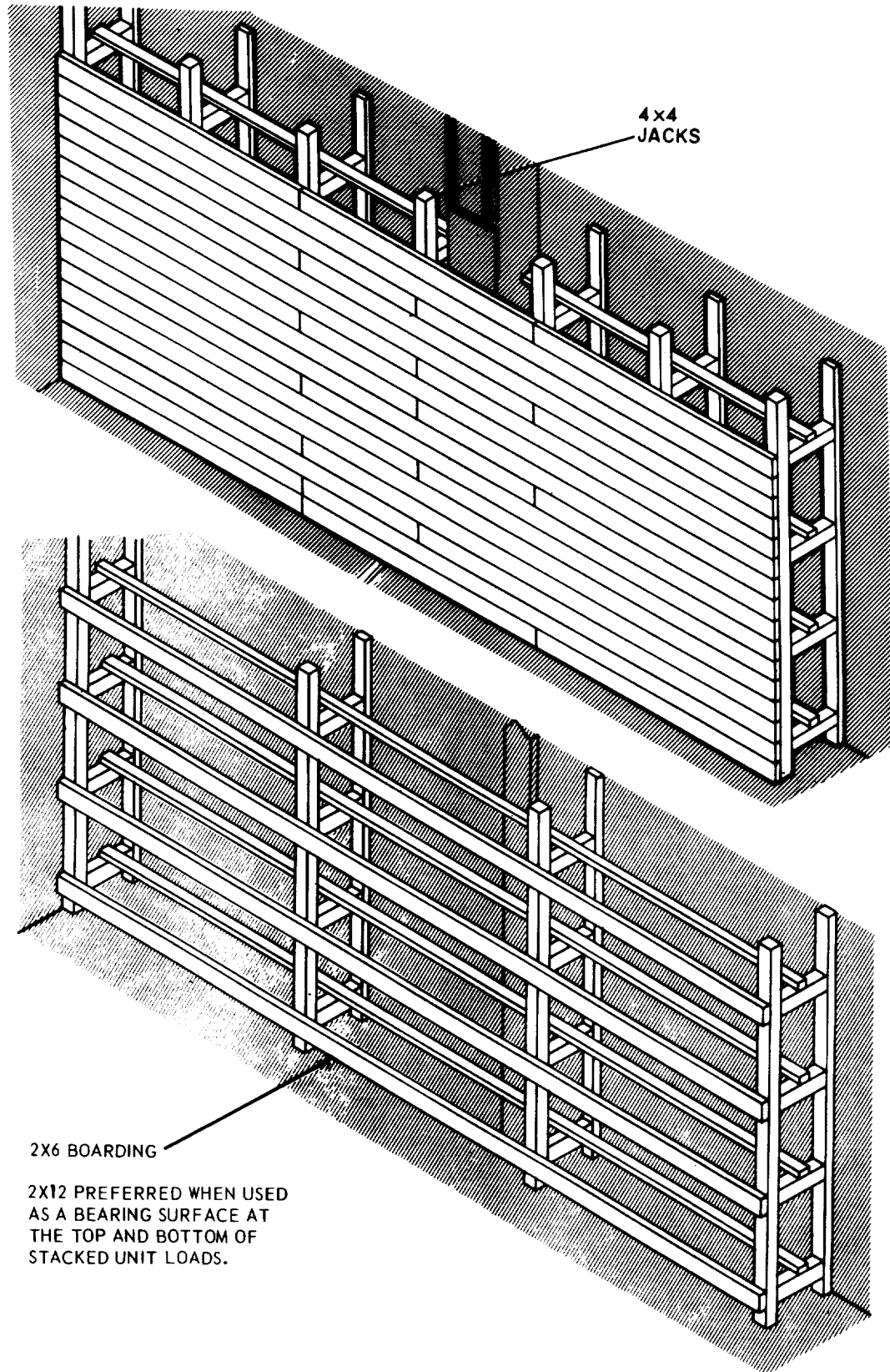


Figure 6-14. Typical completed heat and nonheat bulkheads.

c. In compartments where hull contour is absent or minimal, extensive preload dunnaging is unnecessary, thereby requiring only that minor obstructions such as latches, pipes, or conduit be protected. In such cases, spacer material will be installed prior to stowage, as shown in figure 6-15. The spacers are constructed of uprights of such size necessary to obtain adequate clearance. Normally, 4 by 4-inch lumber is used for this purpose. Obstructions are boarded over with 2-inch minimum lumber, as shown in figure 6-16, when required by the size or configuration of the cargo.

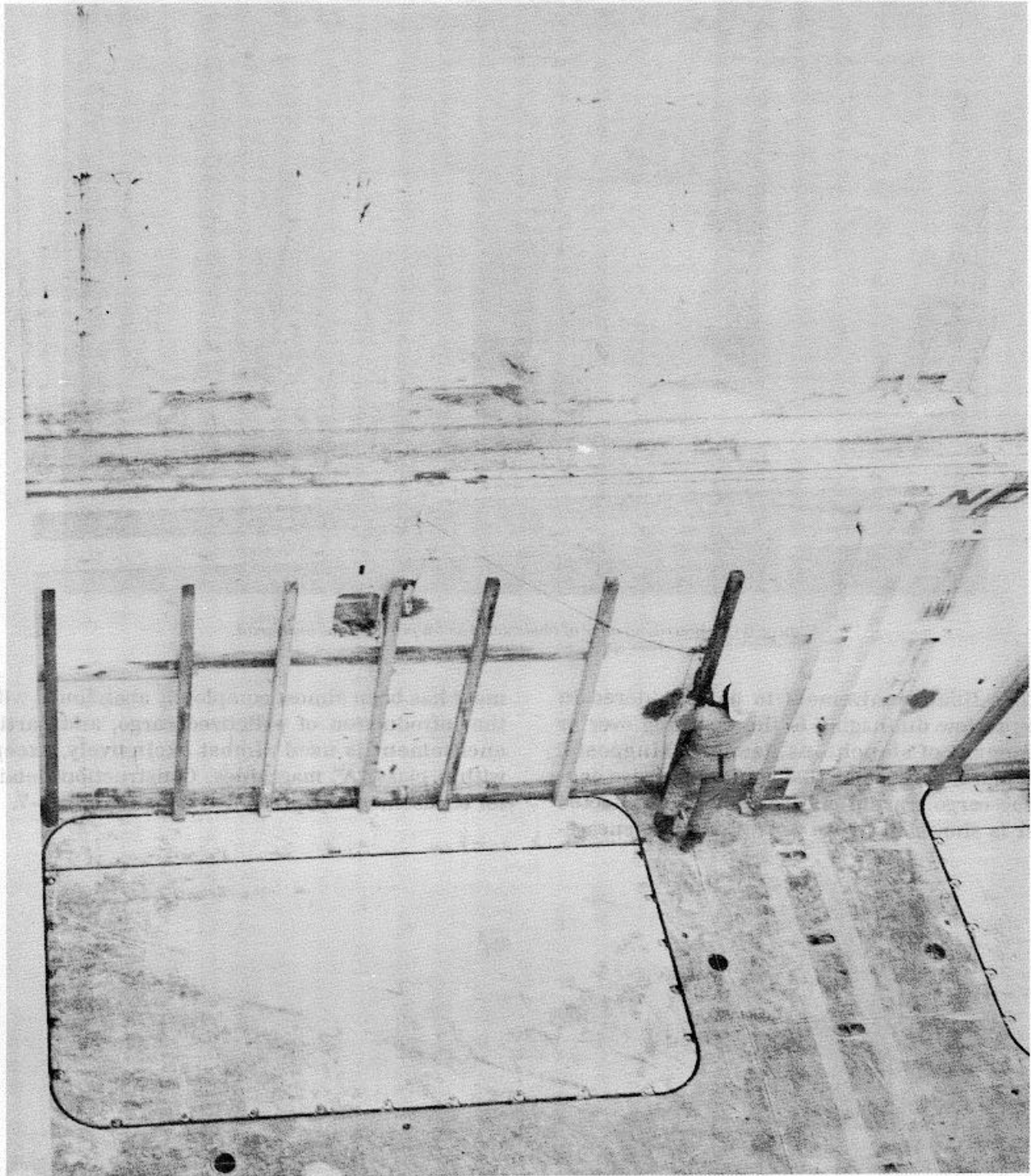
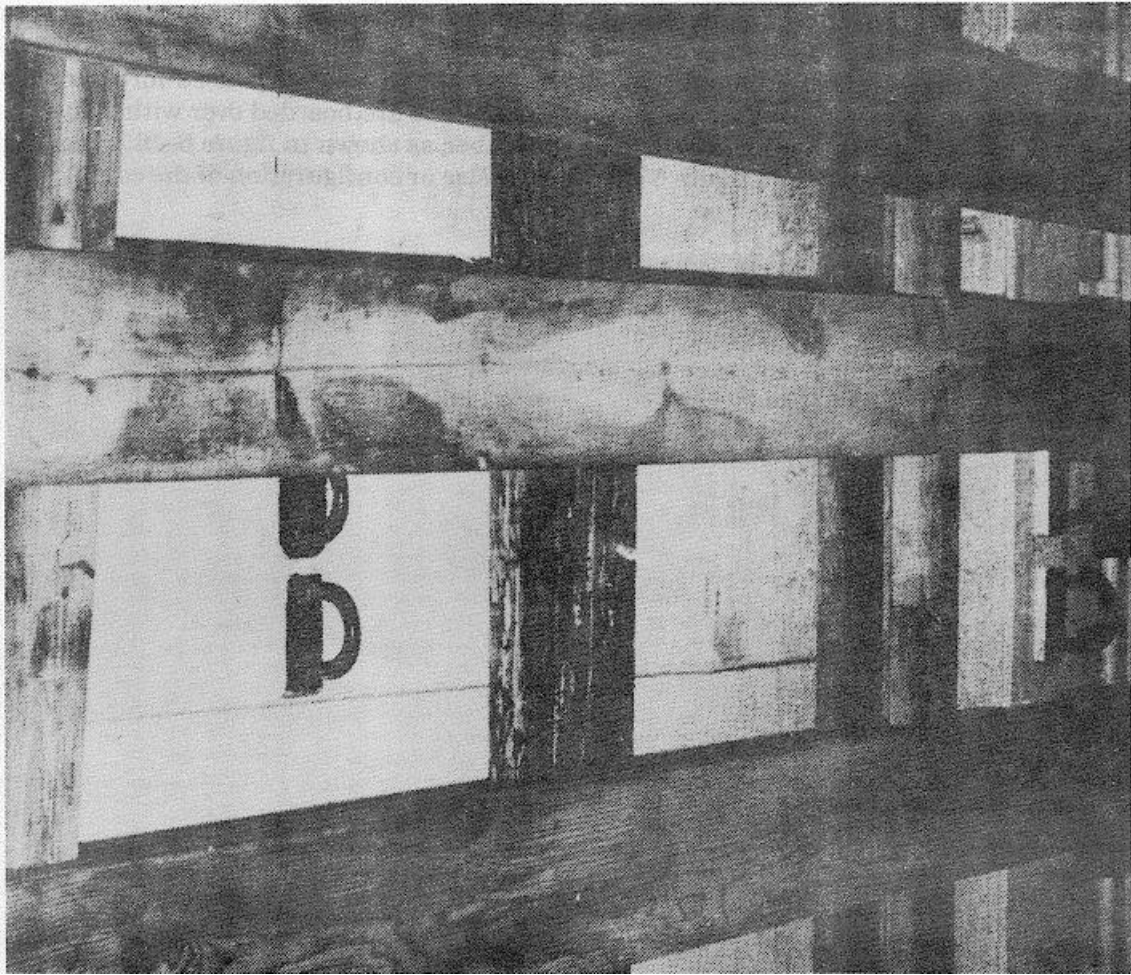


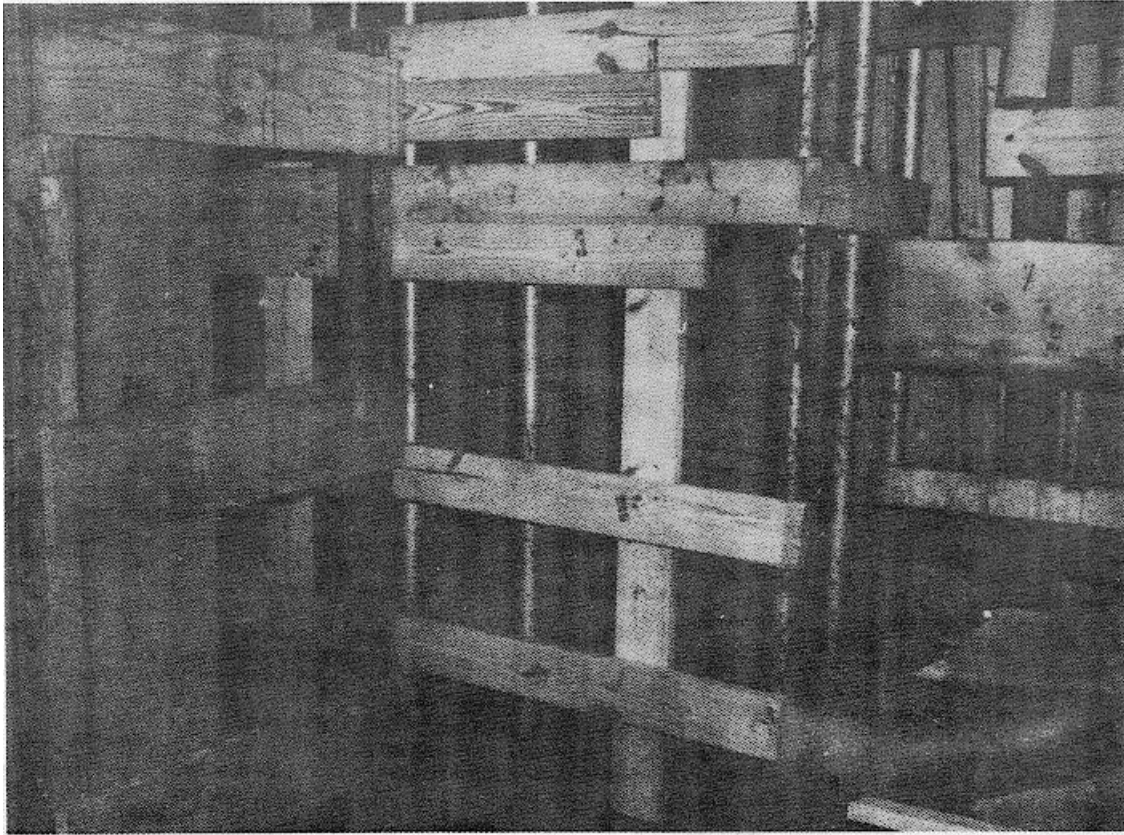
Figure 6-15. Installation of spacer material prior to stowage.



**Figure 6-16. Boarding over of obstructions on permanent bulkhead.**

*d.* The final requirement to be considered in basic prestow dunnaging is the boarding over or encasement of stanchions, ladders, kingposts, vents, pipes, and beams that could otherwise contact the cargo. Partial encasement of a protected ladder is shown in figure 6-17. Complete encasement has been almost completely abandoned with the introduction of palletized cargo, and partial encasement is used almost exclusively, except within class "A" magazines. Construction details for encasement are presented in paragraph 7-7.





**Figure 6-17. Partial encasement.**

#### **6-5. General Sawing and Nailing Practices**

A secure stow is predicated upon accurate measurement and sawing of dunnage lumber and efficient use of nailing in assembling the securing structures.

*a. Sawing.* Close coordination is required between the planning and installation activities to ensure that lumber is procured in standard sizes and is used in its full dimensions, where practicable, to eliminate unnecessary sawing. Careful procurement, supply, and selection can reduce the sawing effort, particularly in avoiding instances in which it becomes necessary to rip long lengths of lumber onboard ship to suit specific structural applications. Many large-size timbers (such as 4 by 4's, 2-inch planks, and 1-inch sheathing lumber) that are to be used in securing structures can be precut by bench-mounted powersaws in dockside wood ships or sawcars to effect considerable time and cost savings (fig 6-18). Precut lumber can be assembled in the vessel, preferably in a compartment not being worked, as shown in figure 6-19. Handsaws are used for fitting lumber in areas where explosives are being stowed aboard the vessel.

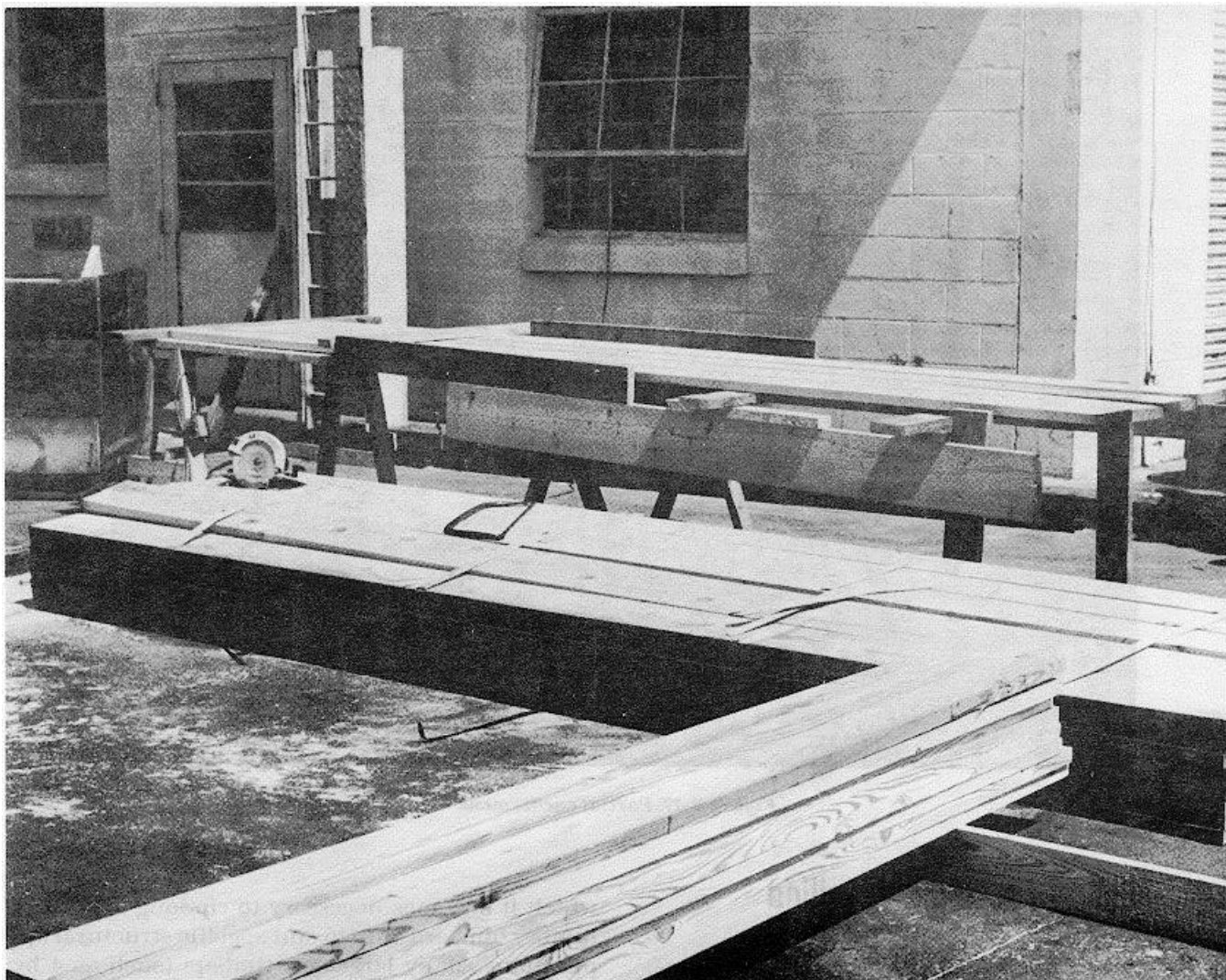


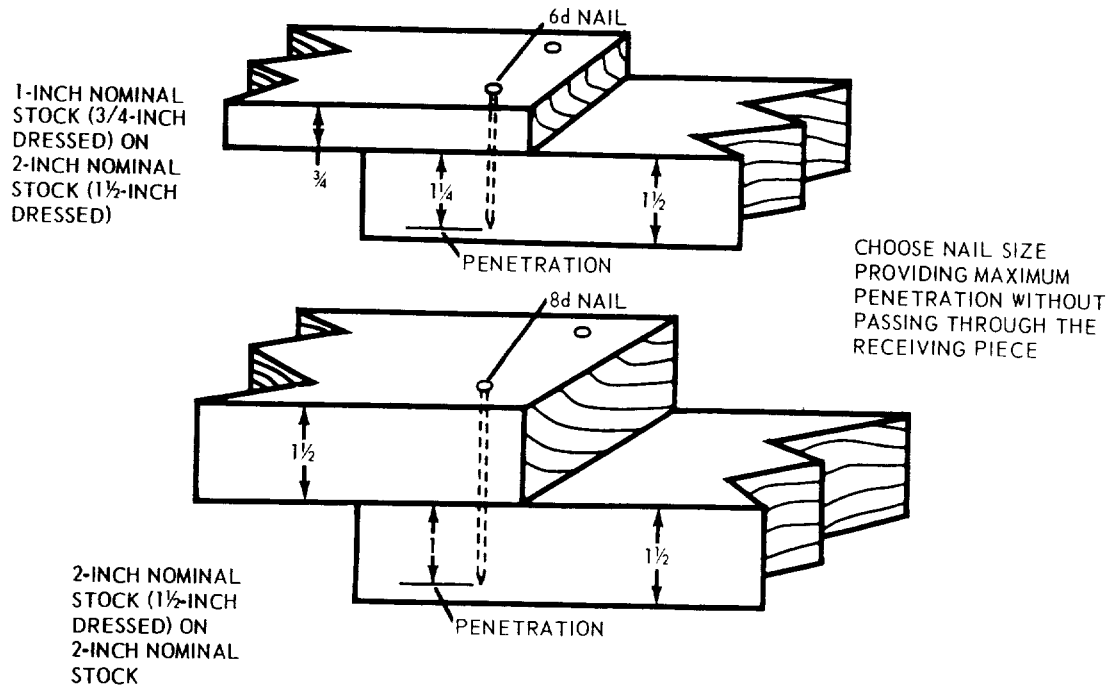
Figure 6-18. Dockside wood shop.  
6-18



**Figure 6-19. Onboard assembly of prefabricated structures.**

*b. Nailing.* Since the integrity of the securing structure depends significantly on adequate fastening and securement of structural members, a summary of general nailing practices is considered essential. The sizes of common wire nails and spikes used in dunnaging operations are listed in table C-1, appendix C. The appendix also provides a detailed summary of the types and allowable load characteristics of securing nails. The following general rules for nail selection and nailing patterns have been developed through experience; they conform to recommendations of the 1973 edition of the National Design Specification for Stress-Grade Lumber and Its Fastenings, published by the National Forest Products Association.

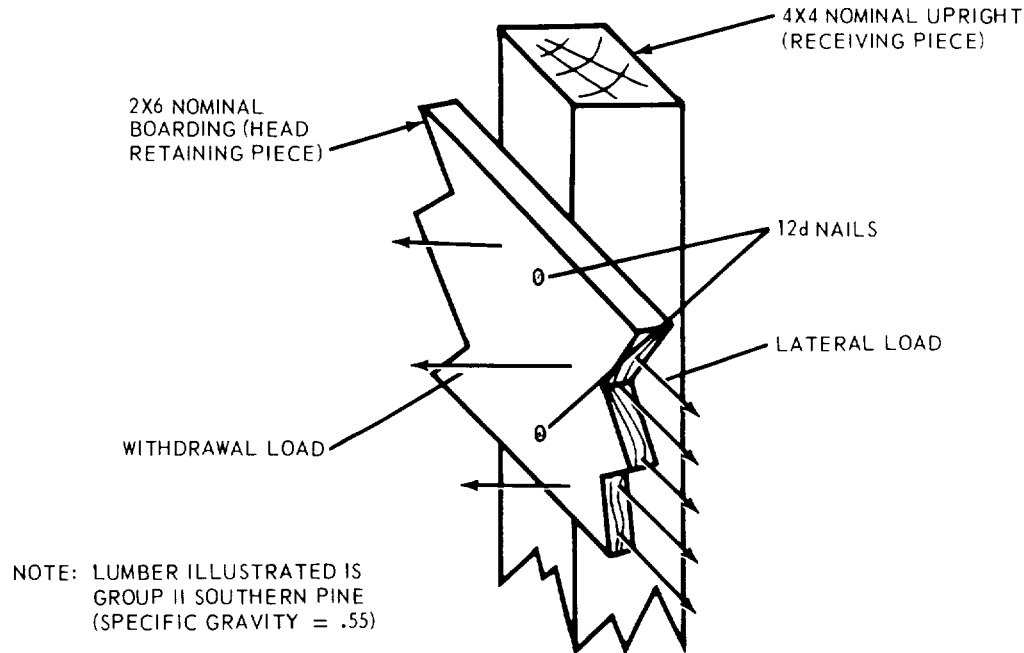
(1) Shoring lumber is directly nailed with this method; nail heads are driven flush to the surface without the nail point penetrating through the receiving piece. Figure 6-20 illustrates the direct nailing principle. Nail sizes should be chosen to permit maximum penetration of the nail into but not through the receiving piece. This is particularly important to eliminate the possibility of the nail point penetrating the boxed ammunition. A nail should not be selected if its penetration depth is equal to the thickness of the receiving piece, as the nail point may splinter the surface and invite personal injuries. Normally, 6 pennyweight (6d) nails are used for direct nailing of 1-inch lumber to 2 inch stock, and 8 pennyweight (8d) nails are used for joining 2-inch material without penetration through the receiving piece. When penetration is not critical, such as when 1-inch or 2-inch lumber is nailed to 4-inch uprights, 10 or 12 pennyweight nails are generally used.



**Figure 6-20. Direct nailing.**

(2) When more than one nail or spike is used in a joint, the total allowable load in withdrawal (tension) or lateral resistance is the sum of the allowable loads for the individual nail or spike, as shown in figure 6-21. The allowable loads in tables C-3 and C4 for nails and spikes are the maximum for normal loading.





SEE TABLES AND APPENDIX

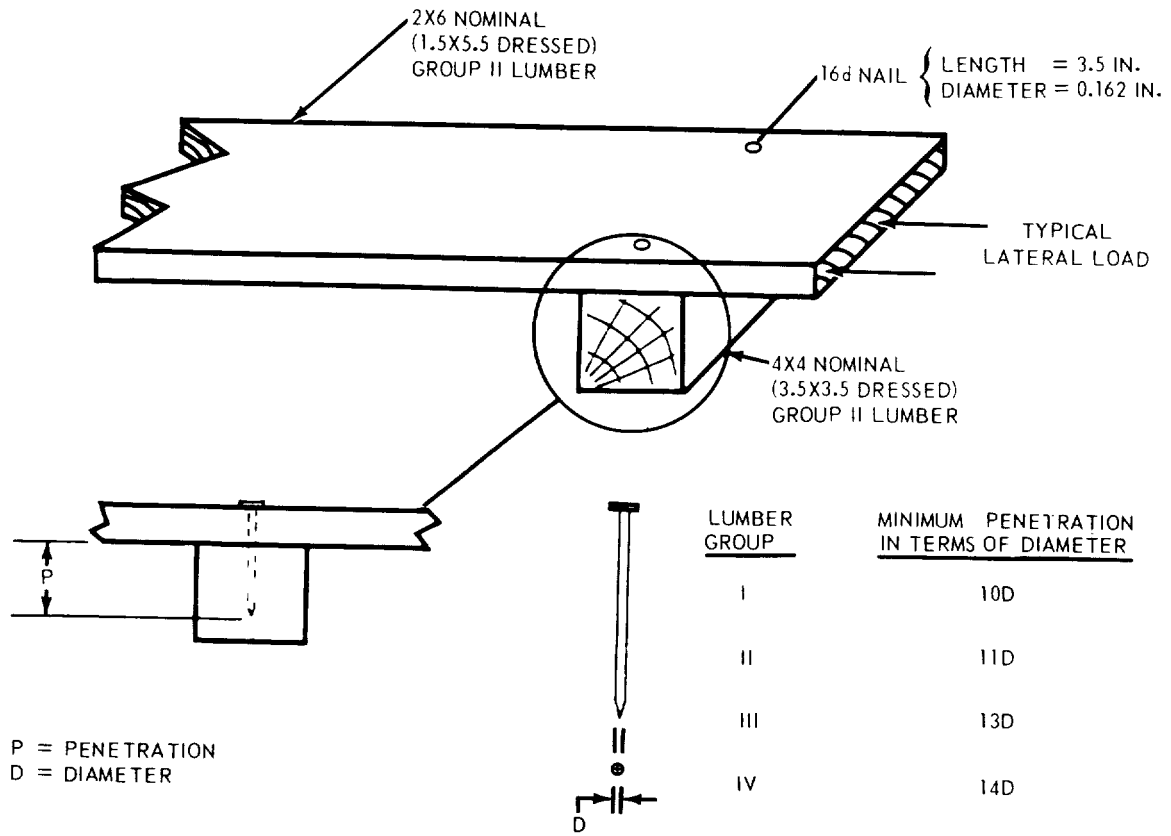
ALLOWABLE WITHDRAWAL LOAD FOR 12d NAIL = 44 LB  
 ALLOWABLE LATERAL LOAD FOR 12d NAIL = 94 LB

TOTAL ALLOWABLE WITHDRAWAL LOAD = 2X44 OR 88 LB  
 TOTAL ALLOWABLE LATERAL LOAD = 188 LB

**Figure 6-21. Total holding power of multiple nails.**

(3) The allowable withdrawal (tension) load upon nails that are driven into the side grain of wood members depends on the specific gravity of the species, as provided in table B-3. Securing structures should be designed so that nails are not loaded in withdrawal. Where these conditions are unavoidable, the allowable withdrawal loads per inch of penetration of a nail driven into the side grain (perpendicular to the fiber) of seasoned wood are given in table C-3.

(4) The allowable loads in lateral (sideward) resistance, when a nail is driven into the side grain of seasoned wood with load applied in any lateral direction, are given in table C-4. Loadings apply only where the depth of penetration into the larger member holding the point is not less than 10 diameters for group I species; 11 diameters for group II species; 13 diameters for group III species; and 14 diameters for group IV species (table B-3 shows groupings). Figure 6-22 illustrates nailing principles to maximize lateral resistance.



**Figure 6-22. Nail penetration required to resist maximum allowable lateral loads.**

(5) Nailheads or nail points may be clinched, when necessary, to ensure that all nailed surfaces are smooth. Normally, the point end is clinched; however, if the point end is inaccessible (for example, when flooring is nailed over a void), the head may be clinched, as shown in figure 6-23.

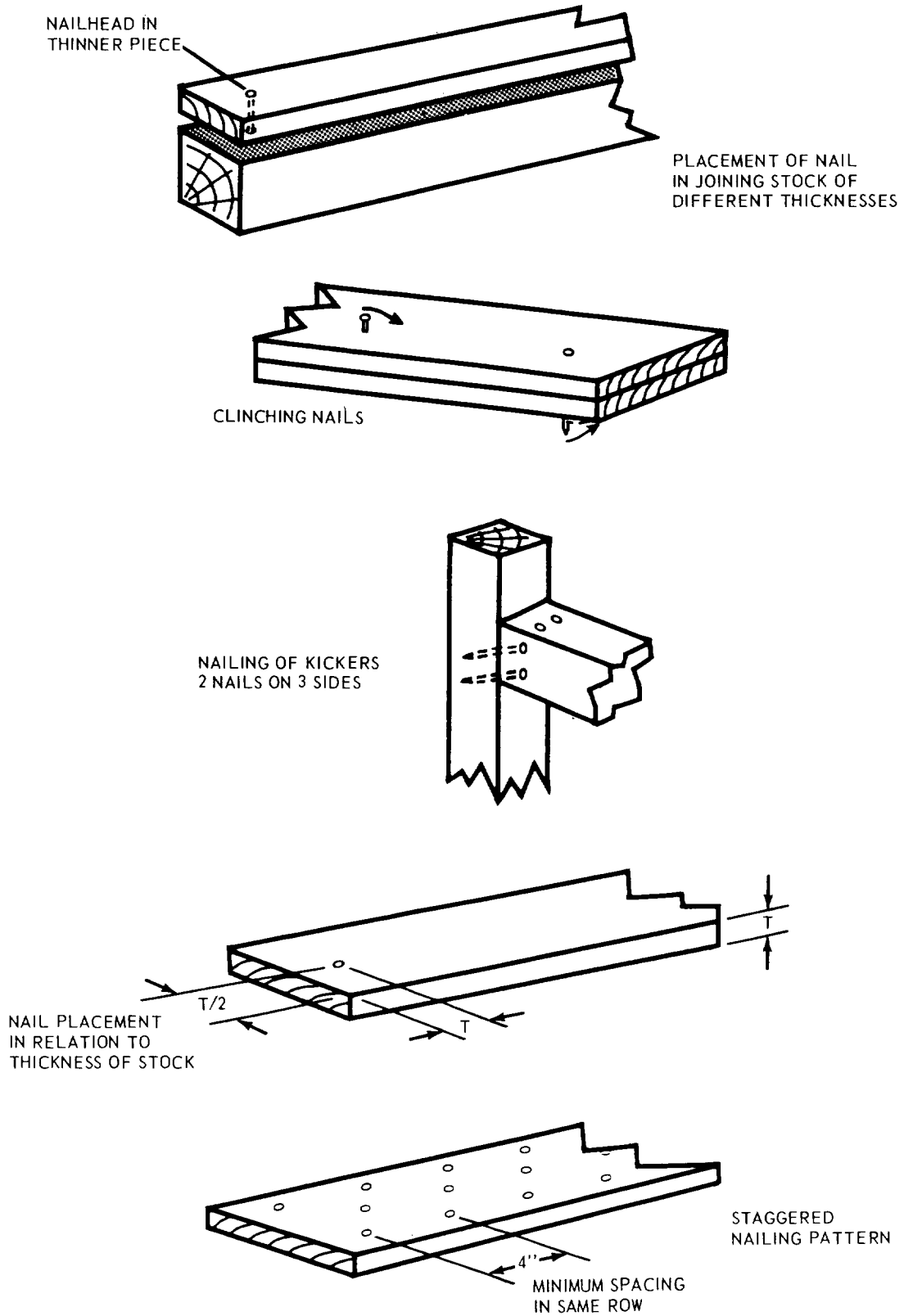


Figure 6-23. General nailing techniques.

(6) The allowable load in lateral resistance for a nail or spike driven into the end grain (parallel to fibers) will be two-thirds of the allowable load for nails driven into the side grain.

(7) The end distance, edge distances, and spacing of nails and spikes shall be such as to avoid unusual splitting of the wood. Generally, no nail shall be driven closer to the edge than half the thickness of the piece holding the nailhead. Figure 6-23 illustrates nail placement in relation to thickness of stock.

(8) When pieces of lumber are of different thicknesses, the nailhead should be in the thinner piece, as shown in figure 6-23.

(9) Nailheads should be driven flush with the nailing surface. In any case, the nailhead should not be driven deeper than one-eighth the thickness of the head retaining piece.

(10) A staggered pattern should be used when nails are driven in boarding or flooring. Nails in the same row should be separated by a minimum of 4 inches, as shown in figure 6-23.

(11) Caution should be exercised when nails are being driven near packages of explosives. Nails not directed toward the package may be deflected into the unit load by a nonyielding substance. In cases where nailing of lumber may present hazards, alternate methods of securing must be approved by authorized inspectors.

### **WARNING**

**Never nail lumber directly to unit loads of explosives. Hammer blows must never directly contact the explosives package.**

(12) When structures such as kickers (which are supported by nails and a functional force-fit) are toenailed, at least two nails will be driven in three sides at each end of the nailed piece (fig 6-23). The allowable withdrawal load in toenailed joints is equivalent to two-thirds of the allowable withdrawal load for the side grain (see table C-3).

*c. Wood Screw Joints.* Although not commonly used in dunnaging operations, mainly because of the increased time requirements for installation, wood screws are acceptable for construction purposes. Tables C-5 and C-6 provide a tabular summary of allowable withdrawal and lateral loads for common wood screws. Withdrawal resistance of screws is a function of the effective penetration; that is, the length of the threaded portion of the screw, in the receiving piece. The following general rules apply to the use of wood screws in the shipyard-securing of ammunition and explosives:

(1) Allowable loads for a single screw, as specified in appendix C, can be summed to determine the total allowable load for more than one screw.

(2) Normal allowable loads for screws, as specified in appendix C, can be summed to determine the total allowable load for more than one screw.

(3) Screws used for fastening purposes in the interior of a class "A" magazine must be countersunk below the surface of the wood.

(4) Lead holes should be prebored to accept screws.

(5) Screws inserted in lead holes should be turned with a screwdriver; hammering is not permissible.

(6) Soap or other lubricant may be used sparingly on screws, or in lead holes, to facilitate insertion and to prevent damage to the screw.

(7) Sufficient spacing, end distances, and edge distance should be provided to prevent splitting of the dunnage.

(8) For lateral resistance, penetration of the screw into the main member should be approximately seven diameters to achieve maximum loads. Penetration depth of less than four diameters is not recommended.

(9) Screws should not be loaded in withdrawal, particularly from end grain. Lateral load capacity of screws in the end grain must be reduced by one third.

**CHAPTER 7**  
**STANDARD SECURING STRUCTURES AND REQUIREMENTS**

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**7-1. General**

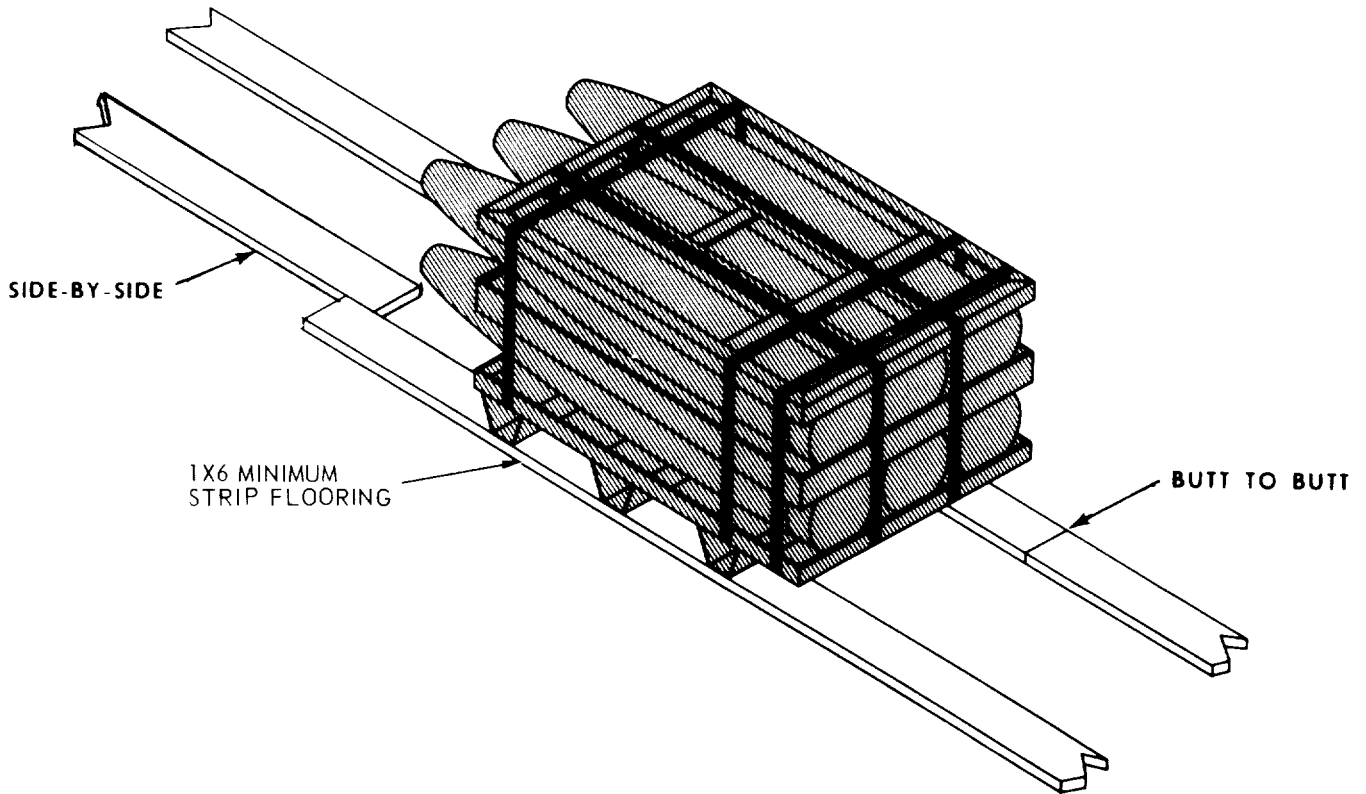
This chapter summarizes construction details and materials used in securing military explosives for the purpose of preventing movement and damage during transportation. The fundamental structures and requirements described herein are already established by Federal regulations or are used regularly in dunnaging operations. Consequently, the procedures do not vary significantly with the loading activity, type of cargo, or hull configuration.

**7-2. Decking**

*a. General Requirements.* Decking, commonly known as flooring, will be laid over metal decks or tank tops, as required, to protect military explosives. However, decking is not required when decks or tank tops are coated with appropriate nonmetallic materials, such as mastic, or if the units are palletized on wood pallets. The entire interior or class "A" magazine must be wood and, therefore, must be completely floored regardless of pallet construction.

*b. Effect of Decking.* Metallic contact constitutes a transportation hazard for several reasons. In the event of loss of stow integrity, spark generation from metal-to-metal sliding contact between the deck and unit loads poses serious danger of fire and/or explosion. Of less obvious effect is the influence of flooring on the integrity of the securing system. Friction is the resistance that is encountered when two solid surfaces slide or tend to slide over each other and, under moderate pressures, is proportional to the normal (perpendicular) load on the rubbing surfaces. Hence, friction acts in addition to restraint that is provided by securing structures and dunnaging to resist movement that would otherwise result from forces generated by ship motions. The amount of frictional resistive force would depend on surface finish, atmospheric dust and humidity, oxides on the deck, temperature, vibration, and surface contaminants such as grease and water. These factors are all present in the holds of cargo ships, and essentially their cumulative effect is a reduction in surface friction, particularly for metal-to-metal surfaces such as metal pallets in contact with the metal deck. Wood flooring serves as an absorbent of contaminants and minimizes the undesirable effects of poor surface conditions.

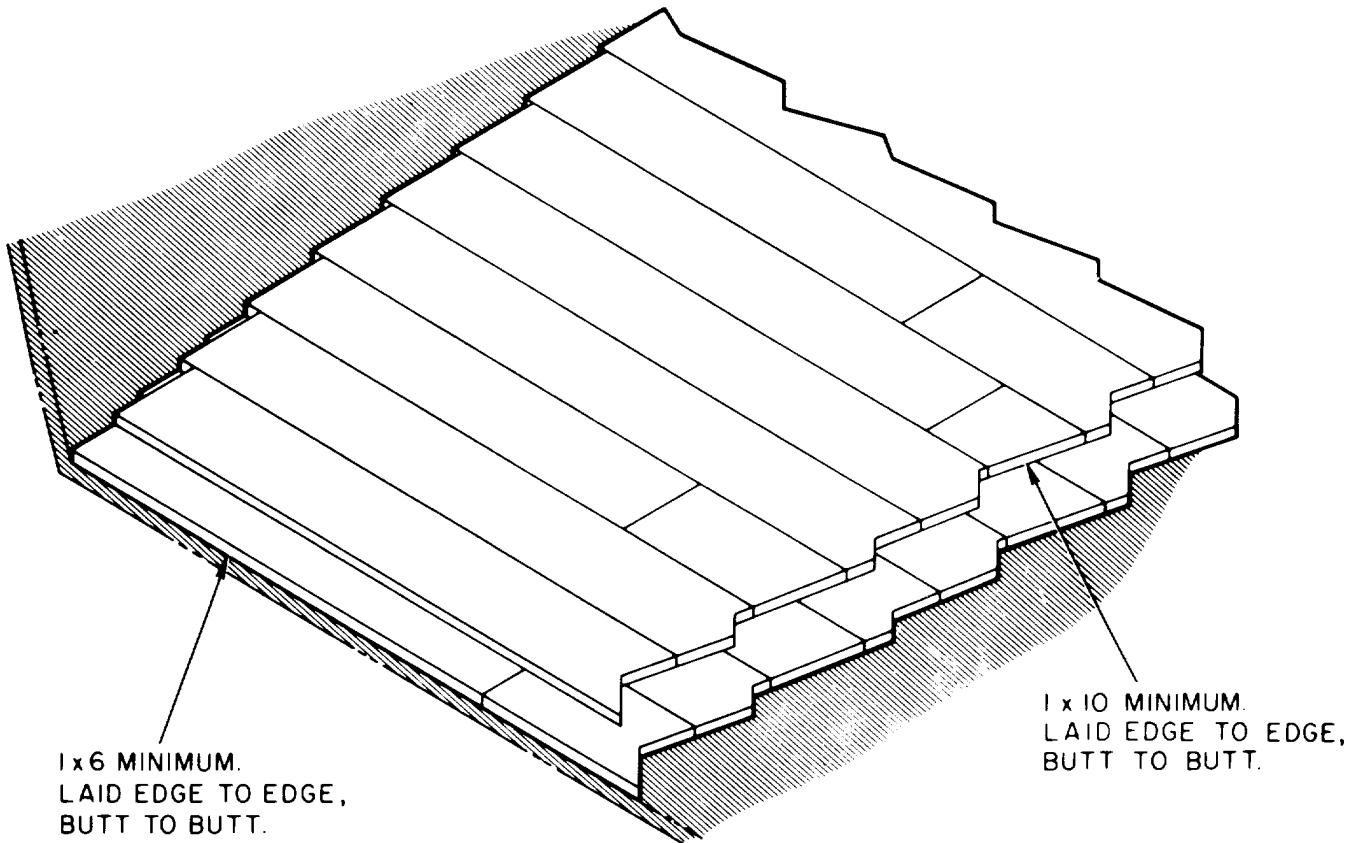
*c. Strip Decking.* Since the main purpose of decking is to prevent metal-to-metal contact between the deck and the unit load, it is necessary to install, as a minimum, strip decking in compartments where metal pallets or the strapping of wooden skids bound with metal straps would otherwise contact the deck. Figure 7-1 illustrates the use of strip decking, also referred to as strip flooring. Since the strip decking bears only compressive loads, 1 by 6-inch lumber is adequate for stripping purposes. Strip decking is normally laid butt-to-butt. However, instead of being cut, ends may be overlapped side-by-side when they are too long. Stripping should be positioned crosswise to the pallet skids, as shown, to minimize any possibility of the unit load's being displaced from the stripping in transit.



**Figure 7-1 Strip decking/flooring.**

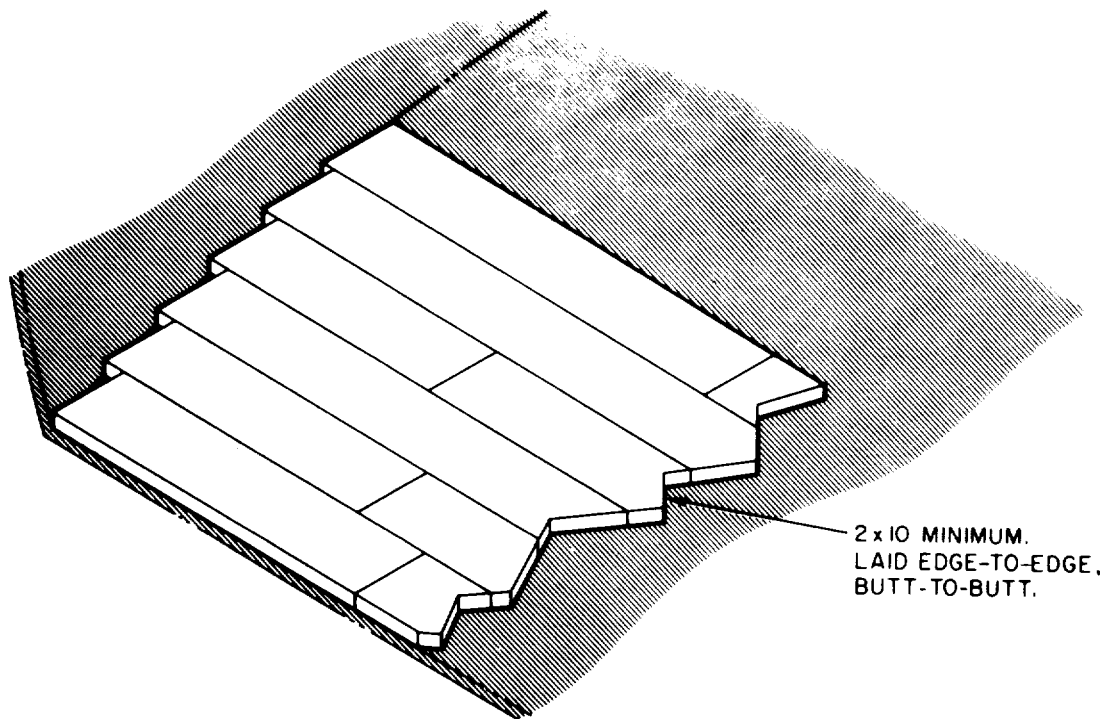
*d. Full Decking.*

(1) Generally, full wood decking (flooring) is constructed of 2-inch lumber at least 10 inches in width. Lumber of lesser widths is more readily displaced and damaged by the wheels of forklift trucks. Two layers of 1-inch lumber can be used to construct full flooring, provided the bottom layer is at least 6 inches wide and the top layer, at least 10 inches wide. Construction details of wood decking are shown in figure 7-2. Decking is laid in crosswise layers if within a class "A" magazine (described in para 7-8). This technique is preferred when two course decking is used. The decking is fitted tightly, edge-to-edge and butt-to-butt; however, adequate space should be left at the hull to permit drainage of condensation runoff.



**Figure 7-2. Construction of wood decking with 1-inch lumber.**

(2) Figure 7-3 illustrates basic flooring techniques in the tween-deck holds with a single layer of 2 by 10-inch lumber. The floor is laid directly on the deck, edge-to-edge and butt-to-butt. Boards may be laid either fore and aft or athwartships; however, the athwartship orientation is preferred if the entire hold is to be floored or if only the curve of the hull is to be floored. Flooring laid in this manner will closely follow the hull contour with a minimum of exposed metal deck. If obstructions on the deck preclude the laying of a flush flooring surface, the flooring may be elevated on a foundation of 4 by 4-inch runners. Runners may be laid fore and aft or athwartships; however, spacing should not exceed 20 inches center-to-center. Adequate space should be left between runners and the shell plating to allow for condensation runoff.



**Figure 7-3. Construction of 2-inch wood decking laid athwartships.**

(3) Inspection covers and fill caps often protrude above the deck surface in the lower holds in which the tops of deep tanks form the deck. Items not requiring wood flooring, such as unit loads that do not require magazine stowage and that are palletized on wood pallets, may be loaded directly on the deck around the obstruction. A void table block of 4 by 4-inch lumber is constructed around the obstruction, and the unit load is placed directly upon the obstruction and the void block. This unit load will exceed the height of the remaining loads stowed directly on the deck, thereby creating an uneven surface for flooring. Hence, this method is used when compartment height or characteristics of the cargo do not require that a floor be installed. However, if a floor is necessary above this tier or subsequent tiers, the stow should be made as level as possible. The surrounding unit loads are stowed in block fashion around the obstruction, and a void table is constructed to support the next tier or floor. Details of this construction are shown in figure 7-4. In some cases, the obstructions are so numerous that working conditions around them are undesirable. In this case, flooring is constructed of two courses of 2-inch planks laid crosswise and secured to 4 by 4-inch runners laid on the metal deck, as shown in figure 7-5. All decking (and runners) should be laid to cover sufficiently any area where forklift truck wheels can reach; however, the decking should not overhang the runners. Runners are not necessary where the tank top surfaces are level, because the flooring is laid directly on the tank top, as required. When used as a stowage area for military explosives, deep tank bottoms are floored over, as required, in the same manner prescribed for the holds.



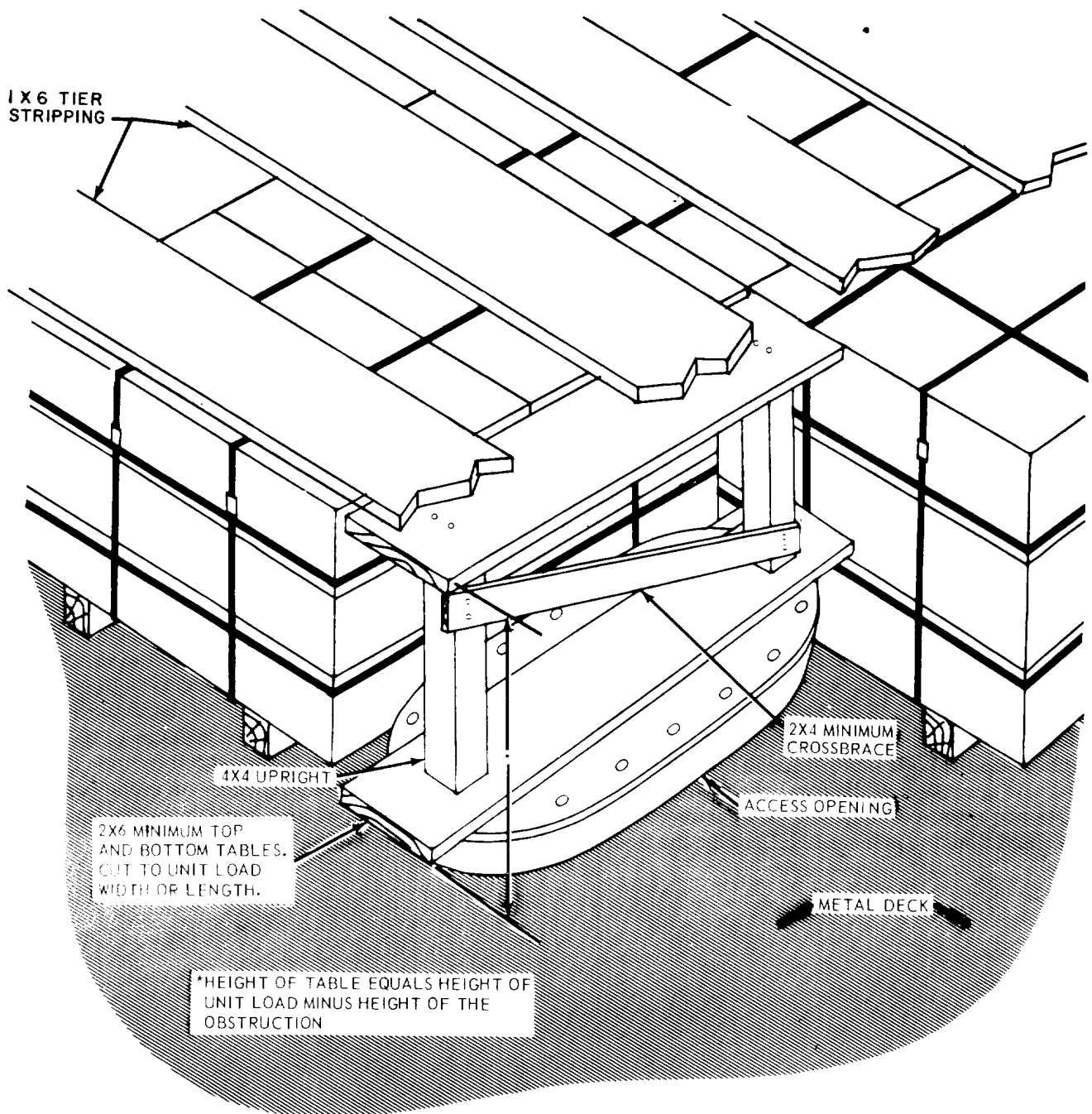
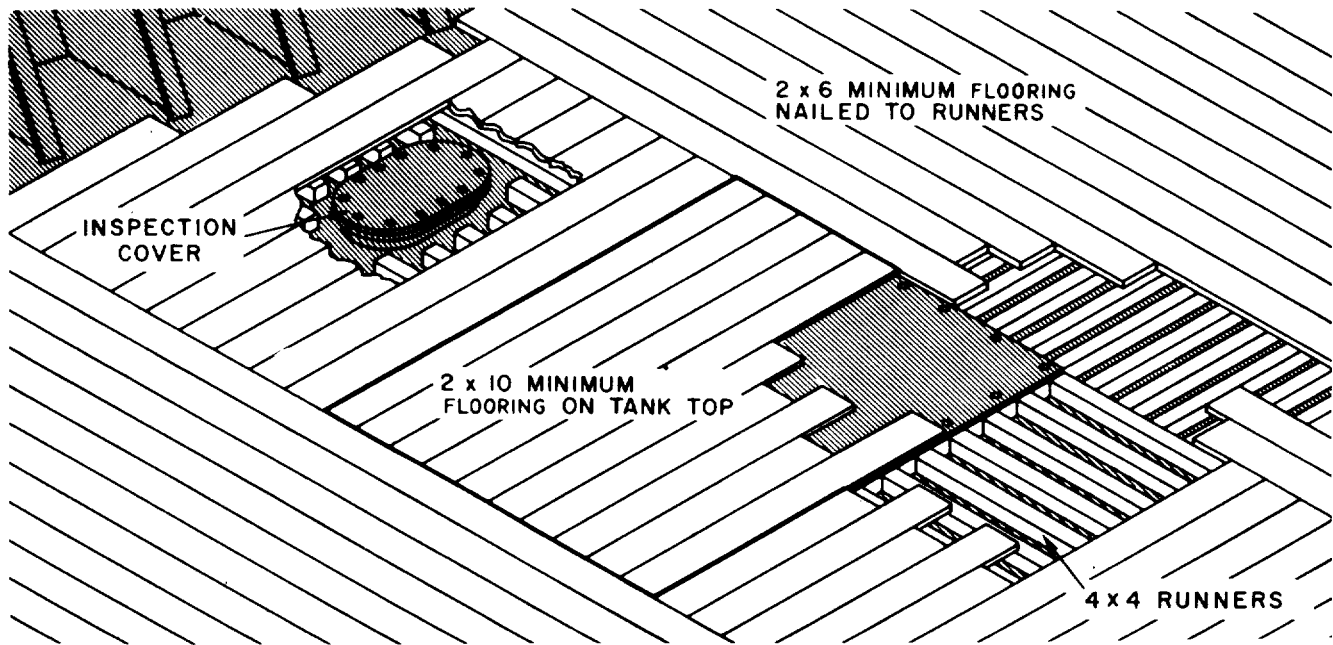
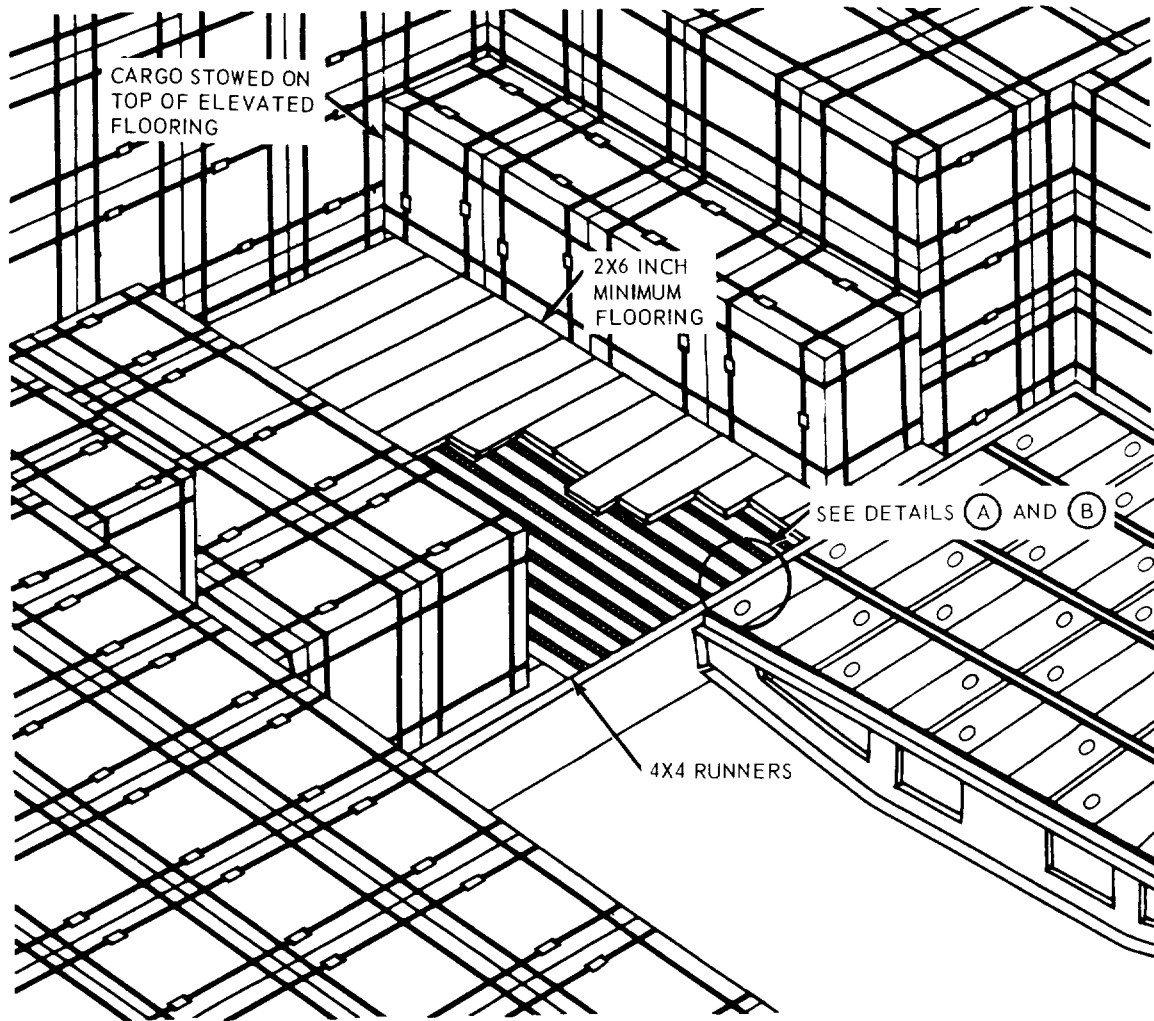


Figure 7-4. Void table method for shoring deck obstructions.



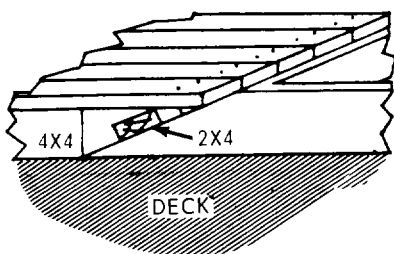
**Figure 7-5. Construction details for flooring over tank top.**

(4) In certain holds or compartments, unusually high brow plates (raised hatch edges) require the installation of elevated flooring in an area adjacent to the perimeter of the hatch. This flooring is used only in an area large enough to provide an unobstructed level surface for the safe operation of forklifts while unit loads of cargo are being stowed in an area adjacent to the hatch level. As shown in figure 7-6, unit loads stowed fore and aft of the hatch and in the wings of the hold may be stowed on the deck, or on strip decking, if required, only to a distance from the brow plate or hatch bevel that will permit safe operation of the forklifts. At this point, forklifts are removed from the compartment and the elevated flooring is installed. Usually, the flooring is laid fore and aft at the same level as the hatch, and it extends from the brow plate or hatch bevel to the previously stowed unit loads in the wing and between the unit loads that form the alleyway. Forklifts cannot negotiate the brow plate or hatch level when they transfer loads from the square of the hatch to the final stowage position on the elevated flooring. Based on the type of cargo being stowed, a spacer assembly with face boards may be required between the unit loads stowed on deck and those stowed on the elevated flooring because of the difference in height. Such loads, which include items such as bombs, particularly those on metal pallets, and irregularly shaped unit loads or containers, can have exposed, unsupported strapping.



DETAIL A

BEVELED DROP-OFF



DETAIL B

STRAIGHT DROP-OFF

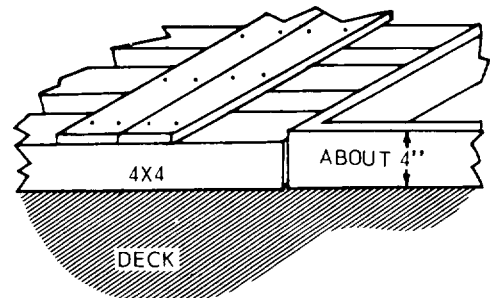


Figure 7-6. Partial elevated flooring.

(5) With the increased use of power-operated folding hatch covers on merchant ships, breakbulk ships that use tween-deck hatch boards are encountered infrequently. However, vessels that use hatch boards are still in operation under foreign flag and should be considered. When flooring is required, construction shall conform to figure 7-7. In most cases, however, wood pallets are loaded directly on the hatch boards, as shown in the figure. Chapter XVII of 29CFR1918 requires that, when mechanically powered vehicles are used aboard vessels, adequate provisions must be made to ensure that all working surfaces can support the weight of the vehicles and loads. Hatch covers, truck plates, or other temporary surfaces should not be dislodged by movement of the vehicles. Therefore, as a minimum, a double layer of 1by 6-inch lumber should be installed over the hatch boards with the top course laid crosswise to the bottom layer and nailed to prevent free movement. Plywood at least 3/4-inch thick or a single layer of 2-inch lumber may be used. However, in all cases, the bottom layer of 1-inch material, the plywood, or the single layer of 2-inch lumber will be laid with its longitudinal axis parallel to the center line of the vessel.

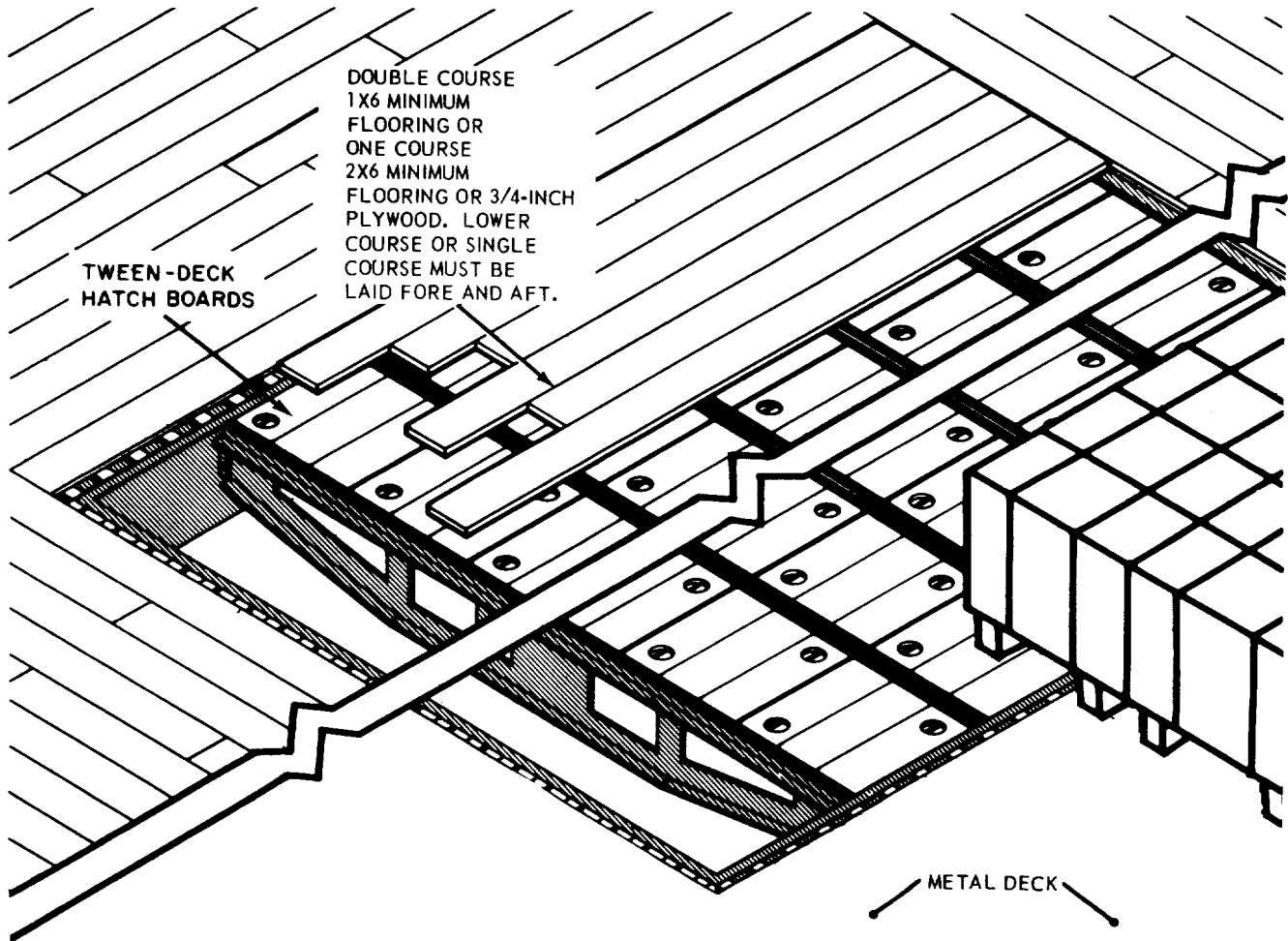


Figure 7-7. Comparison of flooring over hatch boards with stowage of wood pallets directly on hatch boards.

(6) Additional space can be gained for stowage of explosives in lower holds bisected by the shaft alley, provided flooring is installed as shown in figure 7-8. A foundation of 4by 4-inch lumber is supported at the center by the shaft alley and at the ends by 4by 4-inch uprights on 36-inch centers. The figure shows double uprights, which are provided to gain additional lateral clearance with the alley. If no protuberances on the alley need to be cleared, single uprights may be used. The cargo floor would extend wing-to-wing as shown.

(7) When cargo is tiered to the maximum vertical operating range of forklifts and additional overstay is intended, the cargo shall be covered with a tier deck or a "machine floor" (a term so applied because it is of sufficient strength to support materials handling machinery rolling over it). This floor is constructed of two layers of 2-inch lumber, with the top layer at least 10 inches wide, laid edge-to-edge and butt-to-butt. The lower course should be at least 6 inches wide and spaced at intervals of about 3 inches. When certain loads,

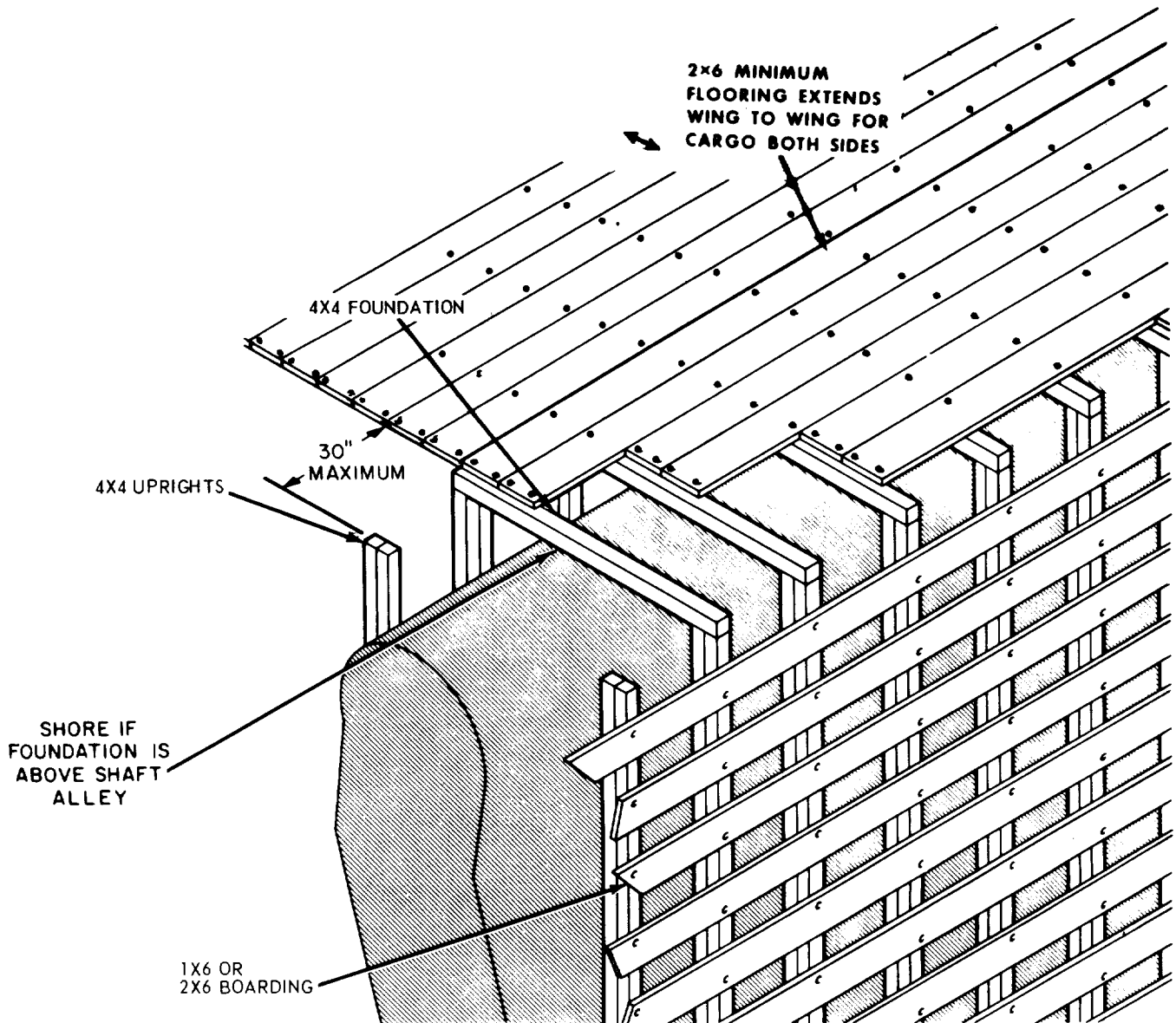


Figure 7-8. Construction details for flooring over the shaft alley.

such as explosive bombs, overhang the pallet or skid and are stowed nose-to-nose, a space exists between the tops of the loads. In such cases, the lower course of decking is laid lengthwise across the narrowest dimension of the space. Also, as the lower course is laid, dunnage, such as short 4by 4inch pieces cut at random lengths, shall be placed on the loads at points where the decking would otherwise bear on an uneven foundation. Figure 7-9 also shows how short lengths of 4by 4-inch dunnage are placed where the unit loads would not support the decking. The top layer shall be laid crosswise to the bottom course and nailed sufficiently to ensure stability.

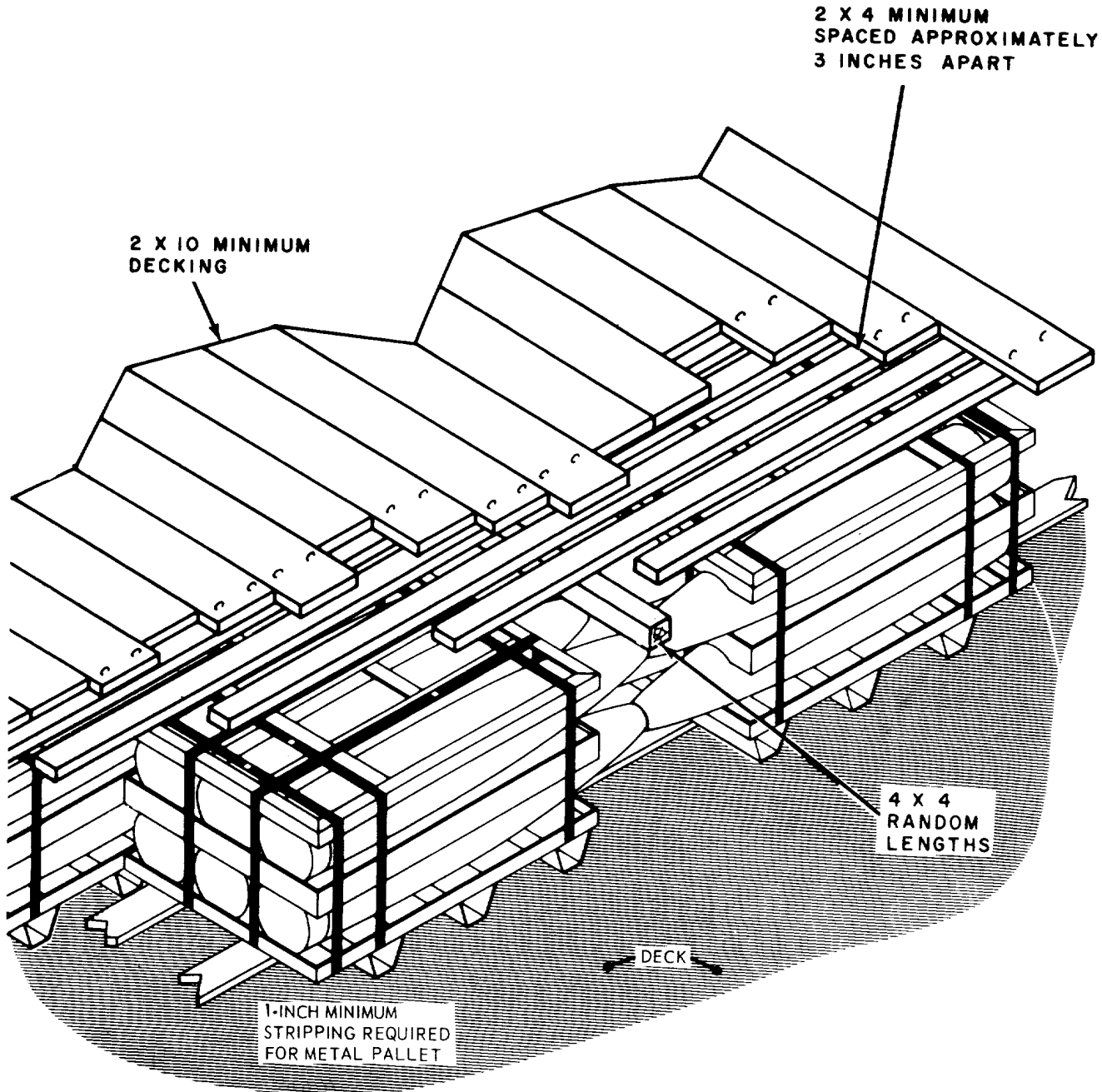


Figure 7-9. Construction of tier decking for unit loads with overhang.

(8) Bombs are often loaded nose-to-butt, as shown in figure 7-10. A lower course of 4by 4-inch lengths of lumber is laid parallel with the longitudinal axis of the unit loads. Each 4by 4-inch piece of lumber should be placed directly over the bombs to span the void between unit loads and transmit load forces through the stringer section of the palletized unit. Runners of this type should never be situated between bombs, since this use would induce compressive loads on portions of the unitized pallet, which is not intended to be a load-bearing surface. The machine floor is particularly important in the stowage of explosives because it forms the foundation for multitiered loads. This floor must withstand the concentrated loads of wheeled forklifts while retaining stability. Therefore, voids under the flooring that are subject to failure in bending should be minimized, and provisions should be made for transmittal of the load to the deck through uprights, particularly when the block-stow technique is used.

**7-3. Dunnage Flooring**

Dunnage Flooring Dunnage flooring, not to be confused with decking, is required by Federal regulations for the separation of certain classes of explosives in the same hold or magazine. Flooring is classified as either type A or type B.

a. Type A Dunnage Floor. The type A dunnage floor is constructed of two layers of commercial 1-inch lumber at least 4 inches in width and fitted as close as possible, edge-to-edge and butt-to-butt, with the top course laid crosswise to the lower course. A single layer of 2-inch lumber of at least 6 inches in width, fitted tight, edge-to-edge and butt-to-butt, can be used as an equivalent. When 2-inch lumber is used over hatch boards, the lumber should be laid fore and aft.

b. Type B Dunnage Floor. The type B dunnage floor is constructed of a single layer of commercial 1-inch lumber at least 4 inches in width and fitted tight, edge-to-edge and butt-to-butt.

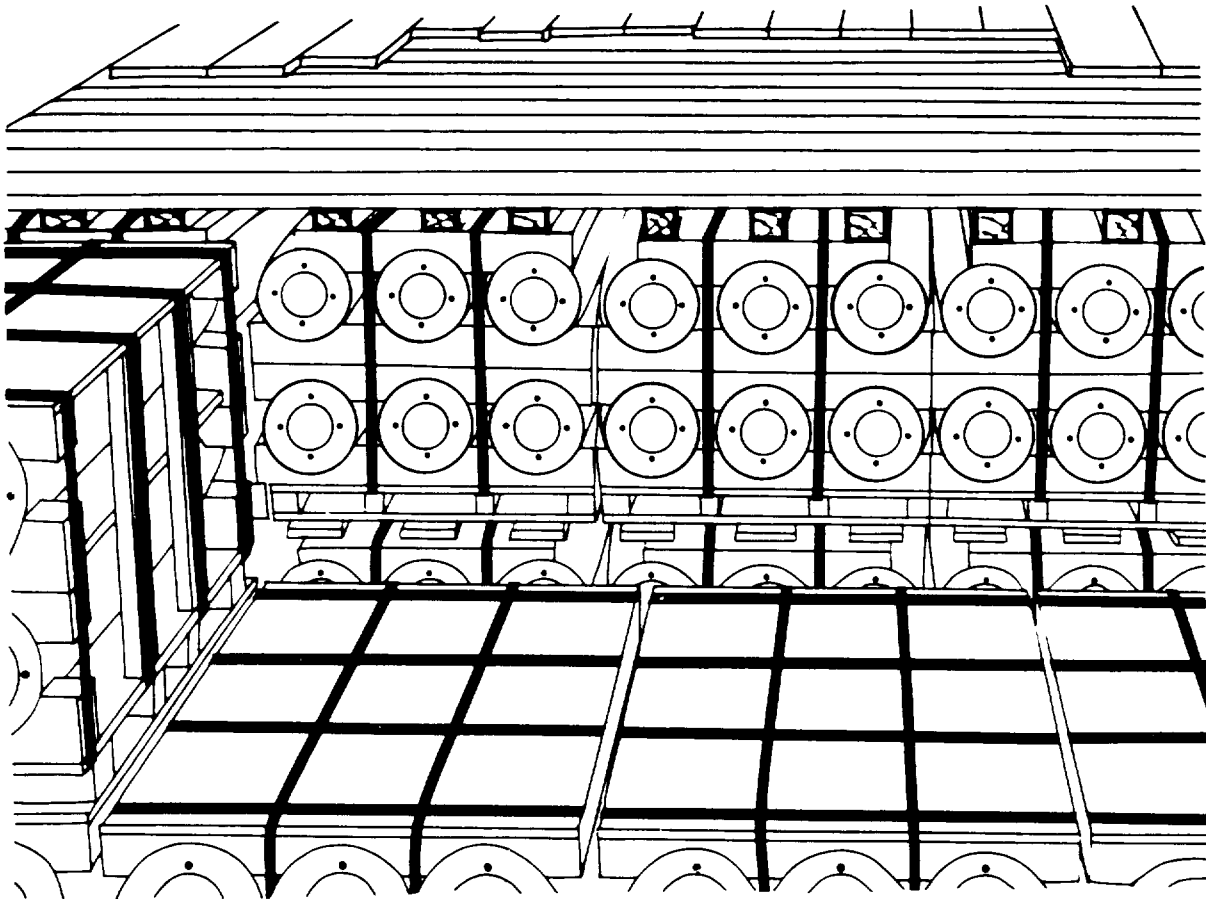


Figure 7-10. Construction of tier decking for nose-to-butt bomb stowage.

#### 7-4. End Bulkheads

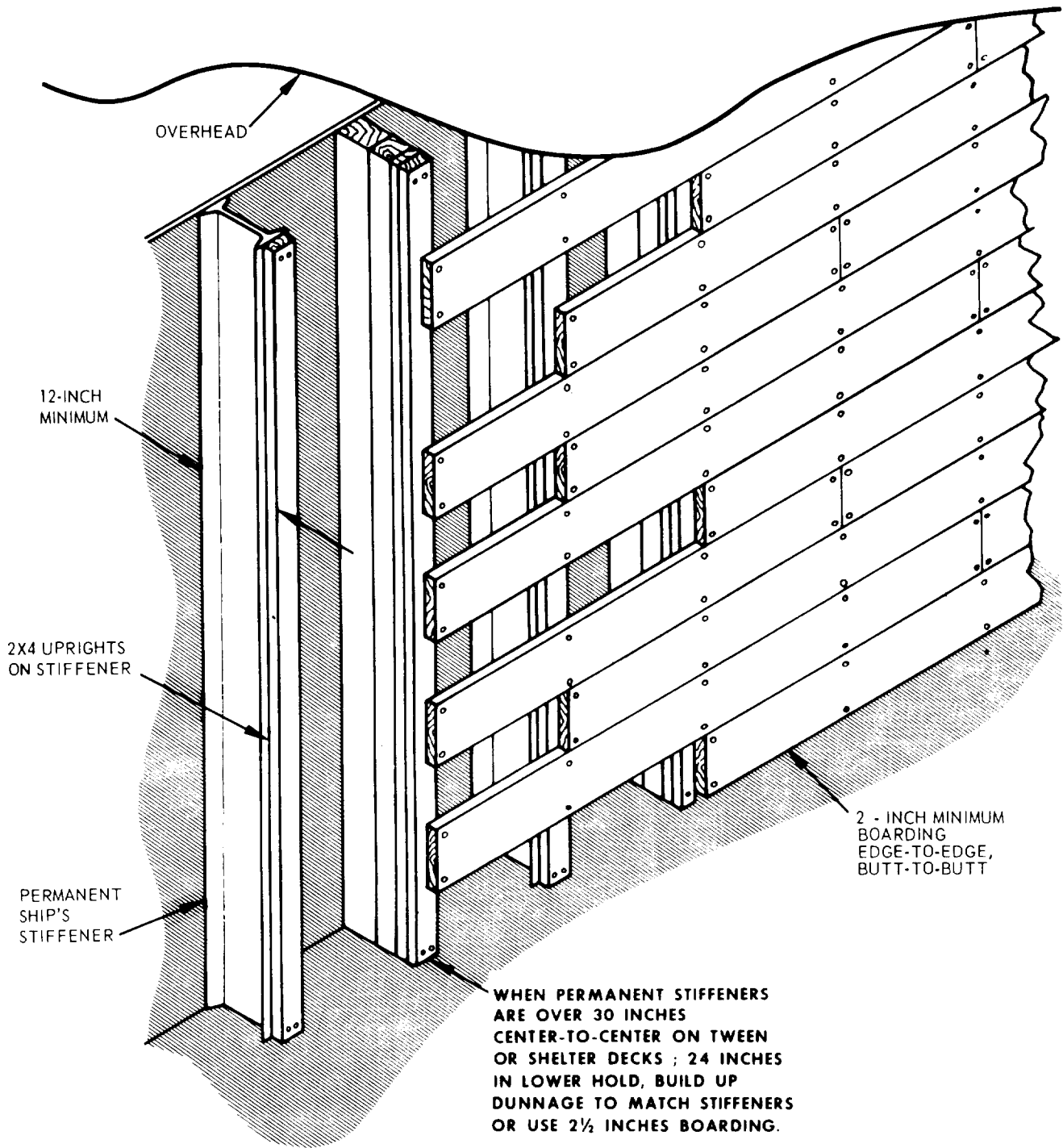
End bulkheads, which must be in place before the initial unit loads are emplaced within the stow, can be either heat type or nonheat type. The type depends on the location of the stow with respect to heat-radiating surfaces, such as engineroom bulkheads.

a. Heat Bulkheads. Heat bulkheads are recognized by tight, unbroken face-boarding constructed at least 1 foot off the ship's permanent bulkhead. The smooth side of the bulkhead must always face the stowage of explosives or ammunition.

(1) In cases where such heat-radiating bulkheads are smooth on the cargo side (that is, where stiffeners are on the side opposite the cargo), construction will conform to 46CFR142.29-75. This regulation requires that a minimum separation of 12 inches be maintained between the boarding of the heat bulkhead and the ship's bulkhead; this requirement must be considered for all construction. Sheathing is constructed of 2-inch lumber, preferably at least 10 inches in width. Federal regulations require 4by 6-inch uprights spaced not more than 30 inches apart in the tween or shelter deck or 6by 6-inch uprights spaced not more than 24 inches apart in the lower hold. Shortages of 4by 6-inch and 6by 6-inch lumber, however, are increasingly evident. With special exemption in accordance with 46CFR146.02-25 and 49CFR107, use of the more abundant 4by 4-inch stock may be considered for bulkhead construction. As summarized in table 5-1, 4by 4-inch uprights will be spaced at intervals not to exceed 24 inches between decks or on the shelter deck and will not exceed 16 inches in separation in the lower holds. Two-by six-inch lumber will be used as necessary for headers and bearers. Bearers are optional if wood flooring already covers the metal deck. Uprights are fastened at the top and bottom to horizontal stringers of suitable size to obtain a 12-inch separation with the ship's bulkhead. Intermediate stringers should not exceed 5 feet in actual separation from the upper and lower stringers.

(2) When stiffener beams are on the cargo side of the ship's bulkhead, construction details of the heat bulkhead shall conform to those shown in figure 7-11. Uprights of 2by 4-inch minimum lumber are fitted against the stiffeners in sufficient amounts to provide the required 12-inch bulkhead separation. Headers are not generally required; bearers need to be laid only if the metal deck has not been floored over. If the ship's permanent stiffener beams exceed a center-to-center spacing of 30 inches, dunnage should be built up to match the stiffeners or 2/2-inch boarding should be used as an alternate method. However, the more common and expedient method is to build up dunnage between stiffeners, since the 2½2-inch material is not readily available in many areas. The uprights are sheathed with 2-inch lumber, preferably 2by 10-inch or 2by 12-inch stock, or with ¼4-inch plywood sheets. As an alternate method of heat-bulkhead construction, jacks may be used to provide the necessary support for the 2-inch boarding. This type of bulkhead may be used on either the smooth side or on the stiffener side of the ship's bulkhead, and is shown in figure 7-12.





NOTE: SEE TABLE 5.1.

Figure 7-11 Construction details for heat bulkhead on stiffener side of ship's bulkhead.

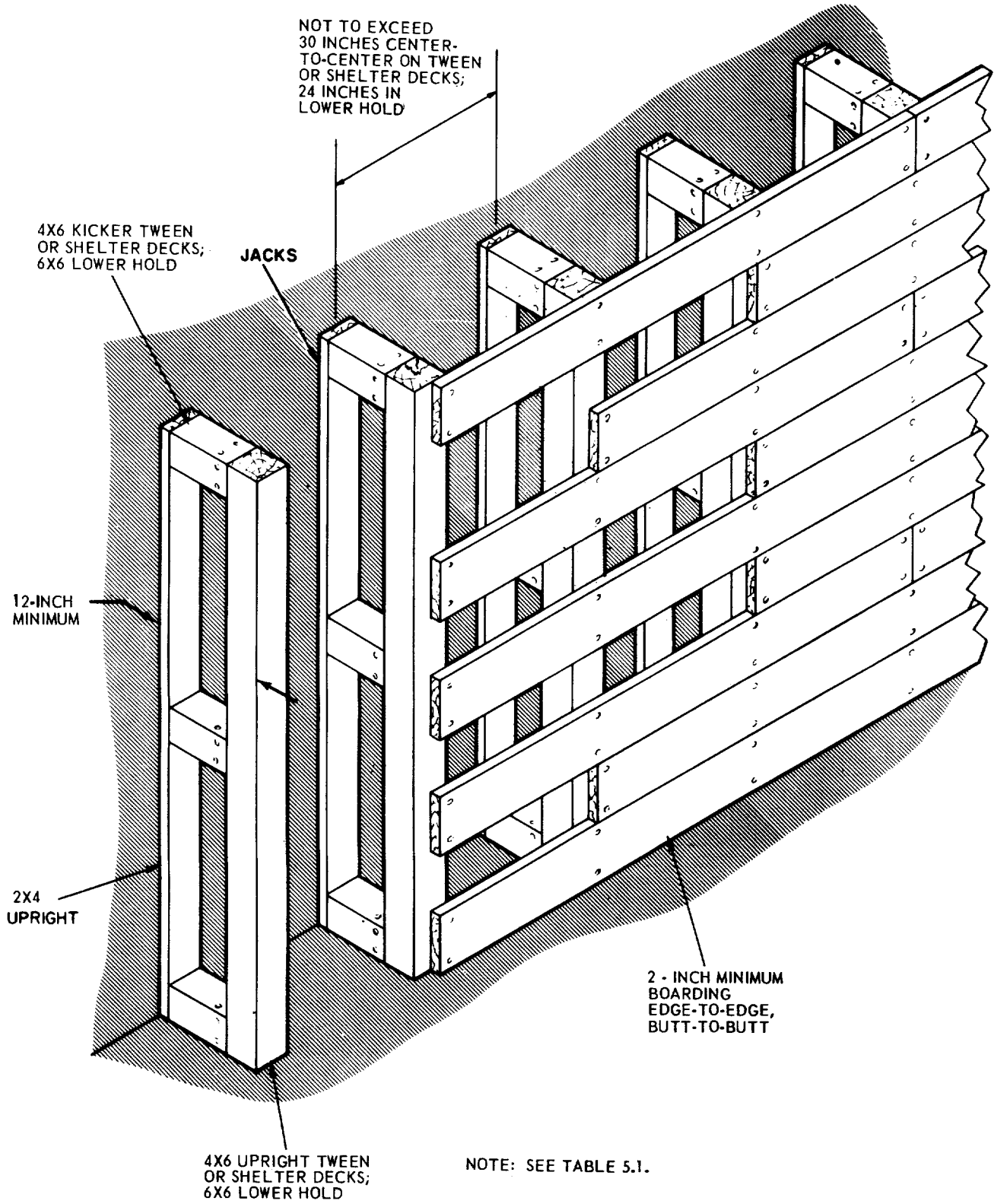


Figure 7-12. Construction details for heat bulkhead with jacks.

b. Nonheat Bulkheads. Nonheat bulkheads are constructed in the same manner as the heat bulkheads, except that the boarding need not be fitted edge-to-edge.

(1) As shown in figure 7-13, the bases and tops of palletized unit loads tiered two high are properly supported by 2-inch boarding. This figure illustrates several fundamental techniques of securing that also apply to structures other than bulkheads. In general, boarding should be vertically spaced to provide a bearing surface for the top and bottom of each unit load in the tier. Horizontal center-to-center spacing between uprights, whenever possible, should not exceed 24 inches in tween-deck compartments or 16 inches in the lower holds. Nonheat bulkheads constructed on the stiffener side of the ship's bulkhead are assembled as shown in figure 7-14. Uprights of 2by 4-inch minimum stock are positioned on each stiffener. Boarding is vertically spaced in such a manner as to maintain two point contact with each unit load.

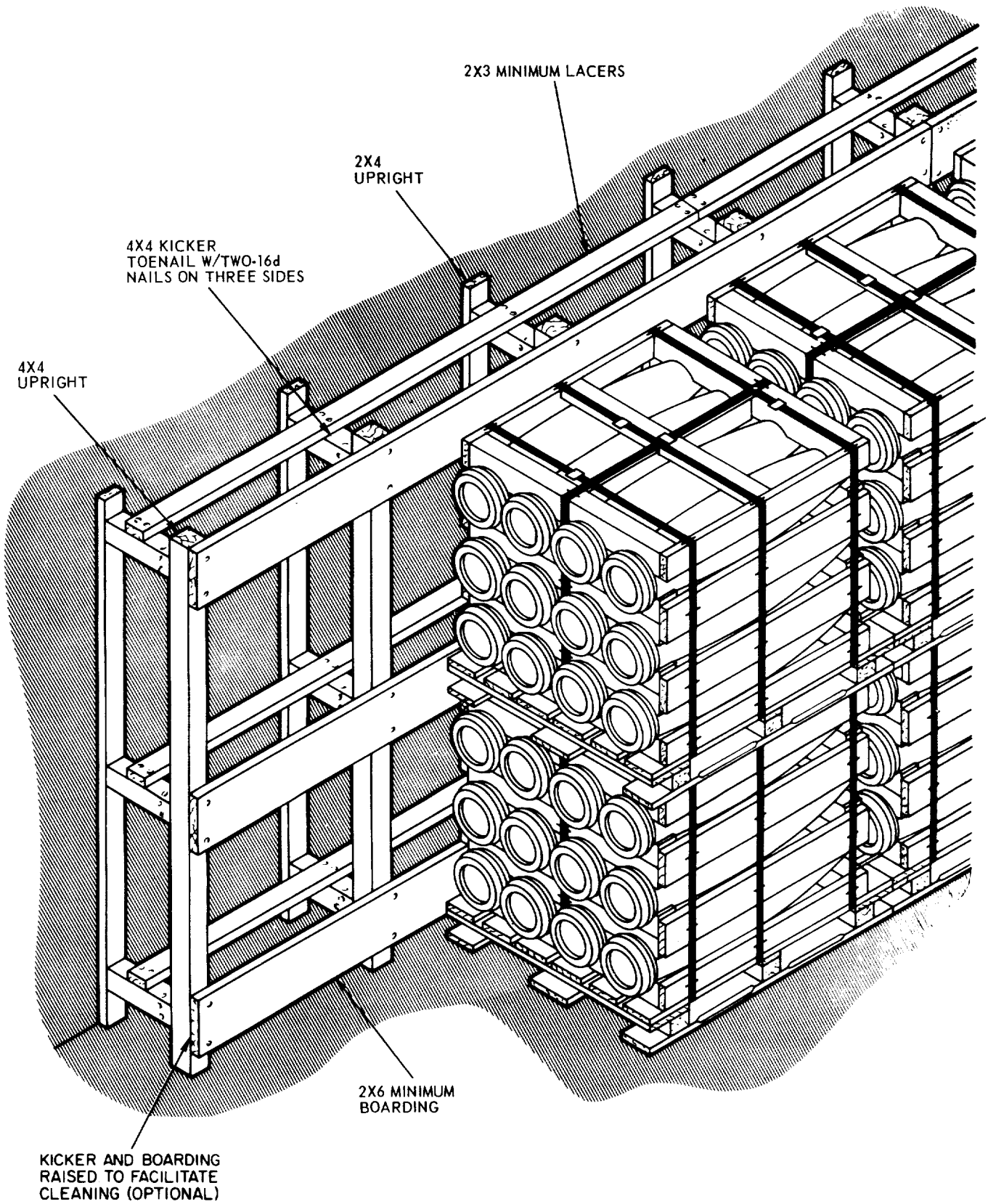


Figure 7-13. Construction details for nonheat bulkhead with jacks.

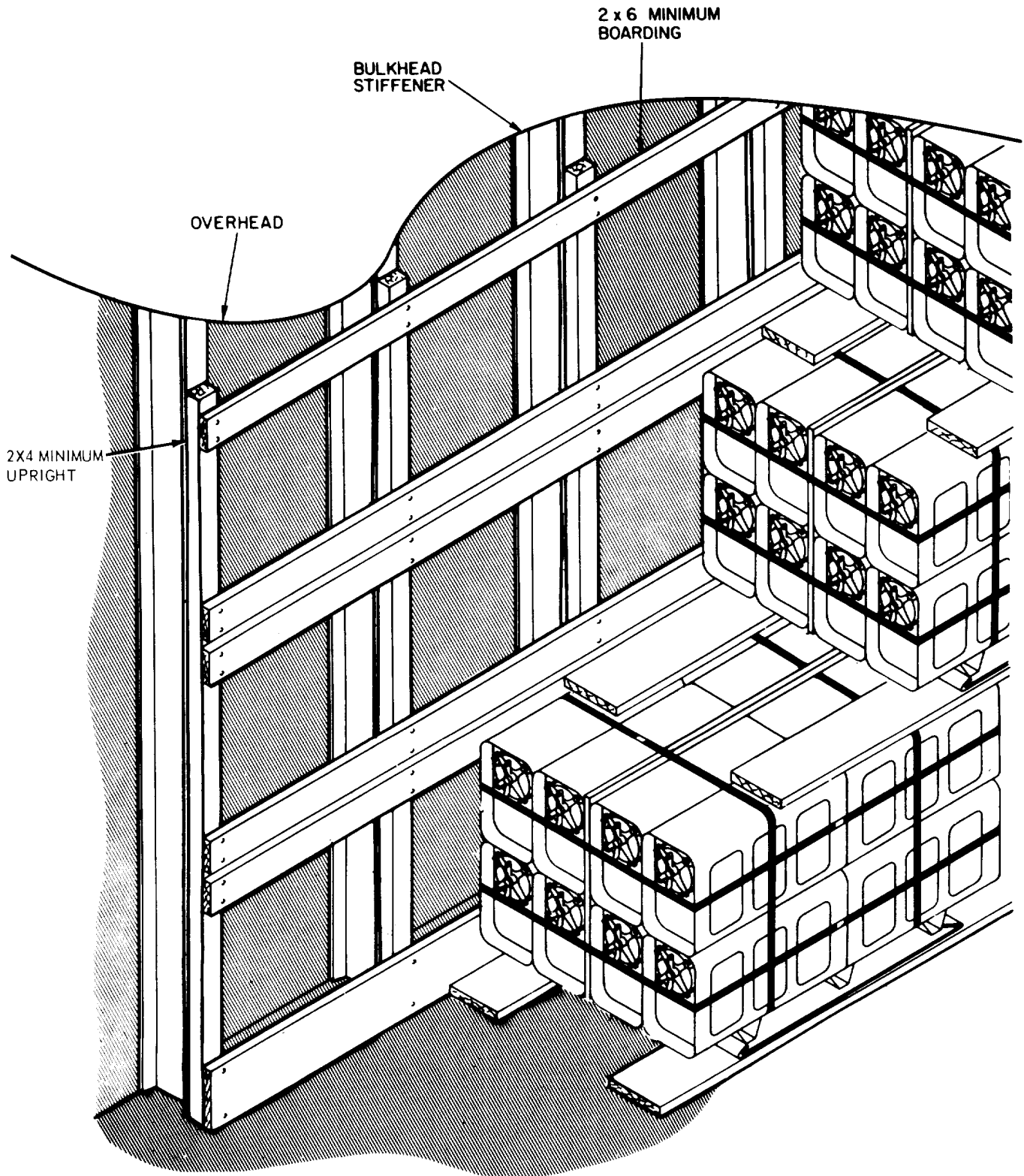


Figure 7-14. Construction details for nonheat bulkhead on stiffener side of ship 's bulkhead.

(2) A-frames may be used to secure stowage that ends in an area of a hold where there is no permanent ship's bulkhead to support an end bulkhead. Figure 7-15 illustrates the construction technique for such a bulkhead. The hatch coaming and deck are used as support points for 4by 4-inch main braces. Kickers provide the required bracing of the uprights. Braces and kickers are constructed of 4by 4-inch stock, cut-to-fit. The structure should be securely laced with 2by 3-inch lumber; cleats under the kickers are 2by 4-inch material.

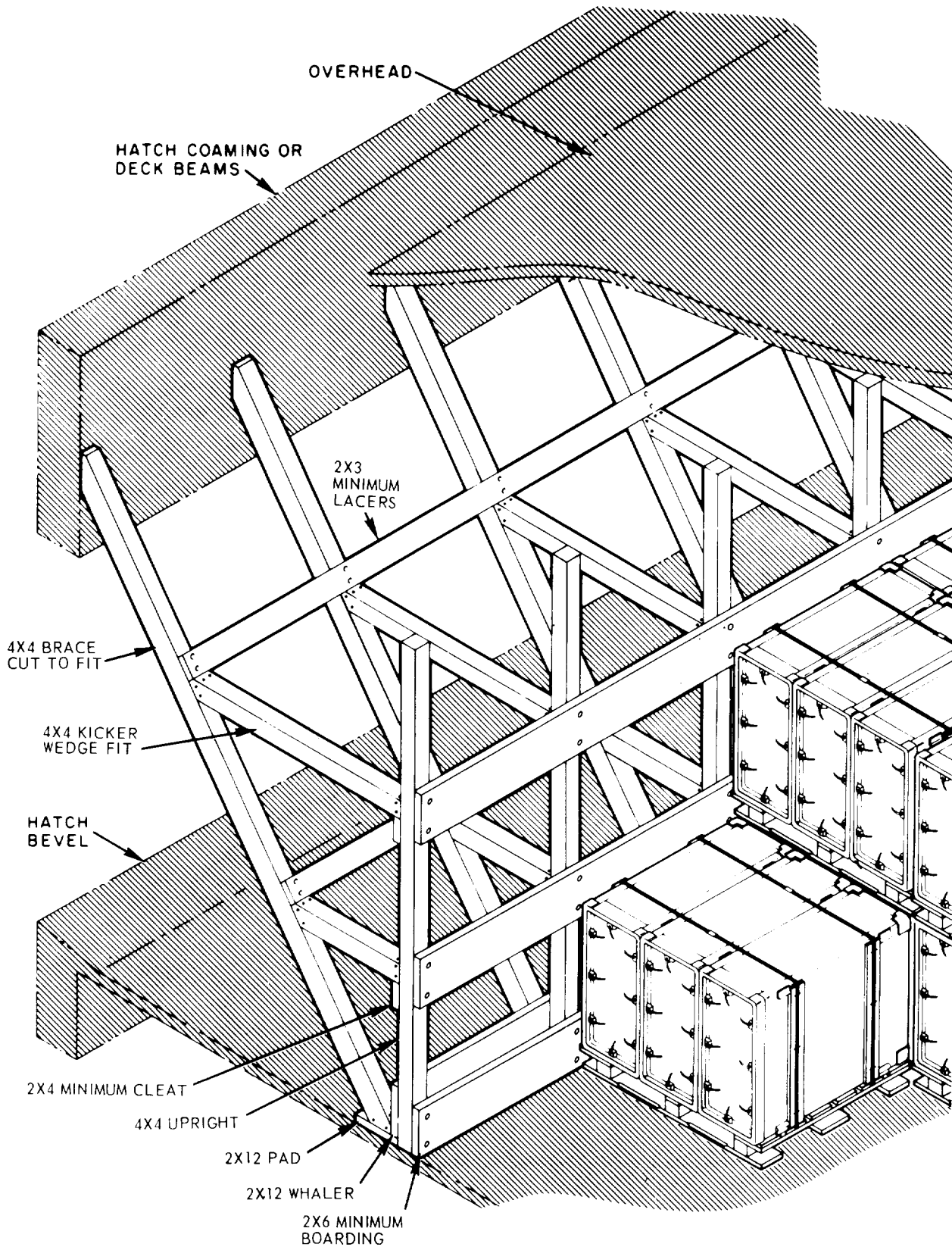
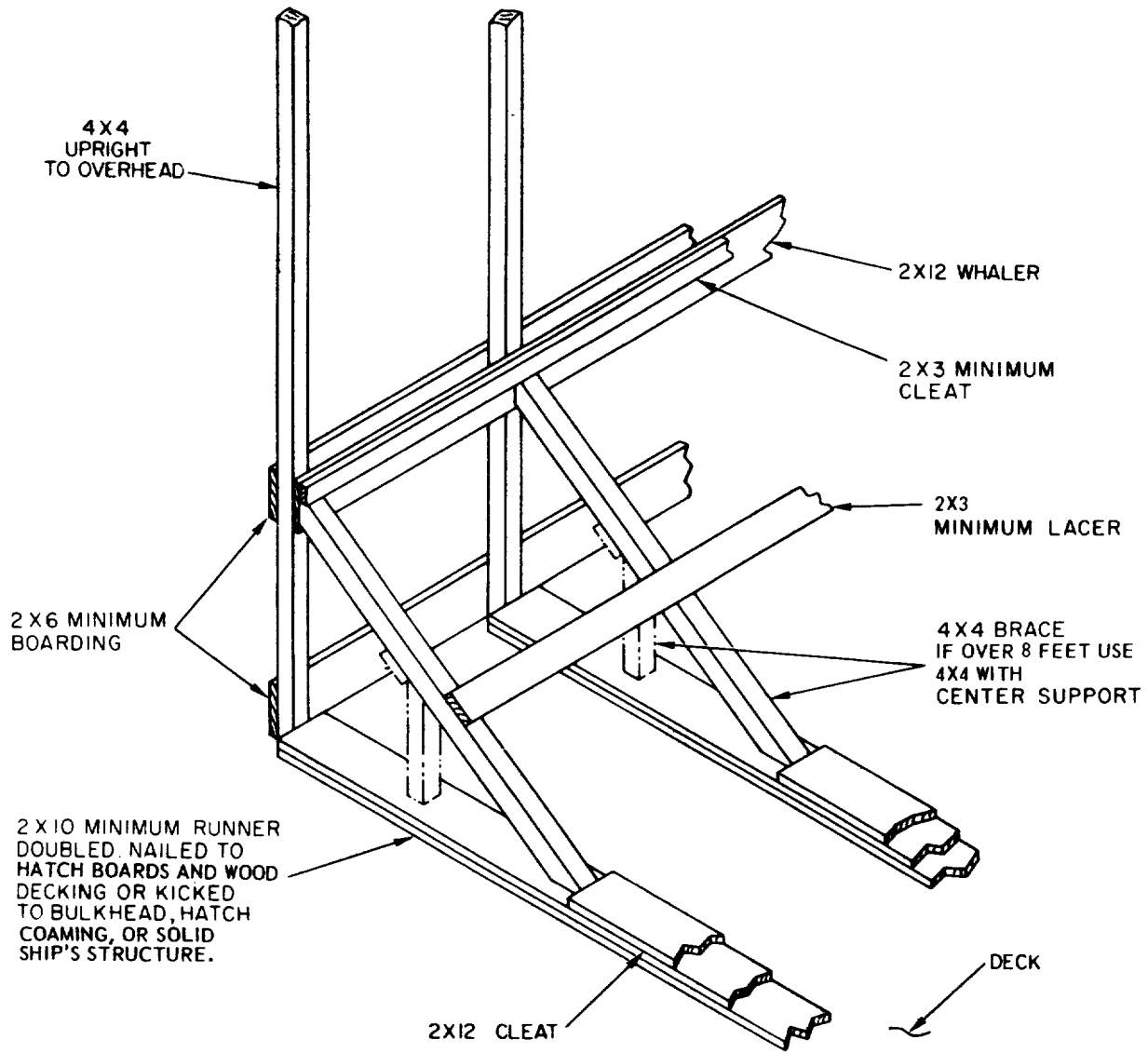


Figure 7-15. Construction details for nonheat bulkhead with A-frame.

(3) In cases where the cargo is at such a distance from the coaming as to make A-framing impractical, the bulkhead can be braced in the manner illustrated in figure 7-16. Braces bear on the bulkhead at the same level as the top of the cargo. These braces are secured with 2by 12-inch cleats fastened to two layers of 2by 10-inch or 2by 12-inch runners, which are nailed to the deck or wedge-fitted to a solid ship's structure. The length of the bracing member is determined by maintaining a 3: 1 ratio (3-foot run to 1-foot rise), when possible. Uprights are extended to the overhead to provide rigidity.



**NOTE**  
 WHERE POSSIBLE USE 3/1 RATIO  
 (3-FOOT RUN TO 1-FOOT RISE)  
 FOR BRACE.

Figure 7-16. Construction details for nonheat securing structures of bulkheads with deck bracing.



(4) Nonheat securing structures can be installed in lower holds through which the shaft alley extends. Construction details are shown in figure 7-17. Uprights of 2by 4-inch lumber on 36-inch centers are cut level with the top of the shaft alley, over which flooring may be laid to provide additional stowage space. Double uprights, as illustrated, are not required unless obstructions on the shaft alley protrude from the surface.

**7-5. Partition Bulkheads**

Partition bulkheads are constructed when military explosives must be separated by type or weight or

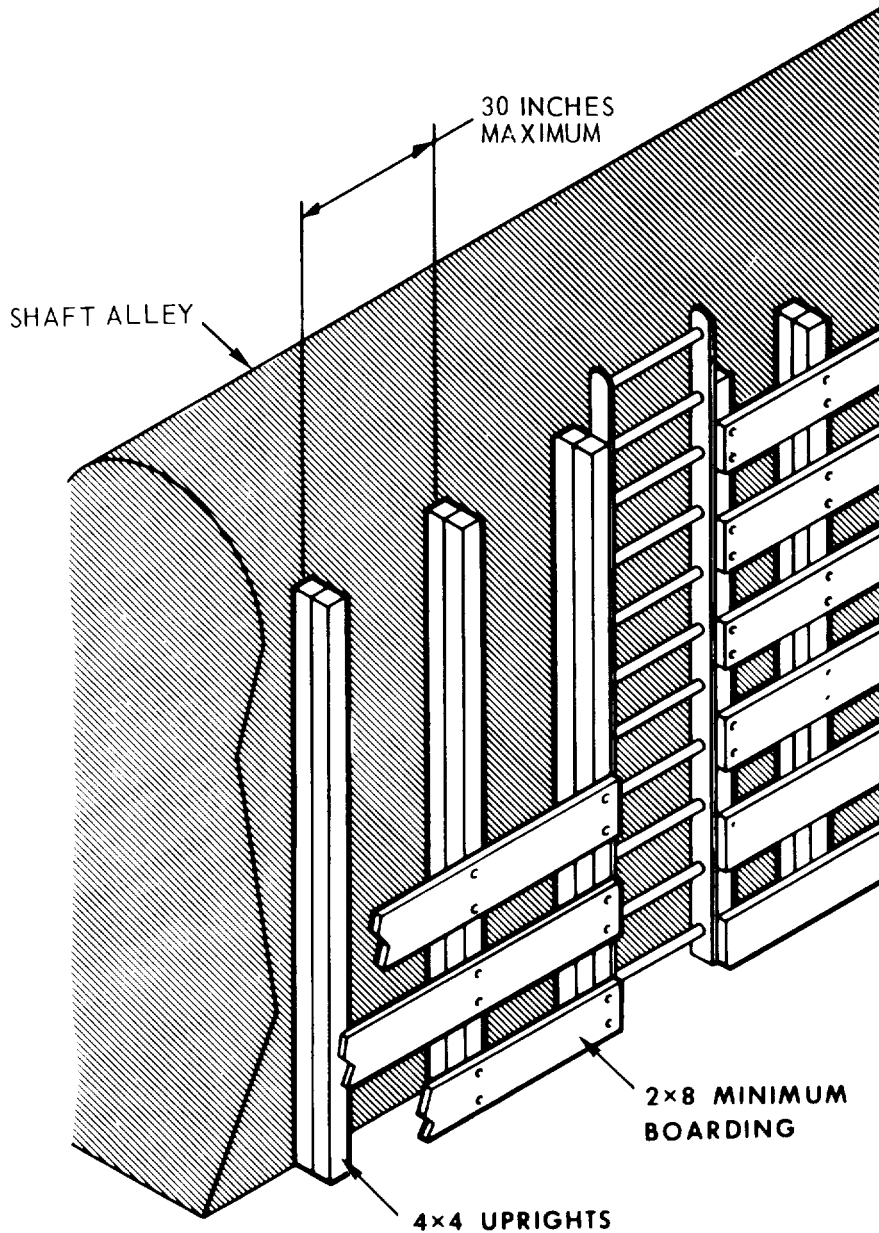


Figure 7-17. Construction details for nonheat securing structures against the shaft alley.

when dissimilarities exist in the packaging construction. This type of bulkhead is constructed of 2by 4-inch minimum uprights, not to exceed 30 inches in separation. Boarding should be a minimum of 1by 4-inch material secured alternately on both sides of the uprights and spaced not more than 6 inches apart. Full construction details for the partition bulkhead are shown in figure 7-18.

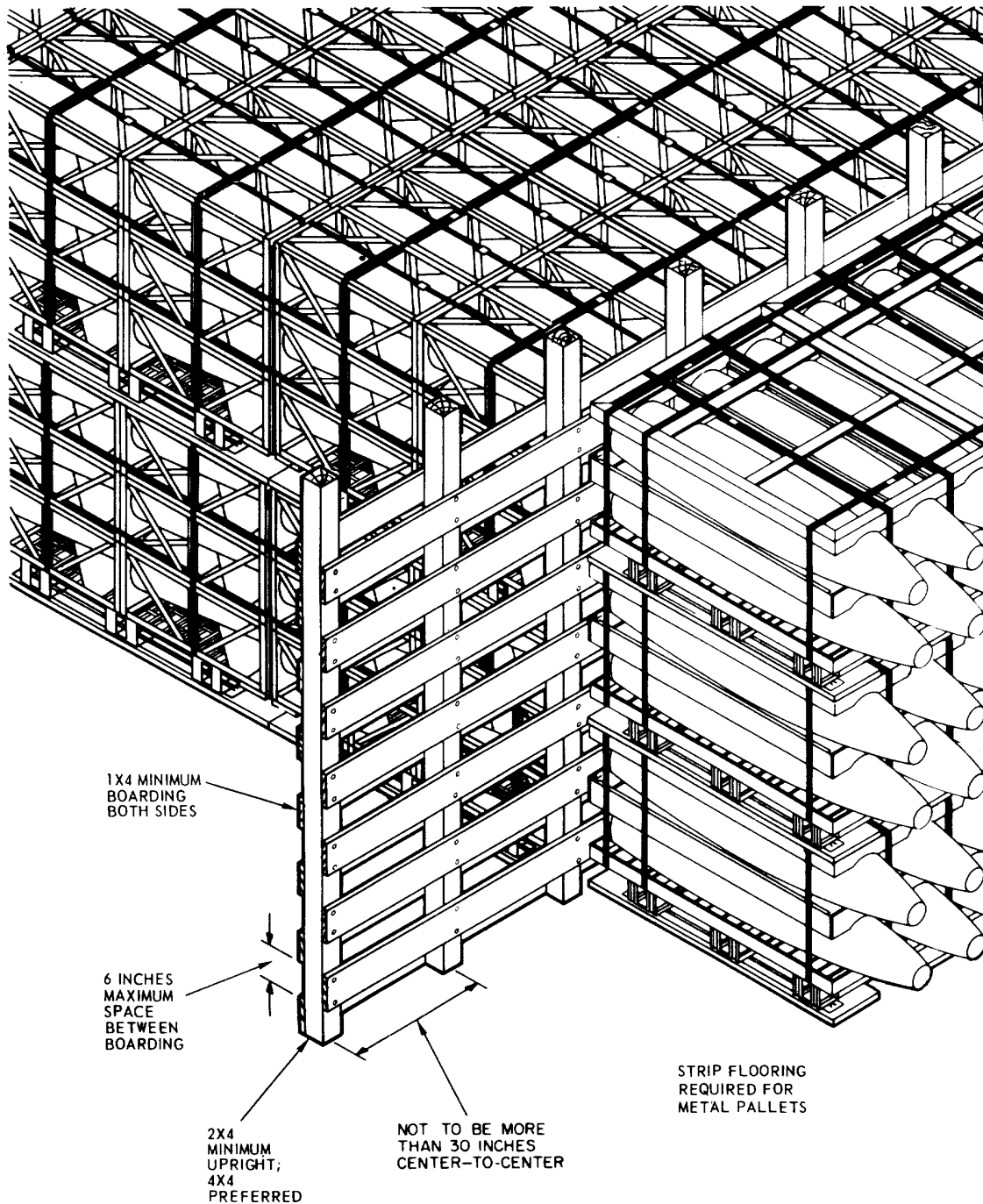


Figure 7-18. Construction details for partitions bulkhead.

## 7-6. Division Bulkheads

When the quantity of explosives stowed is insufficient to fill the hold or compartment completely, general cargo may be loaded in the remaining area, provided the explosives are completely separated from the general cargo by means of a division bulkhead, shown in figure 7-19. Federal regulations (46CFR146.29-11) currently require that commercial 2-inch boarding be secured on 4by 6-inch uprights spaced not to exceed 30 inches center-to-center for tween-deck compartments or holds and on 6by 6-inch uprights spaced not to exceed 24 inches center-to-center for lower holds. However, general shortages of 4by 6or 6by 6-inch stock often necessitate use of 4by 4-inch uprights in construction of the division bulkhead. Special exemptions are required in accordance with 46CFR, 146.02-25 and 49CFR107. Boarding may be of random widths, although 2by 12-inch lumber is preferred. A smooth surface, formed by edge-to-edge and butt-to-butt fitting of the boarding, always faces the explosives stowage. When use of 4by 4inch uprights is necessary, spacing must not exceed 24 inches on the tween decks or 16 inches in the lower holds. Construction details and recommended spacing with 4by 4-inch uprights are summarized in table 5-1.

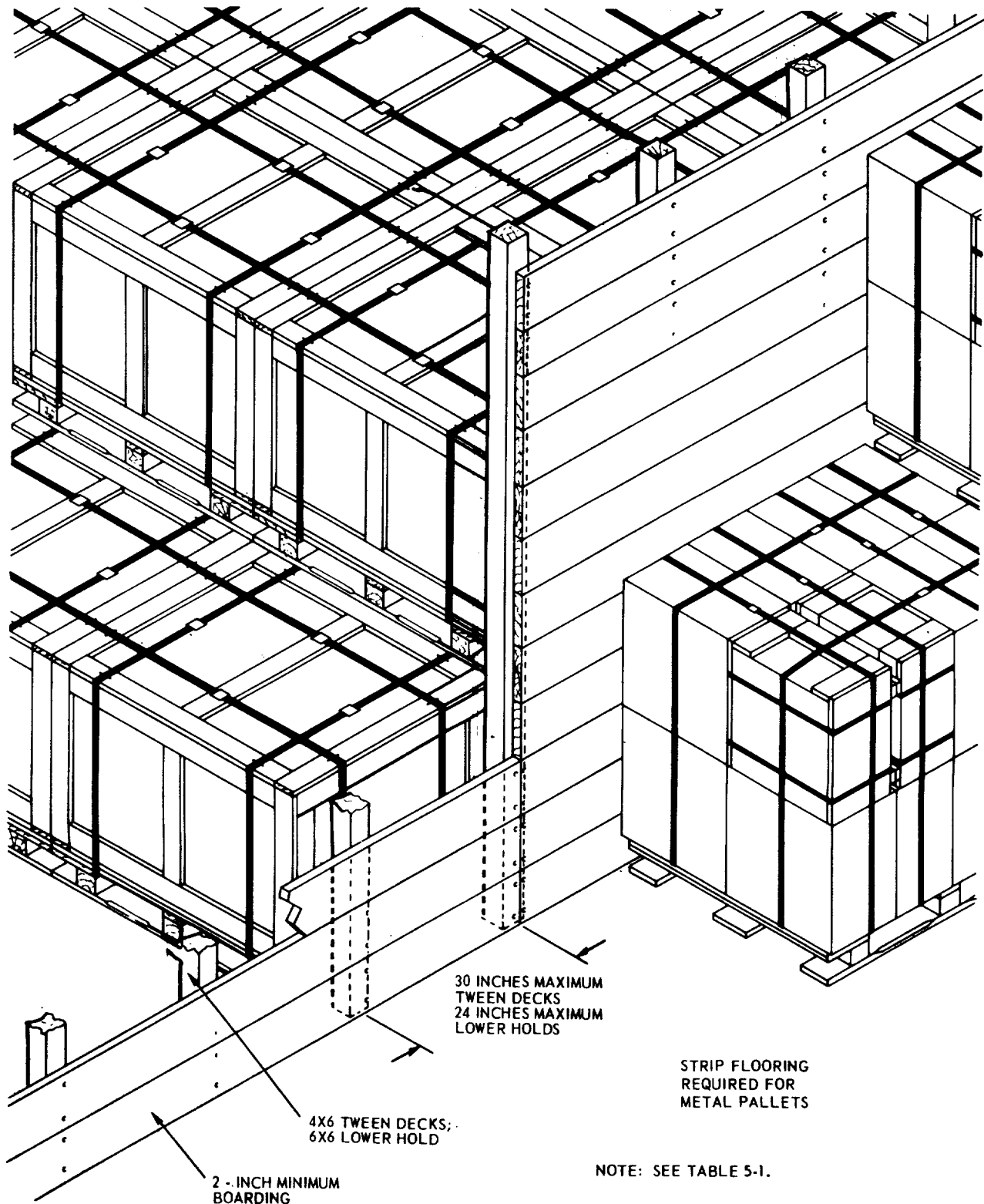
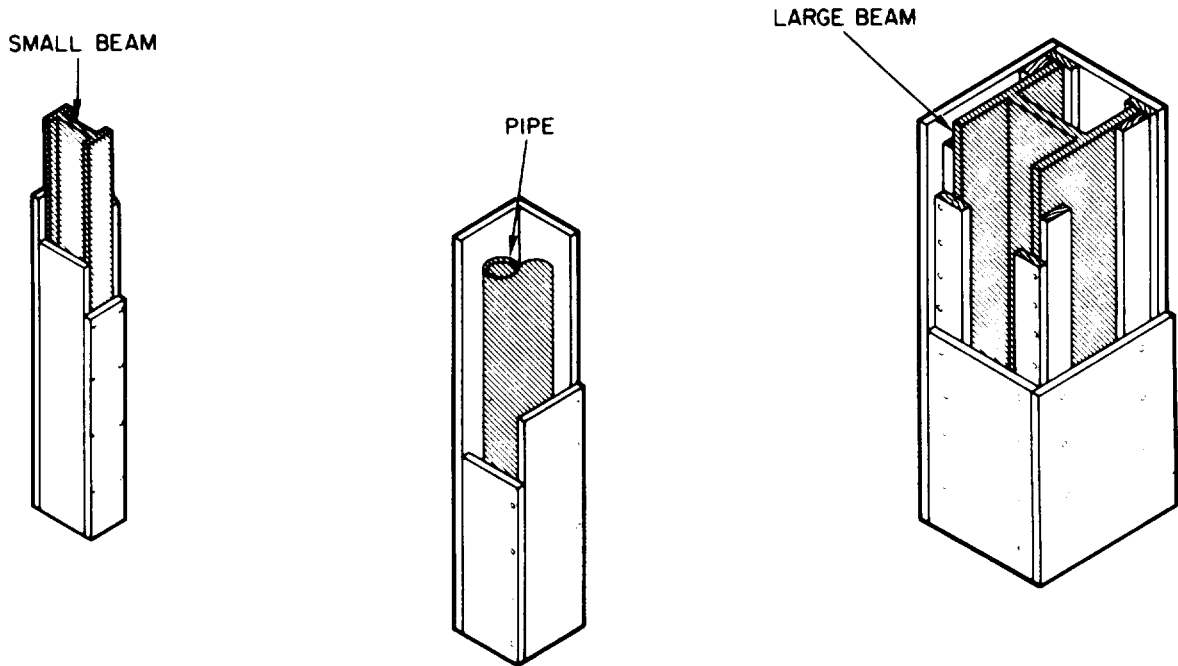


Figure 7-19. Construction details for division bulkhead.

**7-7. Encasement**

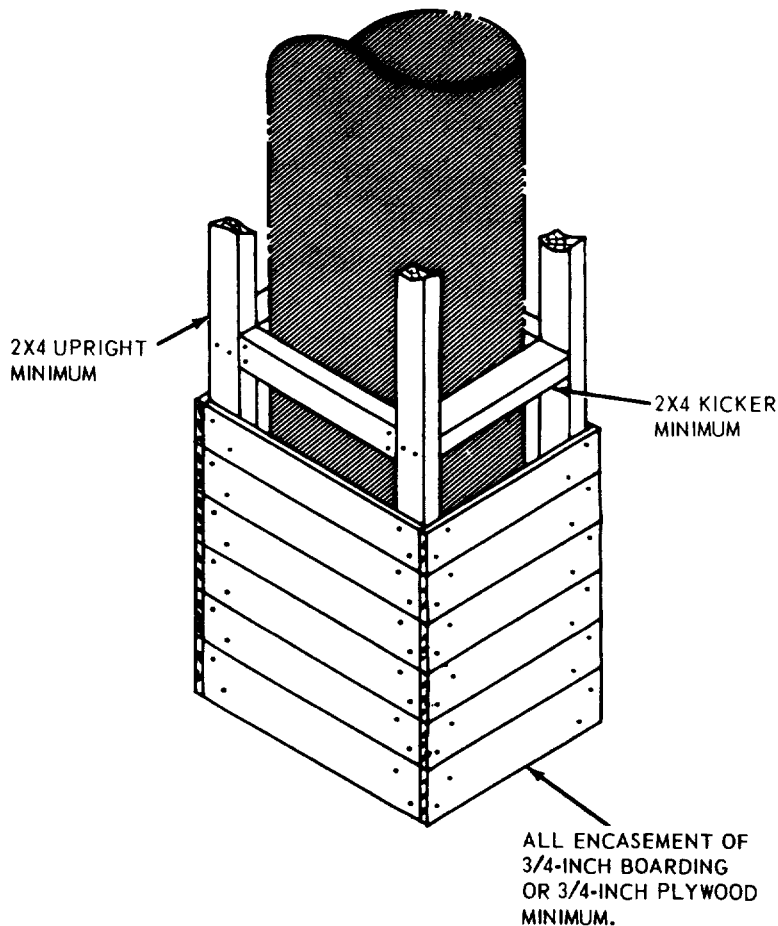
To prevent contact of the cargo with the ship's structures, such as beams, air vents, conduits, pipes, stanchions, and ladders, these structures may be covered or encased with wood material. Encasement may be either complete (boarding over) or partial. Requirements for complete encasement have been almost completely eliminated with the introduction of palletized cargo, but encasement is required by Federal regulation if the structure is located within an area intended for class "A" magazine stowage.

a. Complete Encasement. If a metal stanchion, ladder, or other obstruction is located within a class "A" magazine, the obstruction must be completely encased with wood at least 3/4-inch thick, secured with nails or countersunk screws. Figures 7-20 and 7-21 illustrate examples of such complete encasement.



NOTE: ALL ENCASEMENT LUMBER 3/4-INCH THICK MINIMUM, WIDTHS TO SUIT PARTICULAR APPLICATION.

**Figure 7-20. Complete encasement of beams and pipes.**



**Figure 7-21 Complete encasement of kingpost within class 'A' magazine.**

b. Partial Encasement. Provided the obstruction is not located within a class "A" magazine, partial encasement is used to protect the cargo. Encasement procedures vary slightly, based on whether the sweatboard-to-sweatboard or blockstowage method is employed.

(1) In the sweatboard-to-sweatboard method, obstructions such as ladders and stanchions are first encased as shown in figure 7-22. Unit loads are then stowed against the encased structure. Uprights are spaced around the obstruction, and each upright should provide a bearing surface for the cargo. Kickers of similar size stock and spaced not more than 36 inches apart are used to secure the uprights and unitize the structure. Partial encasement need not be constructed higher than the adjacently stowed unit loads; however, the structure or ladder should remain accessible and available for use, if necessary. If adjacent stowage of rectangular unit loads is intended, uprights and kickers should be constructed of minimum 2by 4-inch stock. Overhanging unit loads are accommodated by boarding of minimum 2by 6-inch lumber secured to the uprights at intervals compatible with the exposed surfaces of the cargo. Finally, the unit load is stowed tightly so that it contacts the encased structure. Figure 7-23 shows a typical partial encasement of a stanchion and ladder with a rectangular type of unit load. Also, partial encasement of an air vent is shown in figure 7-24.

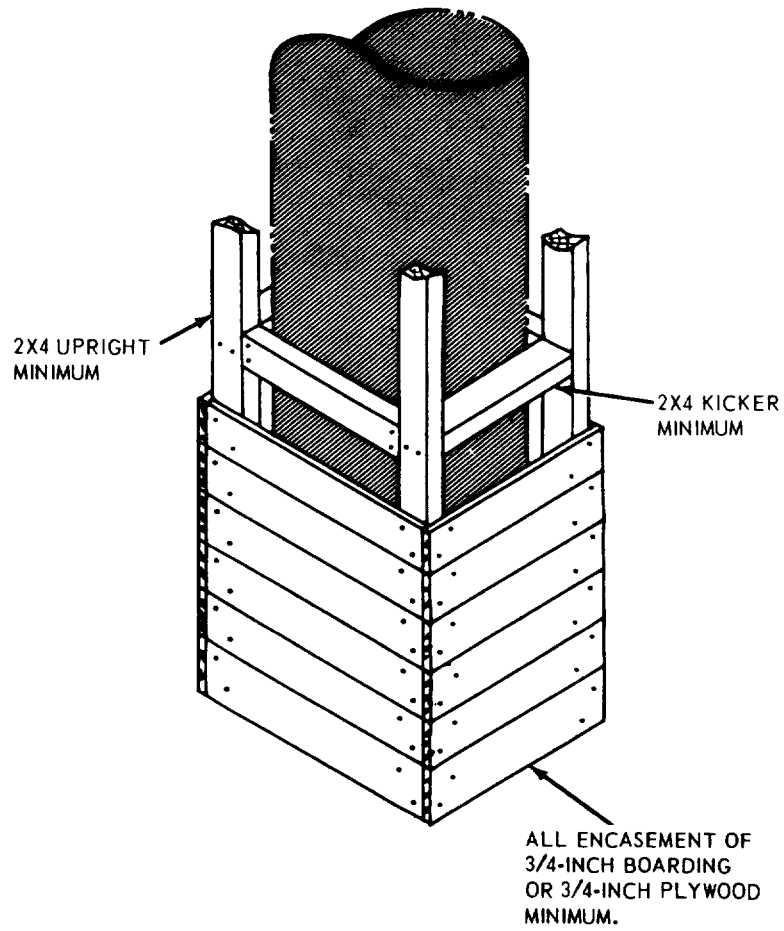


Figure 7-22. Partial encasement of ladder and stanchion.

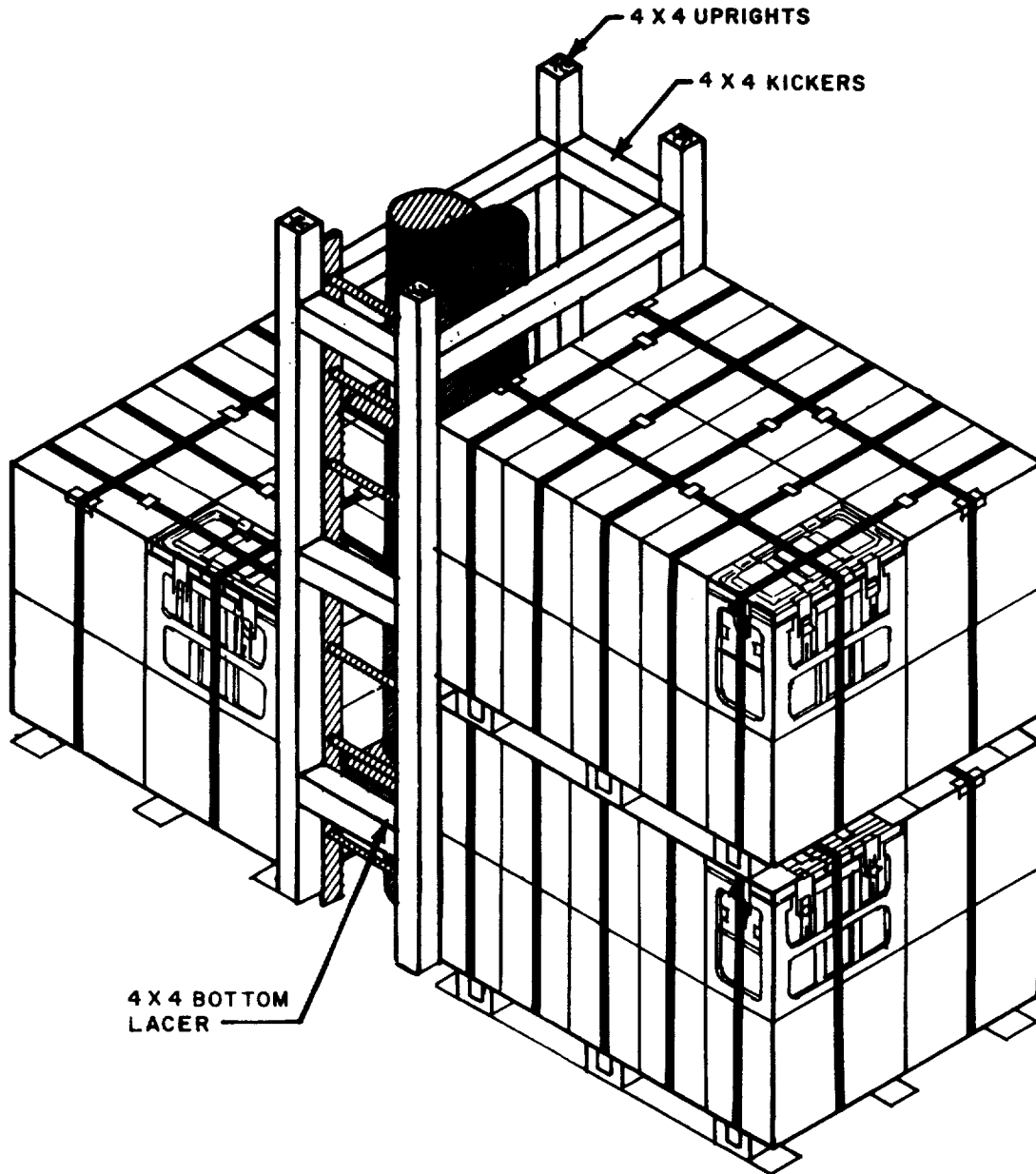
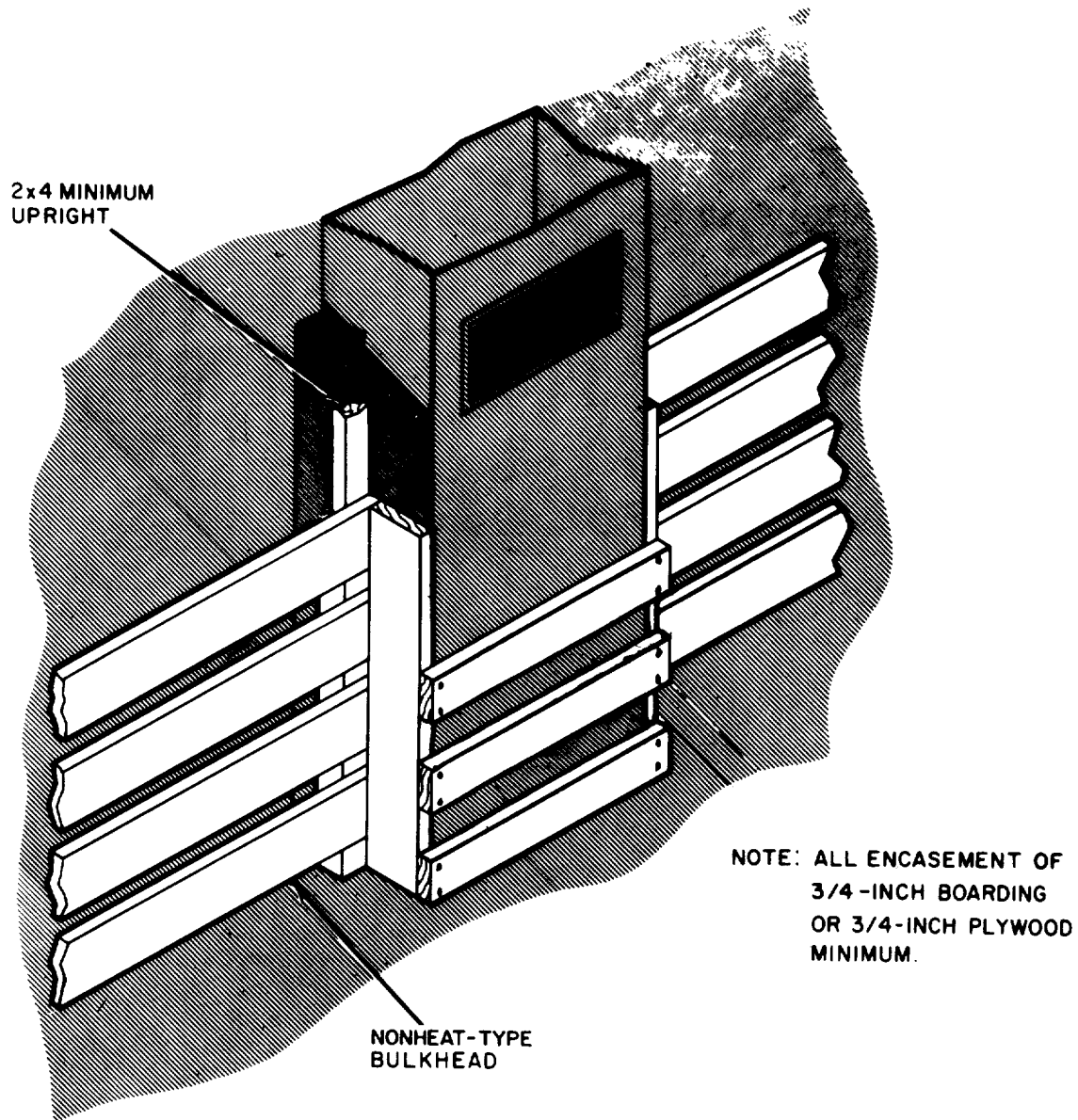


Figure 7-23. Rectangular unit toads emplaced around partially encased ladder and stanchions.





**Figure 7-24. Partial encasement of air vent.**

(2) When block-stowage methods are employed, compartment obstructions, such as ladders or stanchions, are not partially encased before emplacement of the unit loads. Instead, the cargo is stowed in block form around the obstruction and shored at a later time in the operation. An example of block-stow shoring of a ladder and stanchion near the hull is illustrated in figure 7-25. In actual practice, stowage of additional unit loads would continue before installation of shoring to achieve maximum stowage rates. Notice that neither the ladder nor the stanchion bear any cargo loading that might result from ship motions. Instead, all forces are transmitted to the ship's structures through the 4by 4-inch kickers. It should be emphasized that ship's structures, regardless of appearance, might not be structurally adequate for support of cargo loads. All stanchions and posts should be examined carefully and protected with full-block shoring, if necessary. In no case, however, should access ladders bear cargo loads of any type. Ladders are not intended as loadbearing structures, and failure under load could result in serious degradation of the stow.

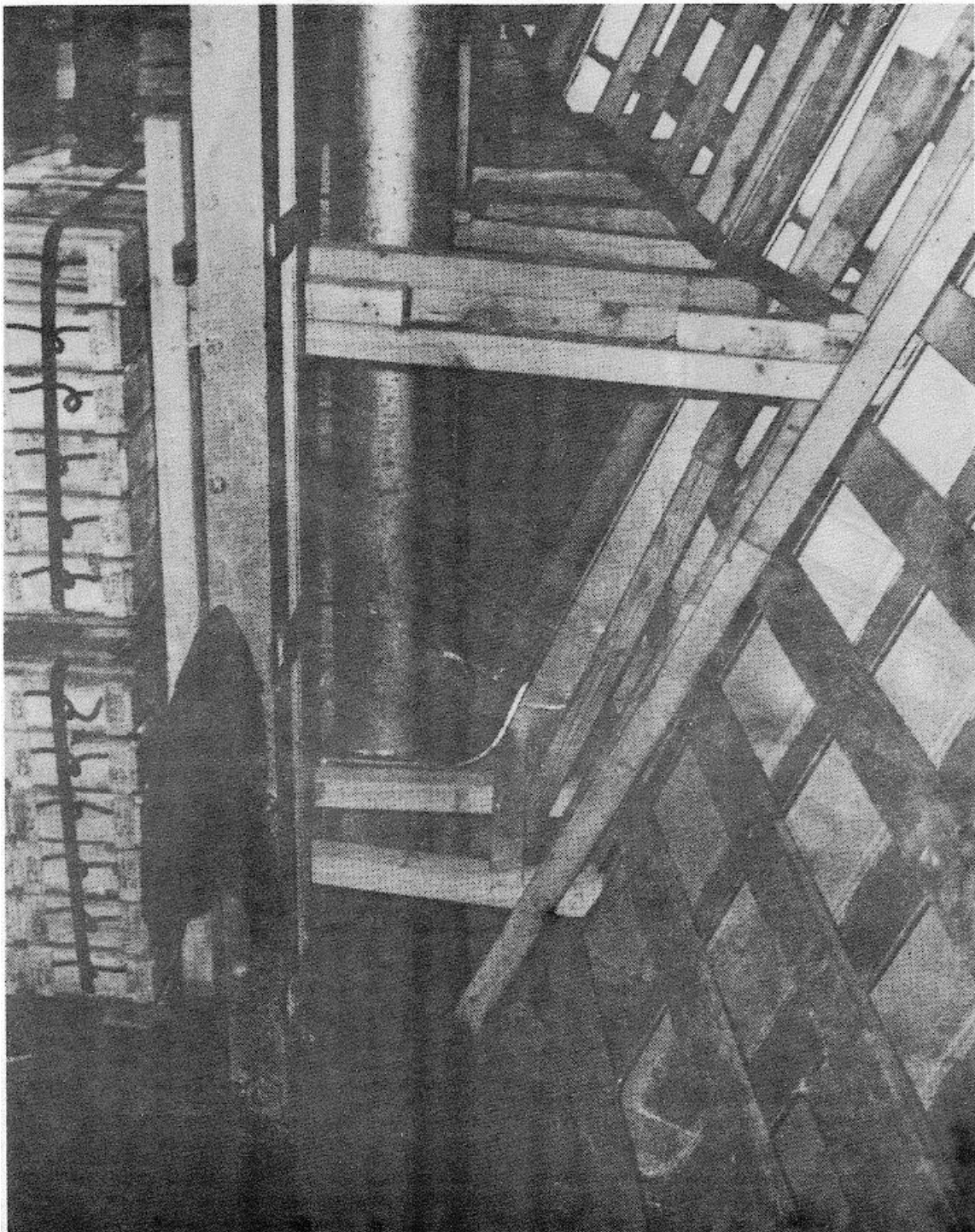
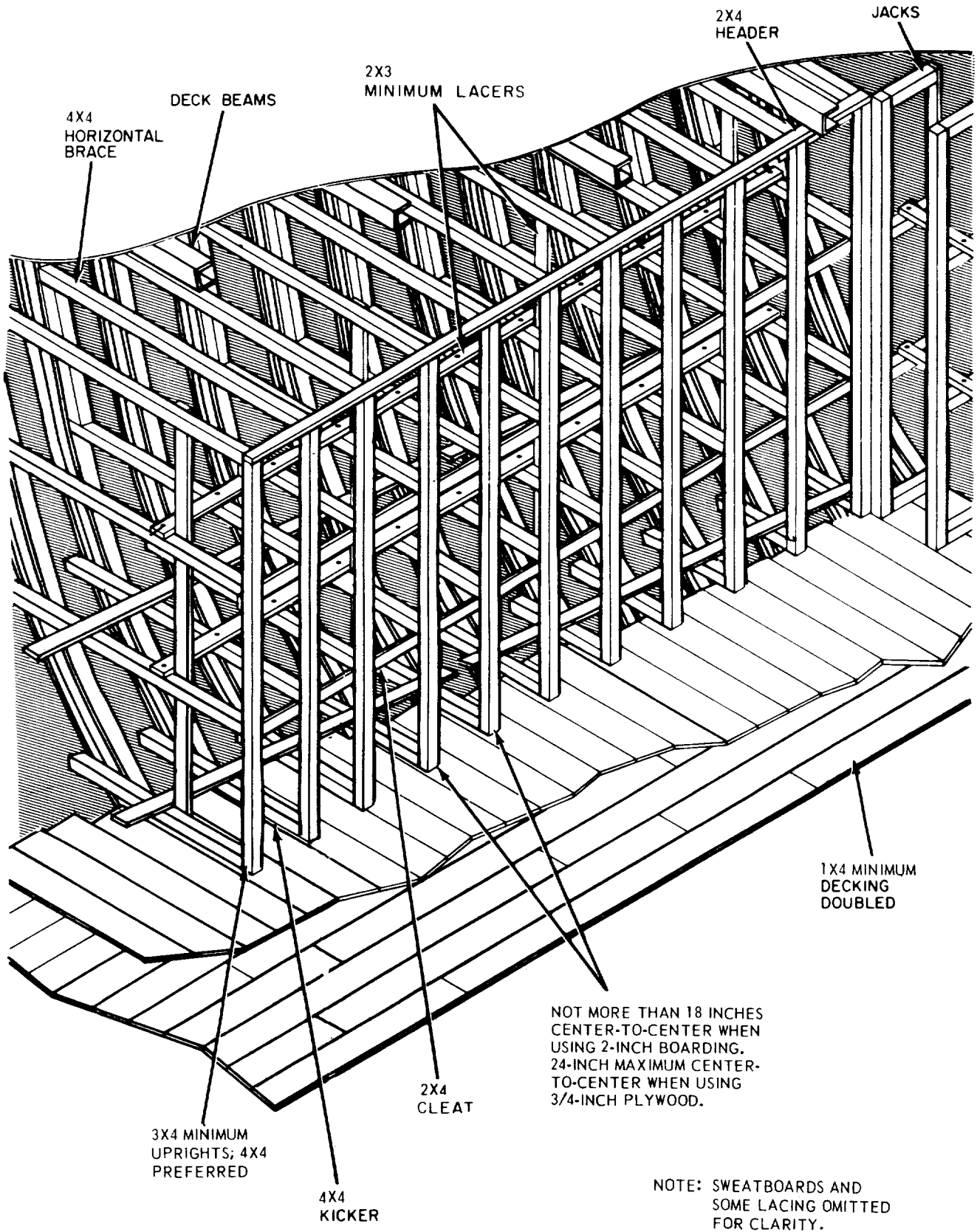


Figure 7-25. Block-stow shoring of typical obstructions near the hull (hull blocking technique).

## 7-8. Class "A" Magazine Stowage

Federal and US Coast Guard regulations specify certain classes of explosives to be stowed in special nonportable or portable structures, known as class "A" magazines, to ensure adequate segregation and protection of the stow. These magazines may be constructed of either steel or wood; full construction details are specified in 46CFR146.29-81 and 46CFR146.29-89. Based on the quantity and compatibility of explosives to be stowed, the magazine may be either nonportable or portable construction.

a. Class "A" Magazine (Nonportable). Figures 7-26 through 7-28 illustrate the construction of a class "A" magazine for stowage of commodities as required by the table in 46CFR146.29-100 and as summarized in paragraph 4-2 of this manual.



NOT MORE THAN 18 INCHES  
CENTER-TO-CENTER WHEN  
USING 2-INCH BOARDING.  
24-INCH MAXIMUM CENTER-  
TO-CENTER WHEN USING  
3/4-INCH PLYWOOD.

NOTE: SWEATBOARDS AND  
SOME LACING OMITTED  
FOR CLARITY.

Figure 7-26. Construction details for framework of class "A" magazine (nonportable)  
7-32

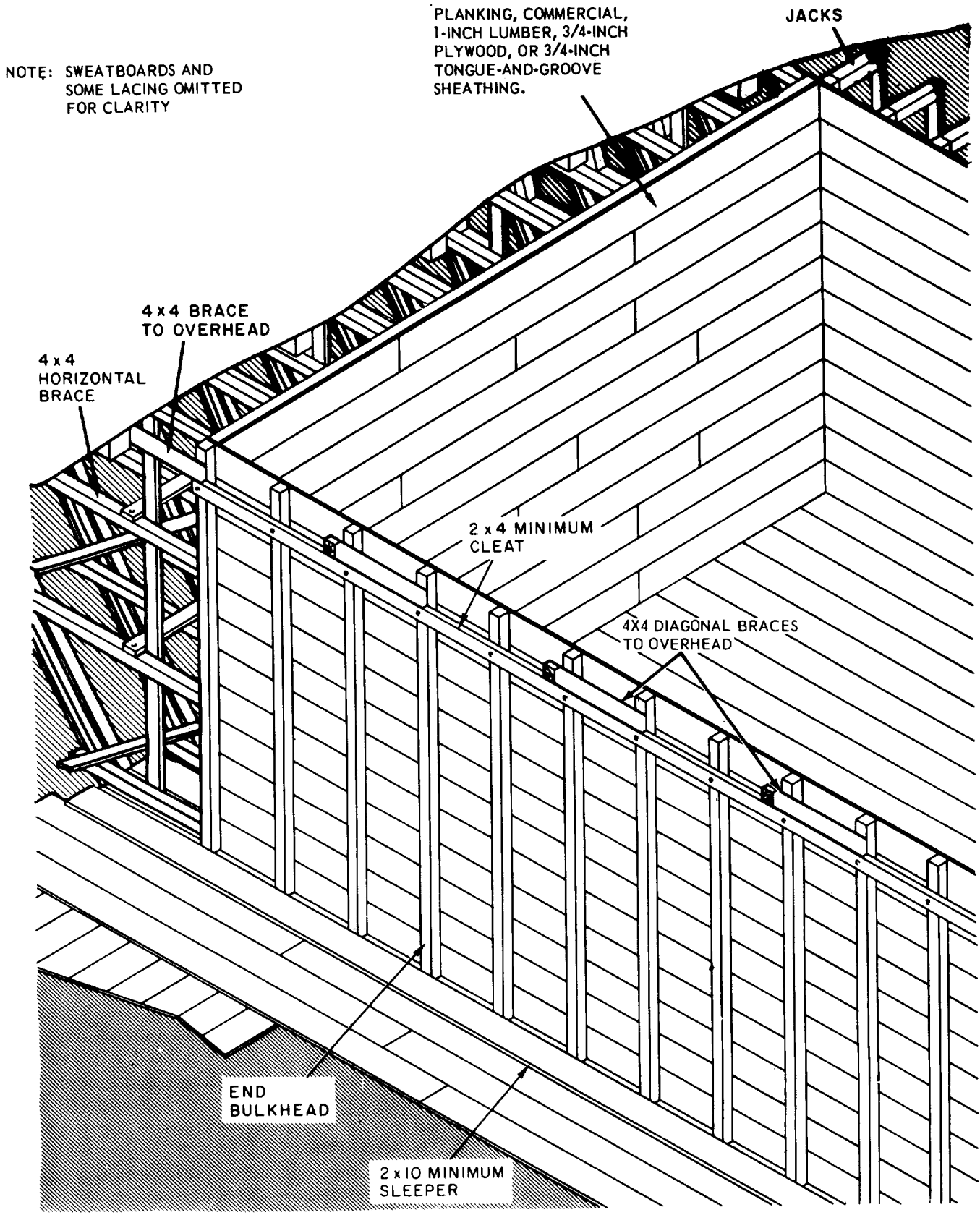
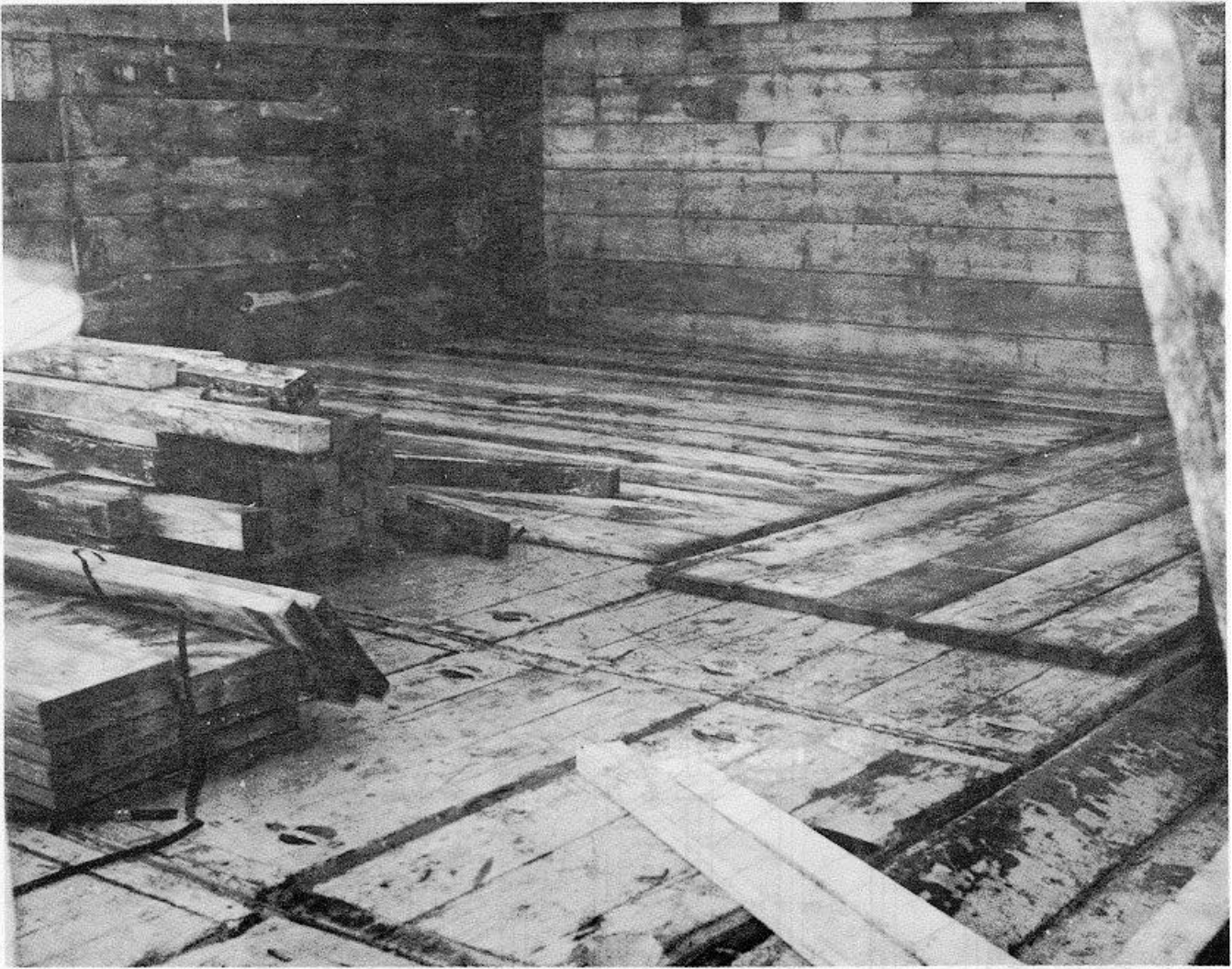


Figure 7-27. Construction details for side of class "A" magazine (nonportable)  
7-33



**Figure 7-28. Class 'A' magazine under construction (nonportable).**

(1) The complete boarding over (encasement) of all metal surfaces or structures is a basic requisite of magazine construction. The interior of magazines constructed of steel, therefore, must be entirely protected by wood at least three-fourths of an inch thick. All ship's structures within magazines constructed entirely of wood, including overhead beams or hatch coaming that is within 12 inches of the top of the stowed explosives, will also be boarded over. Bare steel decks within the magazine will be covered with a wooden floor consisting of at least two crosswise layers of commercial 1-inch lumber at least 4 inches wide. Existing decking needs to be covered with only one course of dunnage. All flooring should be fitted as close as possible, edge-to-edge and butt-to-butt.

(2) Figure 7-26 shows the construction details for the framework of a nonportable wooden class "A" magazine constructed along the side of a ship. The horizontal braces (kickers) extend to the hull plate, as shown, or to strip sheathing secured over the sweatboards. Spacing of the braces should not exceed 36 inches; however, the length of the braces will be determined by regulations governing the separation of the class of explosive from the ship's skin. For Coast Guard classes VIII and IXC, this distance should not be less than 8 feet. Uprights will not be stepped directly onto a metal deck; instead, a 2by 4-inch bearer is used to carry the uprights. The illustration shows that bearers are not required when wood decking is present. A 2by 4-inch header will be fitted between the overhead and the tops of the uprights.

(3) During construction, care should be taken to ensure that nails do not penetrate into the magazine and that the interior boards are fitted and finished to form a smooth surface. When a metal stanchion, post, or other obstruction is located



within the magazine, the obstruction must be covered completely with wood of at least 1/4-inch thick and secured with nails or countersunk screws.

(4) Figure 7-27 illustrates the construction of the sides of a class "A" magazine. Bulkheads that form the sides and ends are constructed of commercial 1-inch lumber, of 3/4-inch tongue-and-groove sheathing, or of 3/4-inch plywood. They are secured to uprights of at least 3by 4-inch stock, preferably 4by 4-inch stock, and spaced on 18inch centers. Uprights can be spaced on 24-inch centers if 1/4-inch plywood is used.

(5) When a class "A" magazine measures more than 40 feet in any direction, a partition bulkhead will be installed to divide the stowage area approximately in half. The bulkhead should extend from the deck to at least the top of the stow. Boarding should be alternately spaced not more than 6 inches apart on both sides of the uprights.

b. Portable Class "A" Magazine. Portable magazines are constructed for stowage of certain classes of explosives, as authorized by the provisions of 46CFR146.29-100. These magazines are constructed of wood or metal lined with wood at least 3/4-inch thick. Not more than 100 cubic feet of explosives plus 10 percent of explosives (gross) will be stowed in a portable magazine.

(1) Construction details of a portable class "A" magazine are shown in figure 7-29. When a portable class "A" magazine is to be constructed of wood, the general materials and dimensions used will not be less than those required for a nonportable-type "A" magazine. It is recommended that 4by 4-inch uprights be used exclusively in the construction of magazine runners, uprights, and cover support members. Spacing of uprights should not be more than 24 inches on centers if 4by 4-inch material is used. The magazine shell is constructed of a single course of minimum 1-inch commercial lumber, although 2-inch material is recommended for added rigidity. Plywood sheathing three-fourths of an inch in width or tongue-and-groove sheathing three-fourths of an inch is also acceptable for construction of the shell. All inner surfaces of the shell should be smooth and free of nails, screws, or other projections.

(2) After completion of the basic magazine, the magazine interior and cover are protected with a moisture barrier of polyethylene or waterproof paper at least four-thousands of an inch thick. The barrier material should be installed as a single piece; however, overlap of pieces is sometimes necessary. Water runoff will be directed toward the magazine exterior by overlapping of the bottom piece over the top piece as shown in figure 7-30. Portable magazines stowed in a hold where protection from the weather is not a factor do not require moisture-barrier construction.

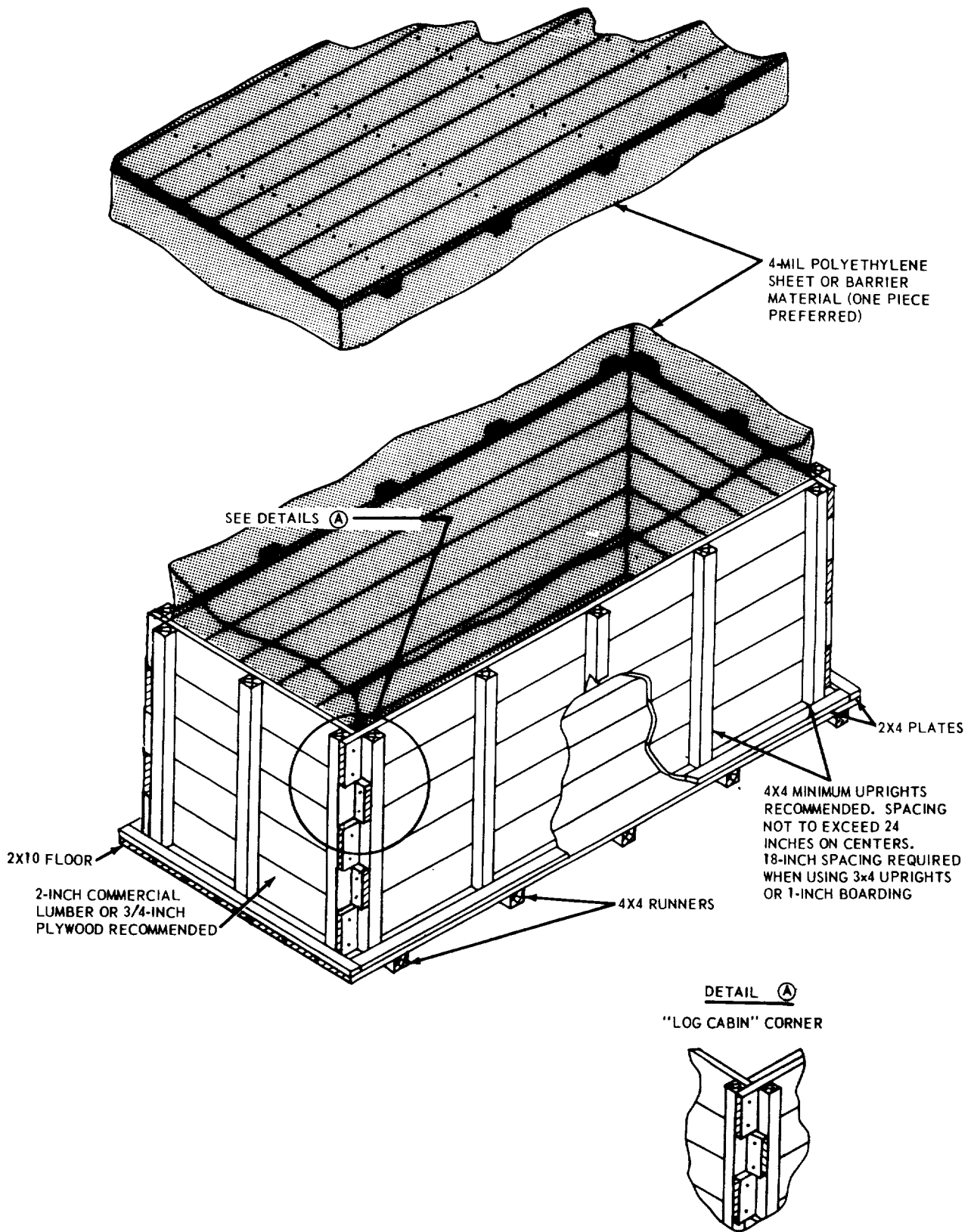


Figure 7-29. Construction details for portable class 'A' magazine.



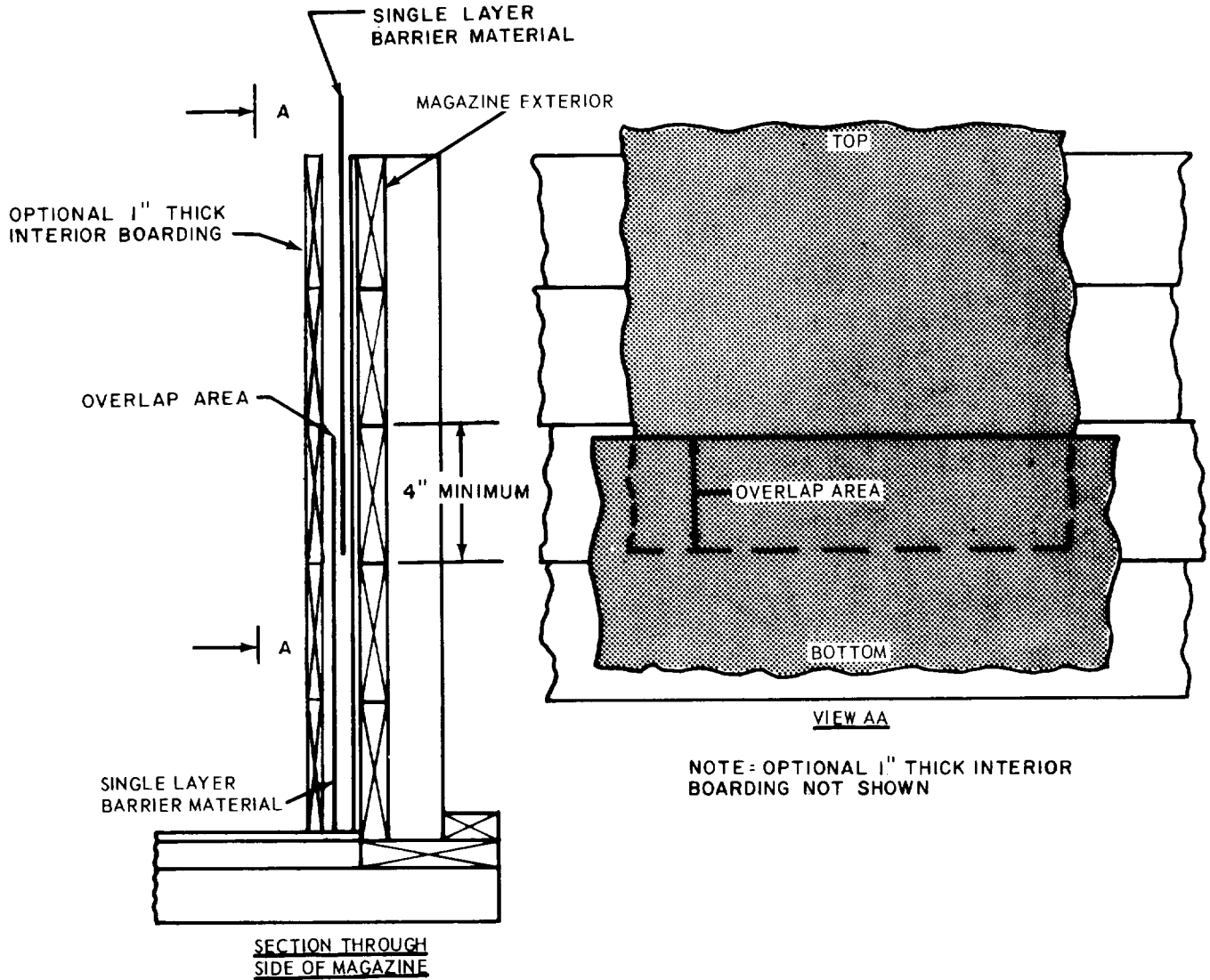


Figure 730. Installation of barrier material.

### 7-9. Tomming

The resultant motion initiated by the cyclic rising and falling action of a ship's bow and stern produces acceleration forces in the vertical direction, which can be significant in securing considerations. In addition, these forces complement the across-the-deck roll forces when the ship rolls away from the vertical. Vertical forces encountered in a marine shipment are often of such low magnitude that securing to resist resultant cargo motion is unnecessary. Palletized and skidded unit loads are not usually secured to resist vertical motion. However, light items, shock-sensitive items, and certain loose, cylindrical items that are susceptible to "riding up" on each other in heavy seas require overhead securement known as tomming. Tomming is accomplished by tying down the cargo to the ship's overhead structures. Overhead bracing frequently uses the A-frame to provide vertical securement. Strips of lumber are laid on the stowed items and serve as the foundation for the A-frames, thereby also providing a means for preventing the "riding up" of adjacent items.

a. Figure 7-31 illustrates the construction details for A-frame tomming. To prevent excessive flexing of the frame members as the height of the structure increases, the required lumber must be similarly increased. In most cases, 2by 6-inch stock will be used to construct the A-frame. When the height of the overhead exceeds 10 feet, the legs of the frame shall be constructed of 4by 4-inch lumber. The angle of the frame (as measured between legs at the vertex) should not exceed 45°. Legs of the A-frame that are greater than 3 feet in length

must be joined with crossmembers. When the length of a leg does not exceed 6 feet, a single crossmember may be used and secured equidistant from either end of the joined legs. Legs that are greater than 6 feet in length will be joined by two crossmembers secured at points one-quarter of the length of the leg from either end. The frames are fastened to double 1 by 6-inch or single 2 by 6-inch lumber strips placed over the cargo. Adjacent A-frames may be unitized by means of 2 by 6 or 2 by 3-inch horizontal lacers.

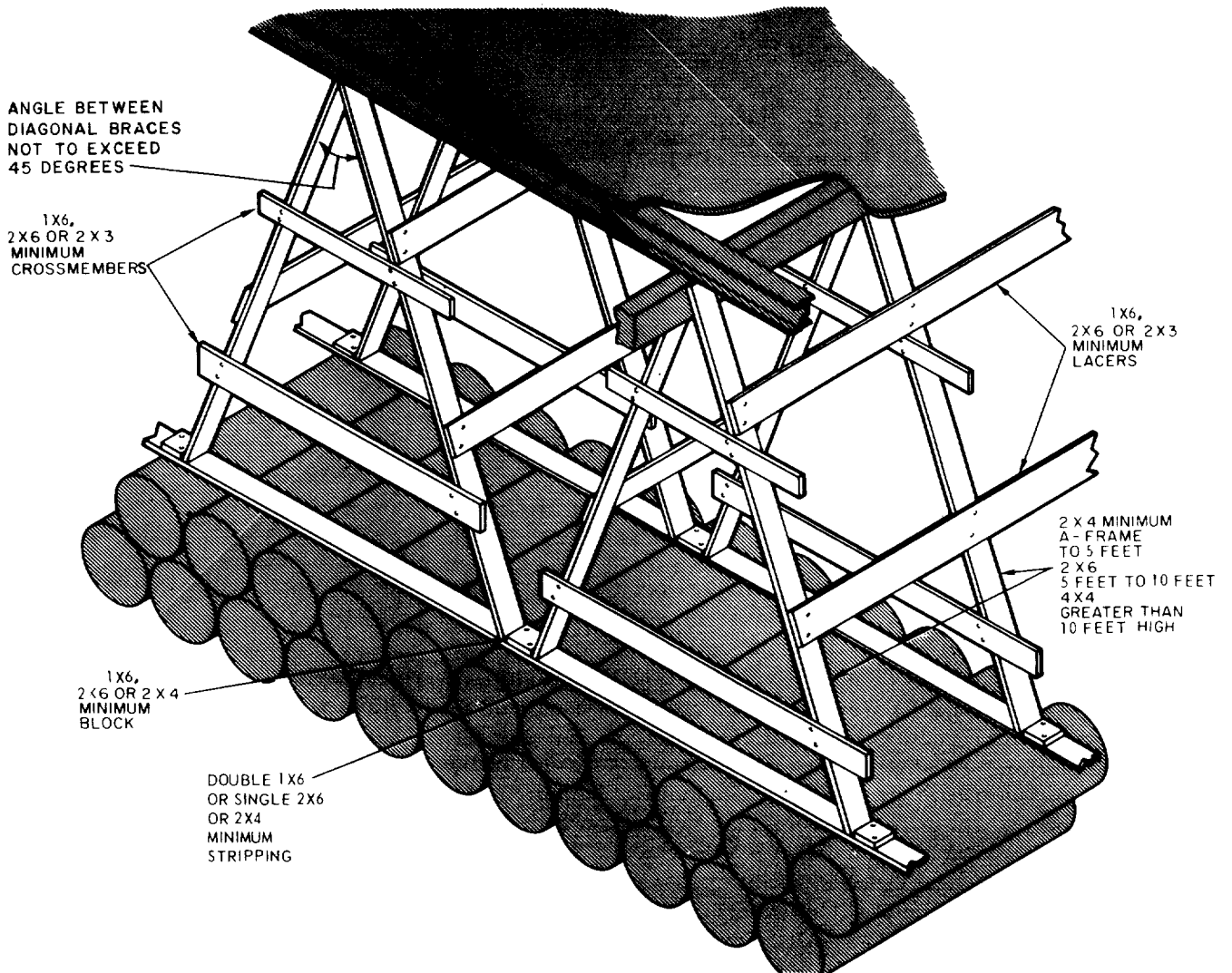


Figure 731 Construction details for overhead A-frame tomming.

b. Construction details for A-frame tommying under tween-deck hatch beams are illustrated in figure 7-32. While hatch boards are infrequently encountered, the techniques described are valid and applicable. Load-bearing sections of the A frame are constructed of 2-inch lumber; however, 1-inch material is acceptable for stripping purposes.

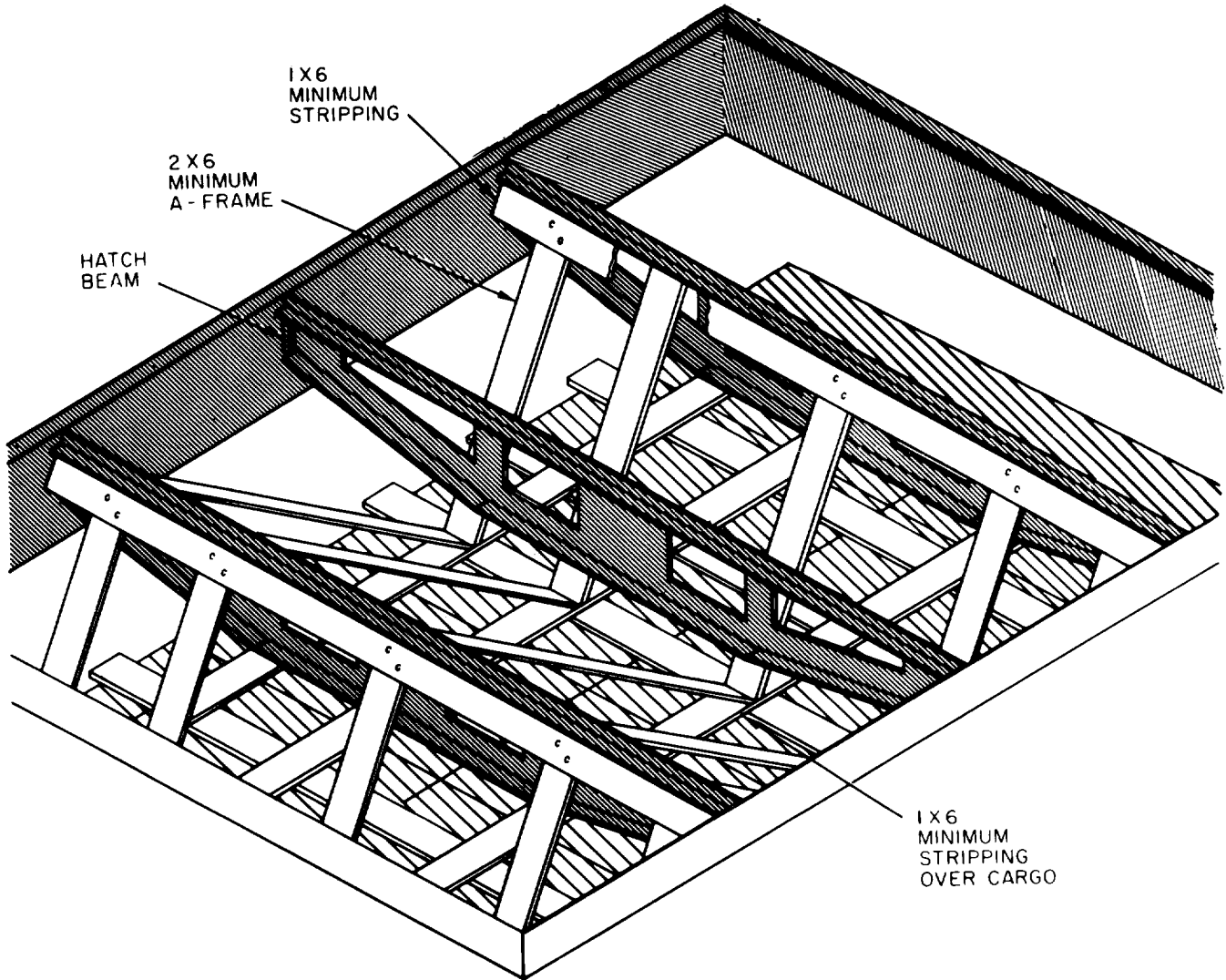


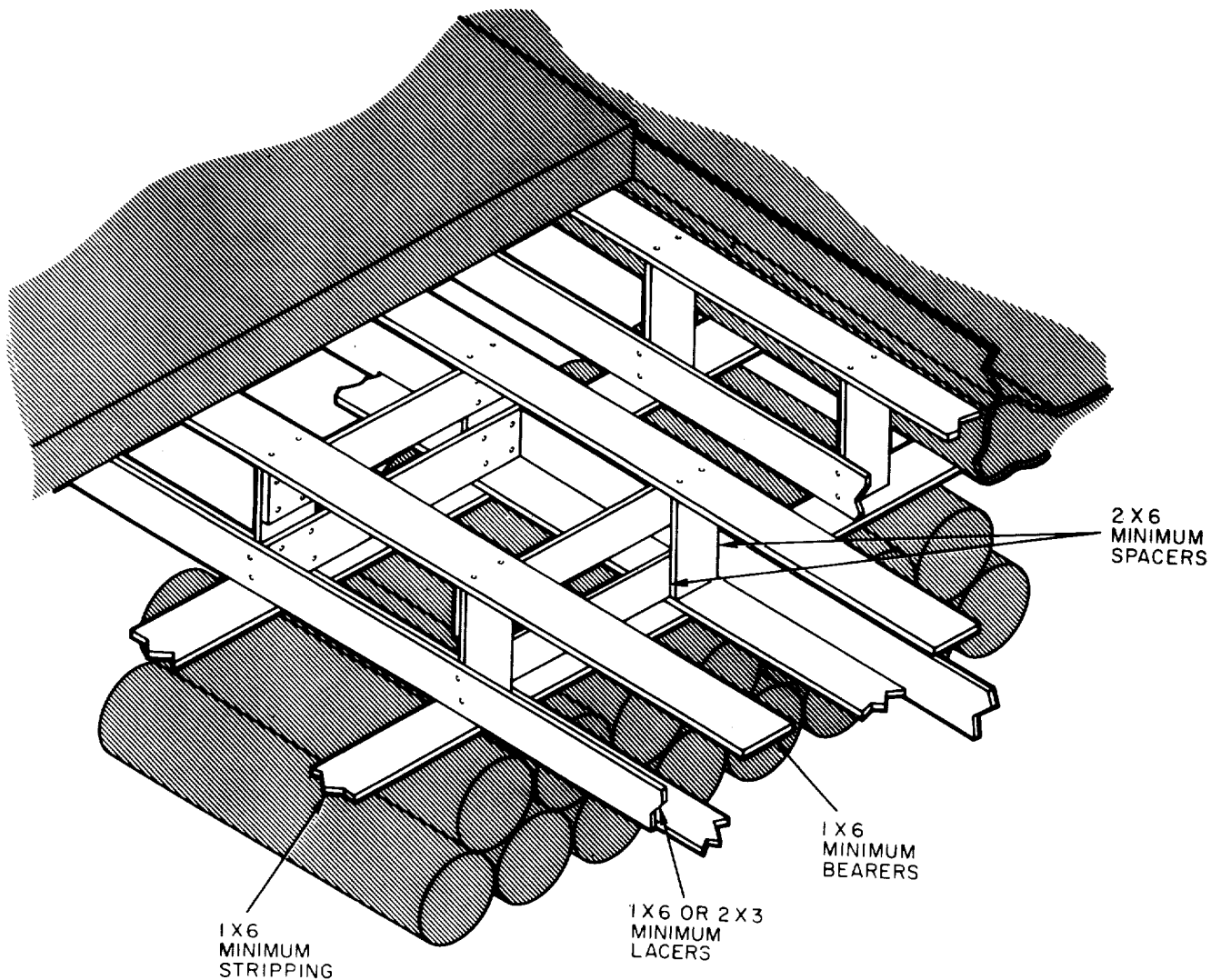
Figure 7-32. Construction details for A-frame tommying under tween-deck hatch beams.

c. Cargo stowed in the square of the hatch can be topped as shown in figure 7-33. The hatch cover must then be locked in place to provide the overhead support for the topping structure.

**7-10. Stepping Down a Load**

a. In some cases, particularly in the upper tween decks when vessel loading is near completion, it may be necessary to fill the hatch completely, because of the lack of sufficient cargo. This action will reduce the number of tiers or layers of cargo as the stow progresses toward the center of the compartment. This technique is generally known as "stepping down."

b. Normally, the stowing process will proceed simultaneously from the fore and aft bulkheads and the wings toward the center of the hatch. If the stepping-down procedure is to be employed, a securing structure that is similar in construction to a partition bulkhead is erected by positioning 4by 4-inch uprights against the tiered unit loads near each end and lacing these ends with 2by 3-inch or wider material. The unit load is then placed against the uprights, and the stow proceeds to completion in this manner. The central areas are loaded last, with remaining smaller or irregularly shaped unit loads. Full-block securing is used to shore any void remaining in the stow. Based on the volume or weight of the cargo in the multiple tiers or layers behind the step-down structure, the structure may need to be braced with diagonal members for added support.



**Figure 7-33. Construction details for topping in square of hatch.**

c. Figures 7-34 and 7-35 illustrate the stepdown principle. Effective preload planning is evident in the efficient use of deck space in the center of the compartment with the remaining cargo.

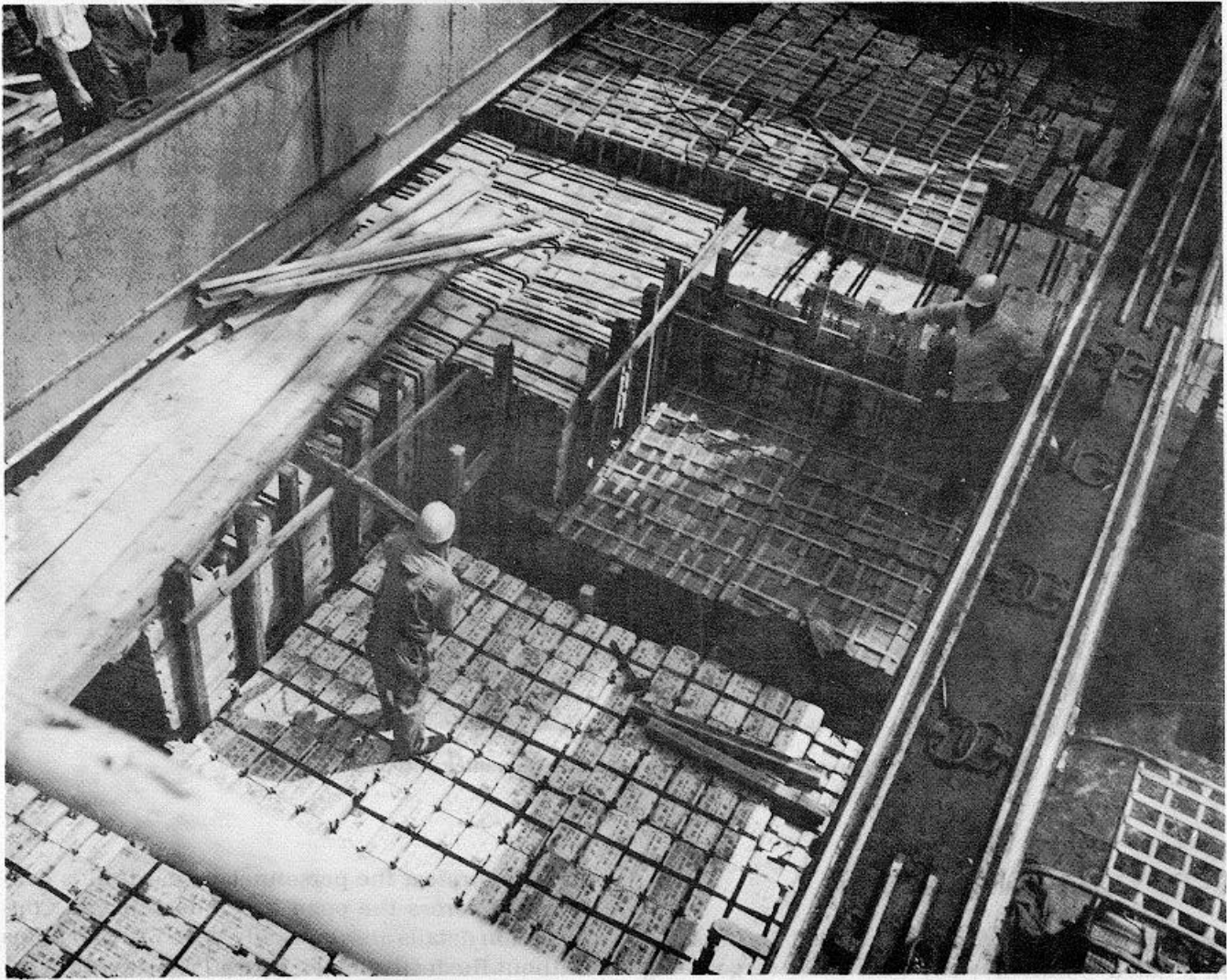
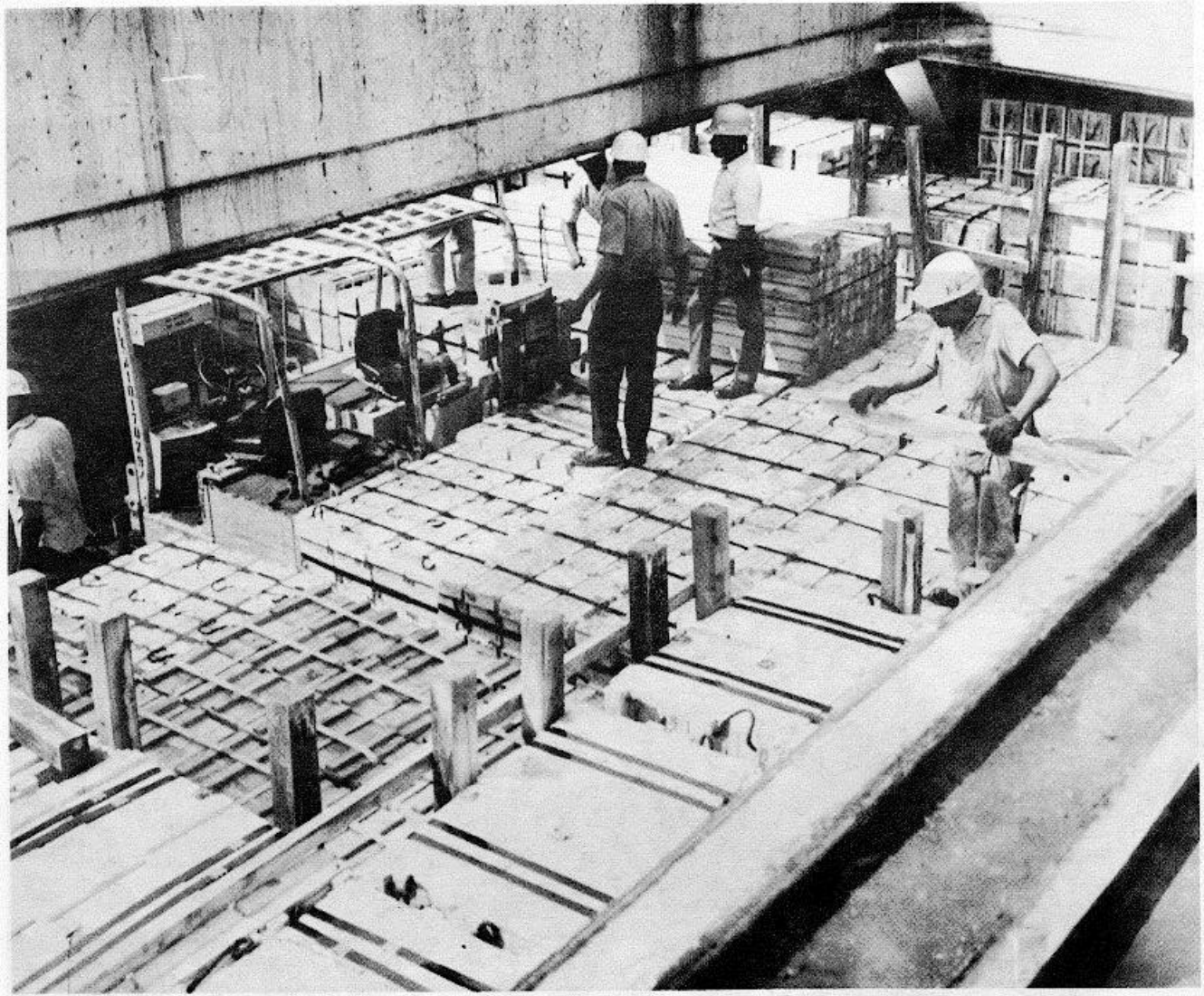


Figure 7-34. Stepping down toward center of compartment.

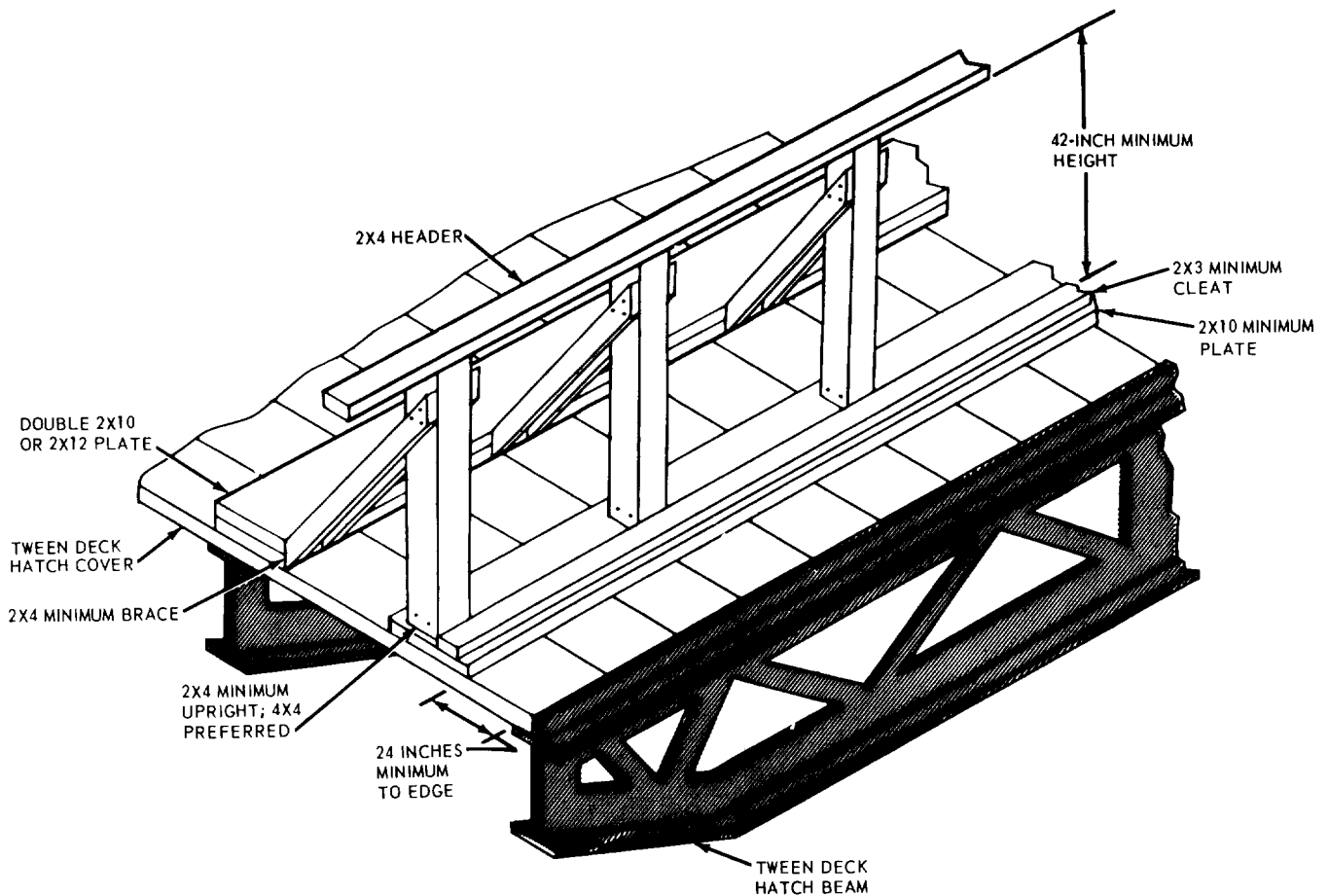


**Figure 735. Completion of stow with smaller unit loads.**

#### **7-11. Open-Hold Guardrail**

Military explosives will not be loaded or unloaded in a hatch simultaneously with other cargo being worked in any hold served by that hatch. In addition, all tween-deck hatch covers must be in place before cargo can be worked in a compartment below which military explosives are stowed. In some cases during the loading of a ship, however, personnel may be required to be present in a higher tween deck hold; for example, to assemble prefabricated structures or to install preload dunnaging while loading operations are proceeding in the next lower level. To protect the personnel, a guardrail is constructed across the open tween-deck hatch. Construction details are shown in figure 7-36 for ships without flush steel hatch covers. The guardrail extends the full width of the hatch and is located a minimum of 2 feet from the edge of the open hold. A minimum rail height of 42 inches above the hatch boards is required. The double 2by 10-inch plate at the base of the bracing acts as a positive stop for forklifts that might inadvertently move toward the open hatch. For ships with flush steel hatch cover, a wire rope or net safety barrier should be constructed.





**Figure 7-36. Construction details for open-hold guardrail.**

**7-12. Deck-Stow Securing**

Unit loads designated for deck stowage must be protected from direct rays of the sun and exposure to the elements. When the explosives container is of such construction as to provide adequate protection, an open deck-stow structure is allowed. Other more sensitive items are required to be stowed in closed structures. Compatibility of the explosives within the deck-stow structure shall conform to the specifications designated by 46CFR146.29-99 and 146.29-100. The construction site on deck must not be within 20 feet of an incinerator or ash hoist or other heat or spark-generating source.

a. Construction details for a closed deck-stow structure are illustrated in figure 7-37. The structure is fabricated mainly of 2-inch lumber and is securely braced to adjacent, permanent ship's structures. Random lengths of at least 1by 6-inch lumber are laid on the metal deck to elevate slightly the entire structure to permit deck water to drain. Runners of 4by 4-inch stock are laid directly on the deck boards and form the foundation of the structure. Construction proceeds in a similar manner to that of a portable class "A" magazine. A course of 2by 10-inch minimum flooring is laid and securely nailed to the 4-by 4-inch runners. The walls of the structure are constructed of 2-by 6-inch minimum lumber and are secured to 4by 4inch uprights. Suitable waterproof barrier material is used to line the interior of the structure. After the stow is emplaced and is covered with barrier material, a single course of 2-by 6-inch minimum runners, spaced at intervals not to exceed 6 inches, is laid on top of the barrier material. The top of the structure, constructed of 2-by 10-inch minimum lumber, is installed and securely nailed to the side structures and to the 2-by 6-inch runners. Finally, if a catwalk is required, it is constructed for access to either side of the stowage area. After sufficient 4-by 4-inch blocking is installed to adjoining coamings or bulwarks, the entire structure is vertically restrained and unitized by means of 1/2-inch cables

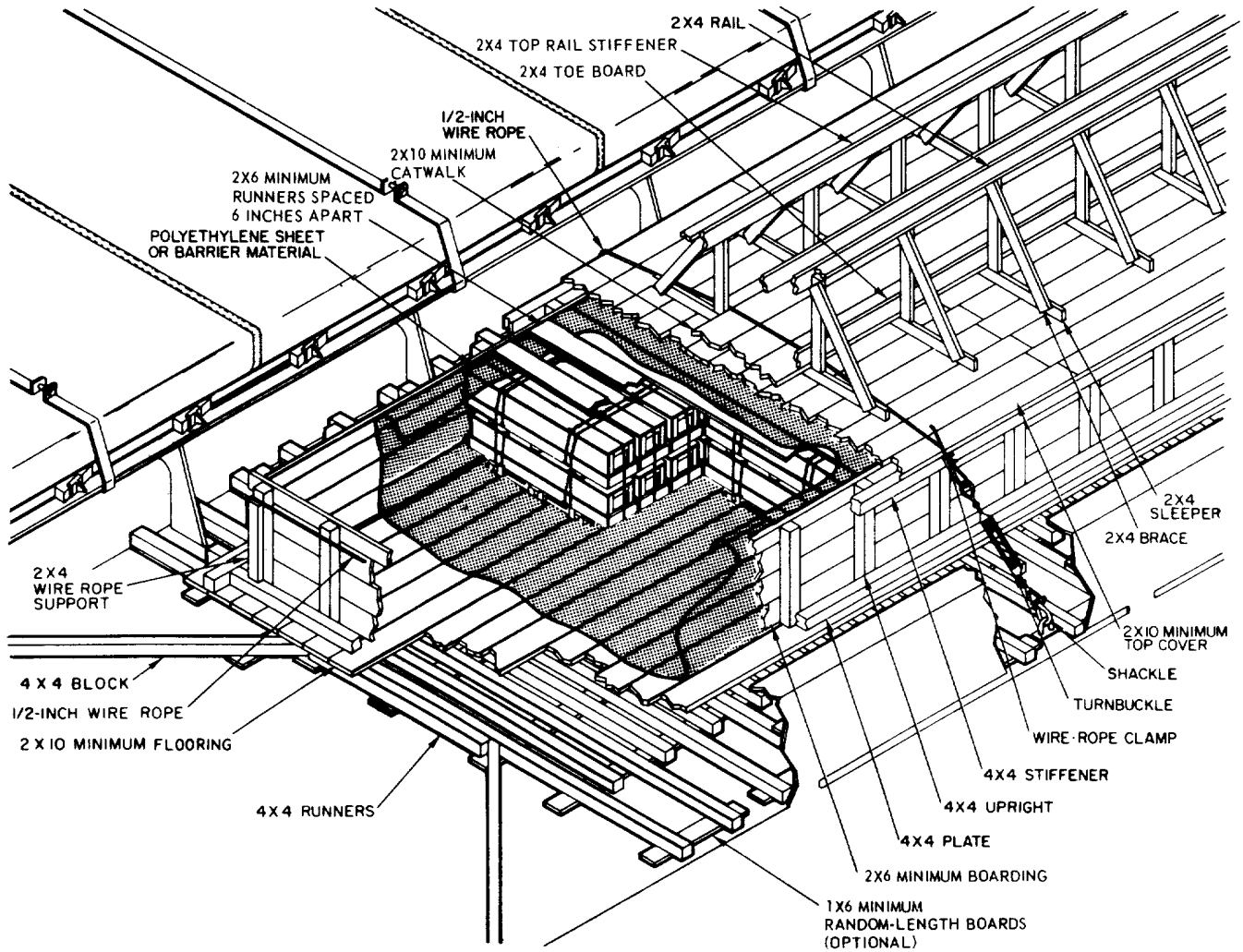
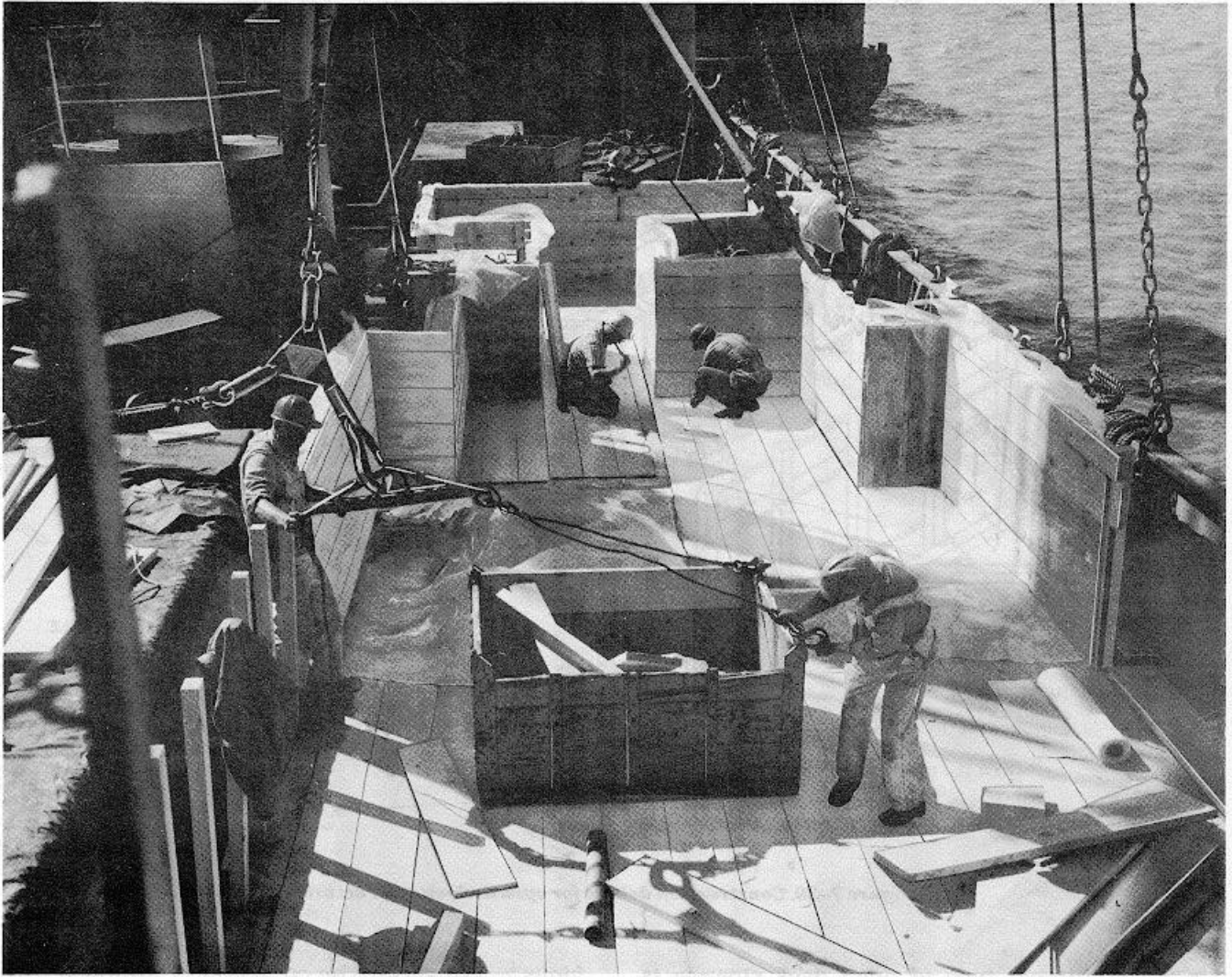


Figure 7-37. Construction details for closed deck-stow structure.

passed over the construction and secured with turnbuckles. Only appropriate padeyes or lashing points will be used for this purpose; guardrails or other structures not specifically designated as lashing points will not be used. A closed deck-stow structure under construction is illustrated in figure 7-38.





**Figure 7-38. Typical closed deck-stow structure under construction.**

b. In figure 7-39, the cargo is packaged in containers, thereby providing adequate protection from the environment; consequently, an open deck-stow structure is used. Open-type construction is sufficient and consists of 2by 10-inch minimum horizontal stiffeners and 4by 4-inch uprights. Bearing plates of 4by 4-inch stock are laid along the uprights at the deck to provide a surface to which 4by 4-inch bracing members may be extended from adjacent, permanent ship's structures. Bracing should be elevated as in the closed structure to permit deck wash drainage. The interior of the stowage area does not need to be floored if the unit loads have been palletized on wooden skids. For metal pallets, 2by 10-inch minimum flooring is installed over and nailed to 4by 4-inch runners laid on 10-inch centers.

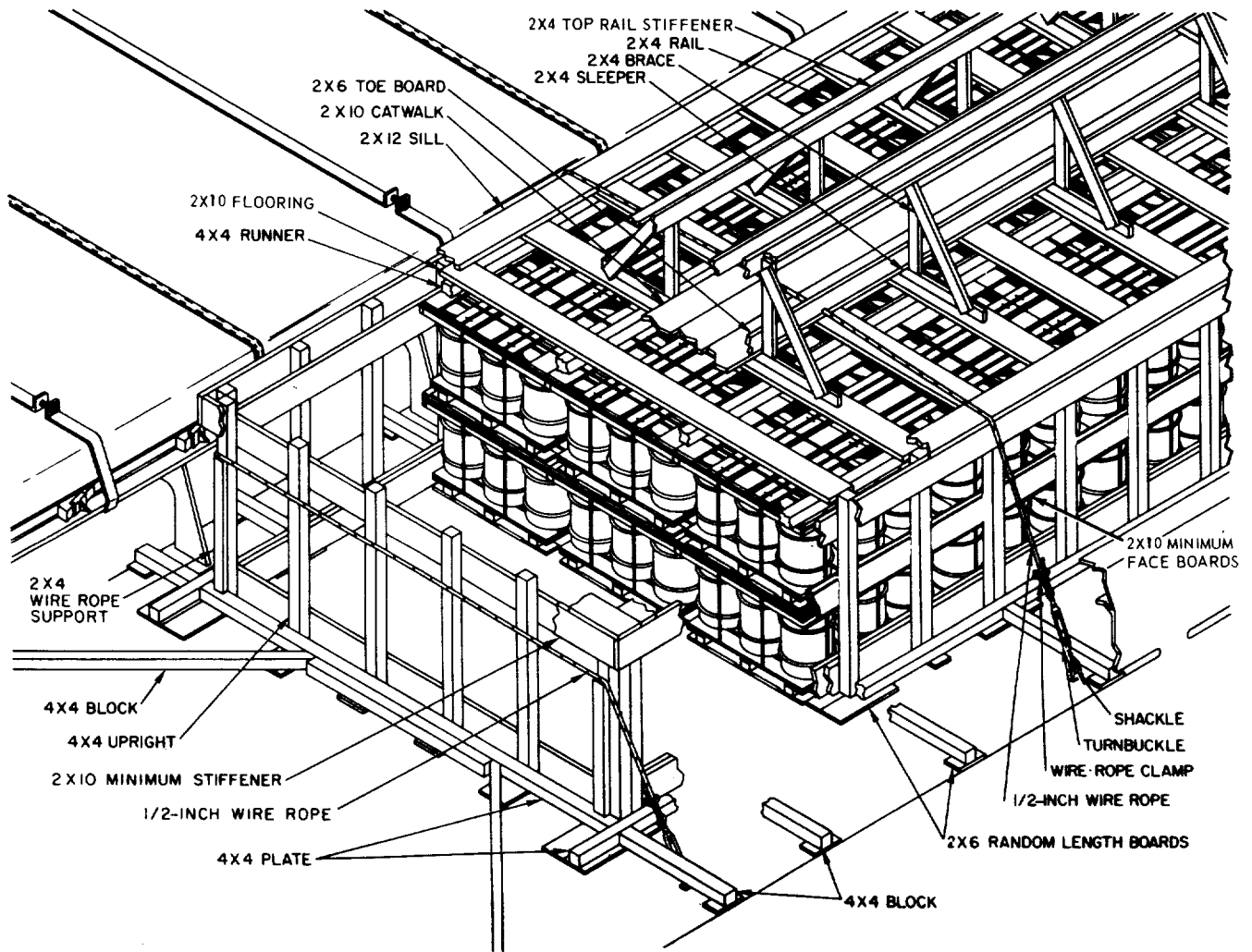
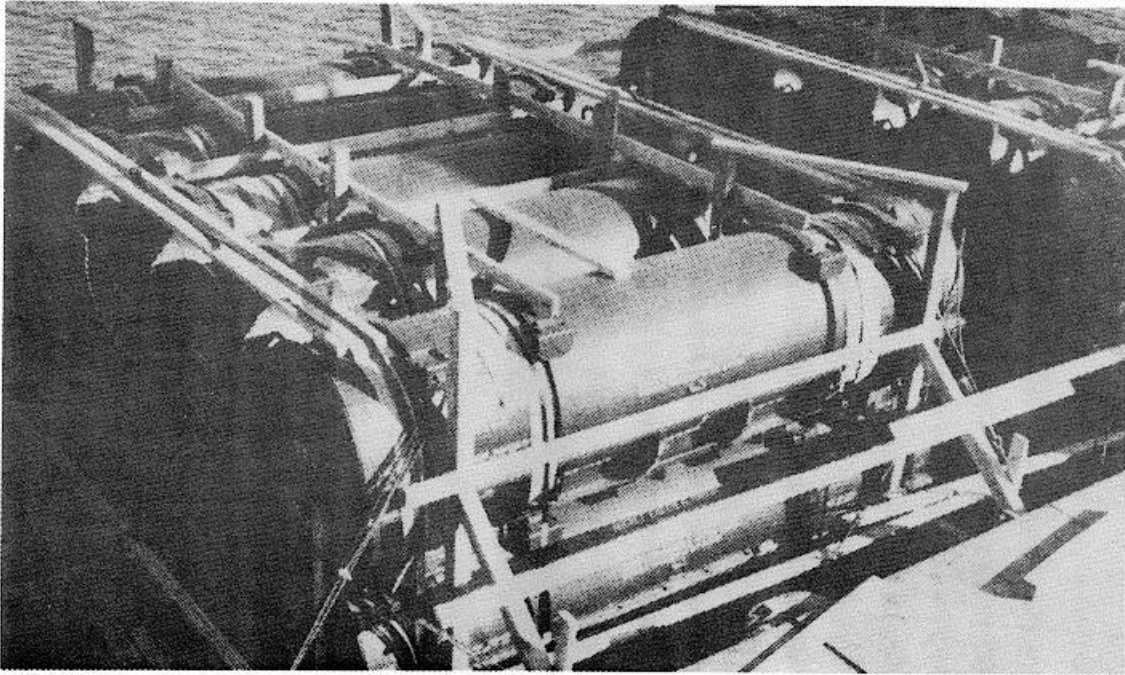


Figure 739. Construction details for opens deck-stow structure.

c. An additional type of open deck stowage is shown in figure 7-40. The item is packaged in a specially designed container that has been treated with a protective heat-resistant paint that is impervious to salt spray. The container is equipped with attachments that are designed specifically for securement.



**Figure 7-40. Special deck stowage of weatherproof containers.**

(1) Before the item (fig 7-40) is loaded, risers constructed of a double thickness of 2 by 10-inch minimum boarding are laid on the metal deck in the athwartship orientation and are positioned so that they have direct and full contact with the container skids. The containers are tiered two high, are strapped together before loading, and are placed on the deck in groups separated a minimum distance of 3 feet from adjacent groups. This spacing provides ready application of the various securing materials and is a requirement of the particular item.

(2) As each tiered unit load is positioned, spaces constructed of 4 by 4-inch uprights cut to a length that extends slightly above the height of the unit load are placed adjacent to the lifting bracket near each end of the container and are laced together with 2 by 4-inch minimum material, as shown. After the final unit load is in place, a single thickness of 2 by 10-inch minimum lumber of sufficient length to span the entire grouping is laid across the top at each end of the container. A suitable barrier material is placed on the unprotected sides of the container at the point where the banding material would otherwise make contact with and cause chafing of the container. The entire group is then banded together, with the 2-inch banding material, on the center of the 2 by 10-inch lumber and barrier material. Uprights and braces of 4 by 4-inch stock are then installed and laced together, and the 1/2-inch lashing cable is attached as shown.

**CHAPTER 8**  
**BLOCK-STOW AND SWEATBOARD-TO-SWEATBOARD**  
**SECURING TECHNIQUES**

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**8-1. General**

a. Military ammunition and explosives are secured for ocean transport based on either the block-stow or sweatboard-to-sweatboard stowage techniques. Figures 8-1 and 8-2 illustrate the basic configurations of these methods. As shown in figure 8-1, block stowage is developed through block like confinement of unit loads by securing structures installed parallel to the ship's center line. Sweatboard-to-sweatboard stowage, however, extends fully to the sweatboards and follows the contour of the hull. Cargo emplacement invariably results in the occurrence of voids within the stow, particularly if sweatboard-to-sweatboard methods are employed. Voids can be safety blocked and braced in various degrees, but the ship's master is the final authority regarding the manner in which voids are dunnaged. This chapter describes in detail the accepted methods of explosives stowage currently practiced by the Services. Figure 8-3 illustrates stowage nomenclature that will apply to the following sections.

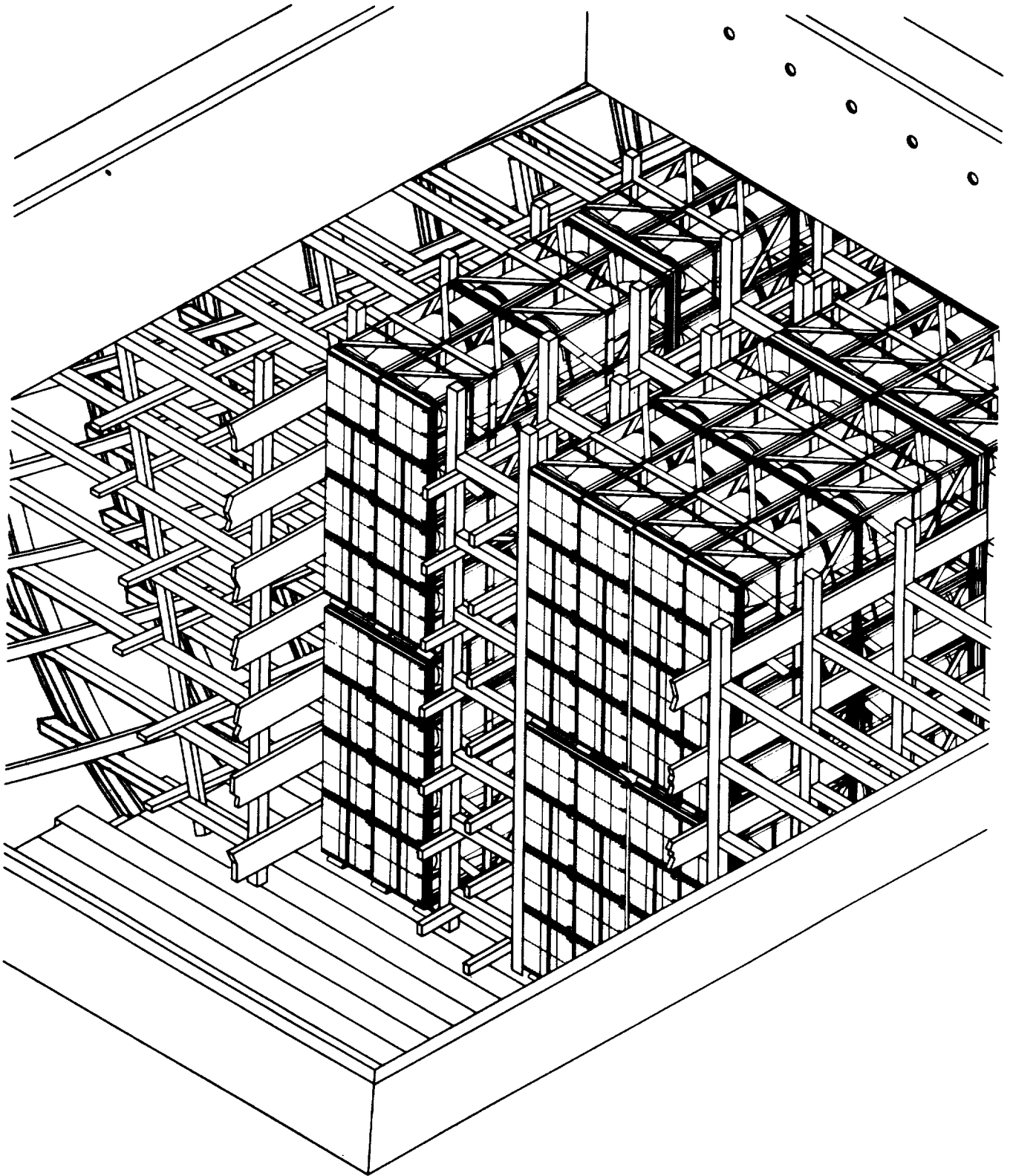


Figure 8-1. Block stowage.  
8-2

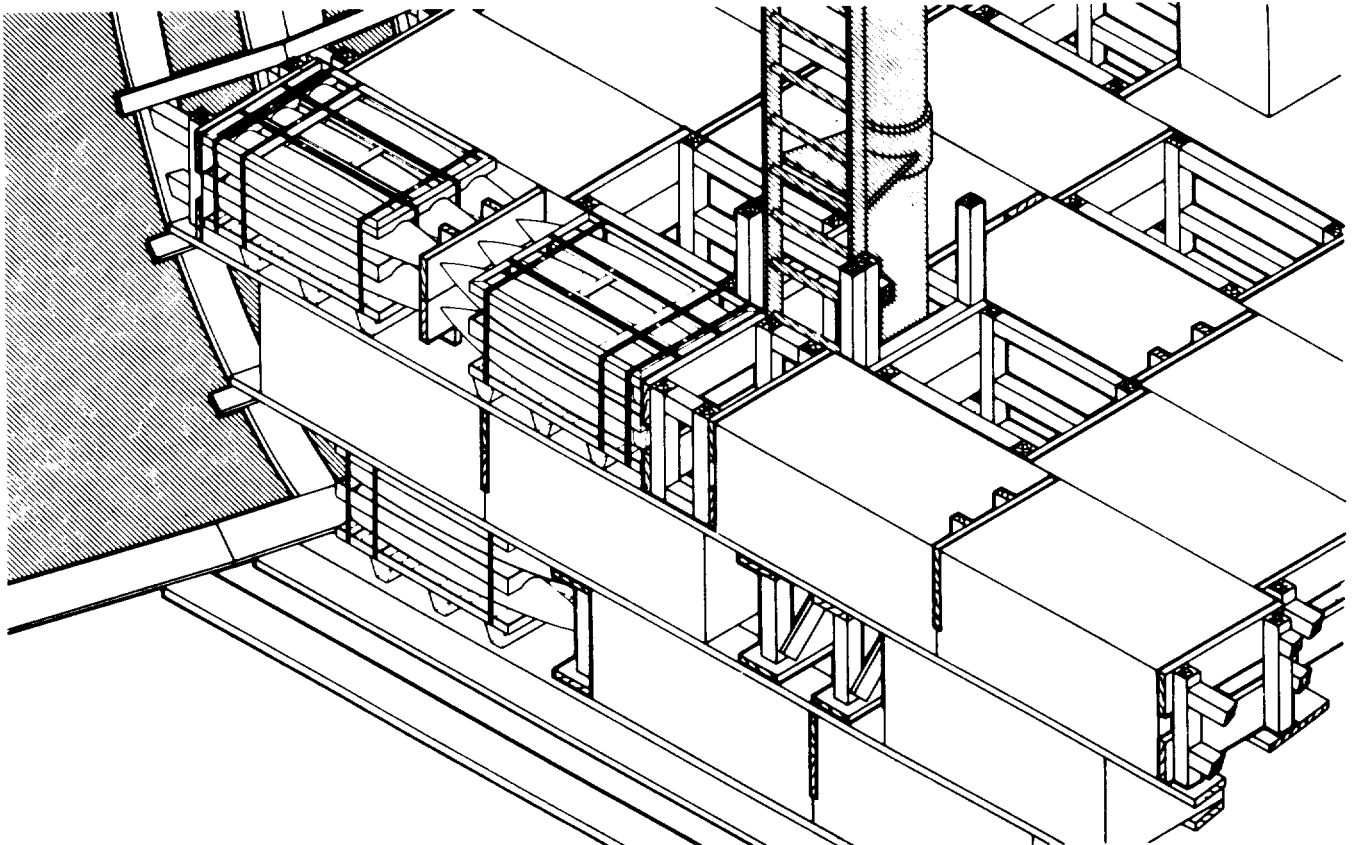


Figure 8-2. Sweataboard-to-sweataboard stowage.

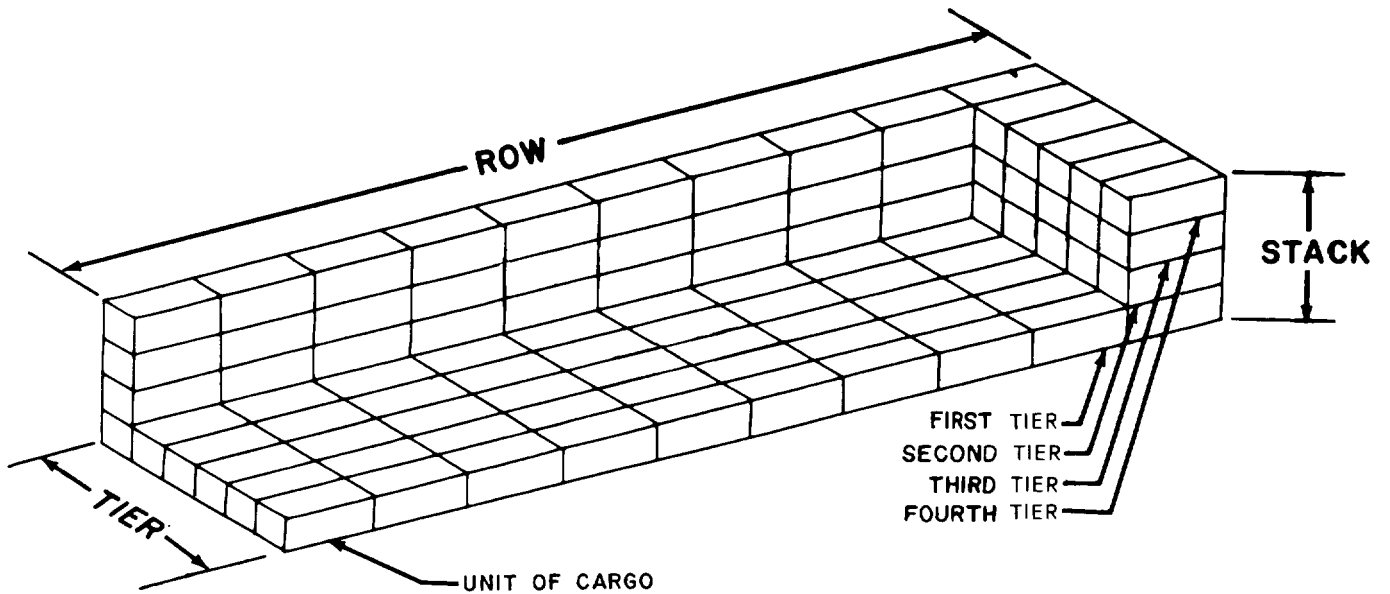


Figure 8-3. Stowage nomenclature.

b. The block-stow and sweatboard-to-sweatboard dunnaging techniques described in the following paragraphs represent the best current loading procedures as practical at DOD outloading ports. Both techniques are practiced to varying degrees at all outloading ports, based on cargo configuration, type of ship, and local preference. With respect to the above dunnaging techniques, two distinct methods of attaching shoring structures to the ship's hull have evolved: (1) the attachment of kickers to the ship's sweatboards and sheathing, which has been historically part of the sweatboard-to-sweatboard technique and is illustrated as such in this manual, and (2) the attachment of kickers directly against the ship's hull plating, which also has been traditionally a feature of the blockstowage technique. This relationship will also be illustrated in this manual. Although both hull attachment techniques are considered equally acceptable, the selection of a method should be made in accordance with local outloading port policy. Strict adherence to a specific local policy will avoid any confusion that could result from indiscriminately mixing the two procedures. For guidance, mixing of these hull attachment techniques within adjacent areas of the same ship is not recommended.

## **8-2. Block-Stow Technique**

Of primary importance in the securing of military explosives is the maintenance of a tight, unitized stow with minimum void space. Ideally, block stowage eliminates voids within the stow and requires only the construction of a simple structure to confine cargo in the block form.

a. Block stowage may begin either in the center of the hold against the forward or aft bulkhead and worked toward the hull, or at the hull and worked toward the center. In holds or compartments in which the sheet angle of the hull is significant, stowage is begun in the center of the compartment and is worked outward toward the hull. Voids will therefore be restricted to the wing areas only. In amidship holds or rectangular compartments in which hull contour is insignificant, stowage may begin against the sweatboards or sides of the compartment and worked toward the center, thereby restricting any voids to the center of the compartment.

b. The fundamental structure employed in block-stow securing of explosives is shown in figure 8-4. Figure 8-5 illustrates use of the structure in the shoring of palletized ammunition in a typical number 1 hold. These structures are designed to provide full support for the palletized unit loads and are constructed perpendicular to the deck and parallel to the longitudinal center line of the ship. An upright should be provided at both ends of the outboard unit load in each row. (Kickers provide lateral support for uprights and are bevel-cut to match the hull curvature.) Kickers are then wedgefitted directly to the ribs or to the skin of the ship as close to the ribs as practical. Horizontal alignment of kickers should be maintained to facilitate subsequent lacing. The use of sweatboards for direct support of kickers or other securing structures is not necessary with the block-stow method. Kickers should bear against the uprights, directly behind the face boarding, if required. Each kicker is secured to the upright with two 10d nails on three sides, as shown in figure 6-23. Vertical spacing between kickers should not exceed 48 inches. To unitize the structure, 2 by 3-inch horizontal and vertical lacers are installed. Precise locations of lacers need not be specified, but each kicker should be laced horizontally and vertically to the adjacent kicker. Lacing must be extended to an overhead ship's structure to prevent vertical movement of the dunnage structure. Lacing is not required at the uprights when face boarding is used; however, in the absence of face boarding, lacing is installed as shown in figure 8-4. In holds or compartments in which hull contour prevents proper alignment of unit loads, a partially preconstructed securing structure can be installed for more efficient loading. This structure, as illustrated in figure 8-6, utilizes 2 by 6-inch face boards spaced to support the top and base of each unitized load and provides a bearing surface for the stow parallel to the ship's center line. The face boards are secured to the uprights as a unit on the deck, after which the entire structure is raised into position and braced to the hull as usual. Uprights of 4 by 4-inch lumber are spaced at intervals not exceeding 36 inches or the length of the bearing surface of the stow, whichever is less.



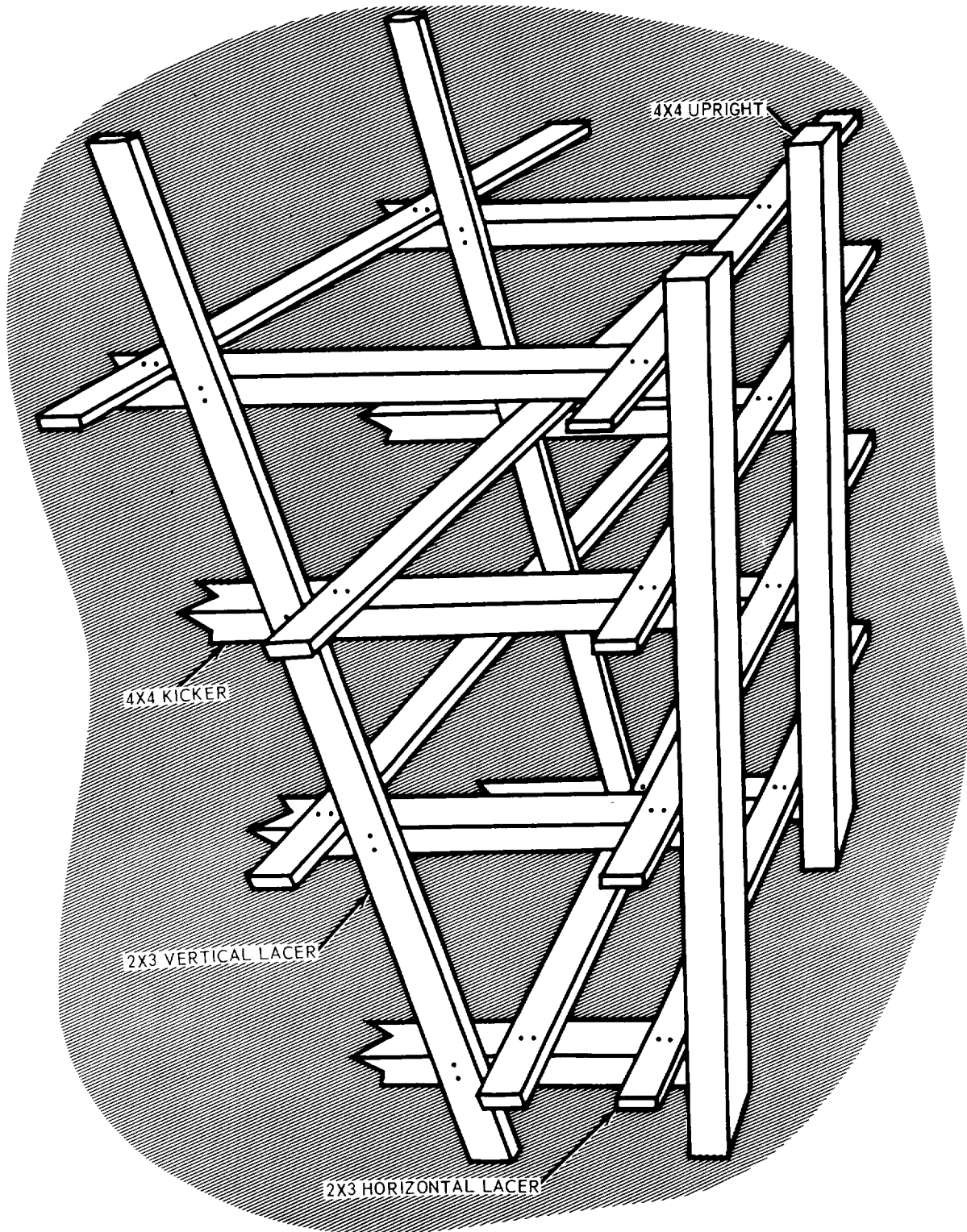


Figure 8-4. Fundamental block-stow securing structure.  
8-5



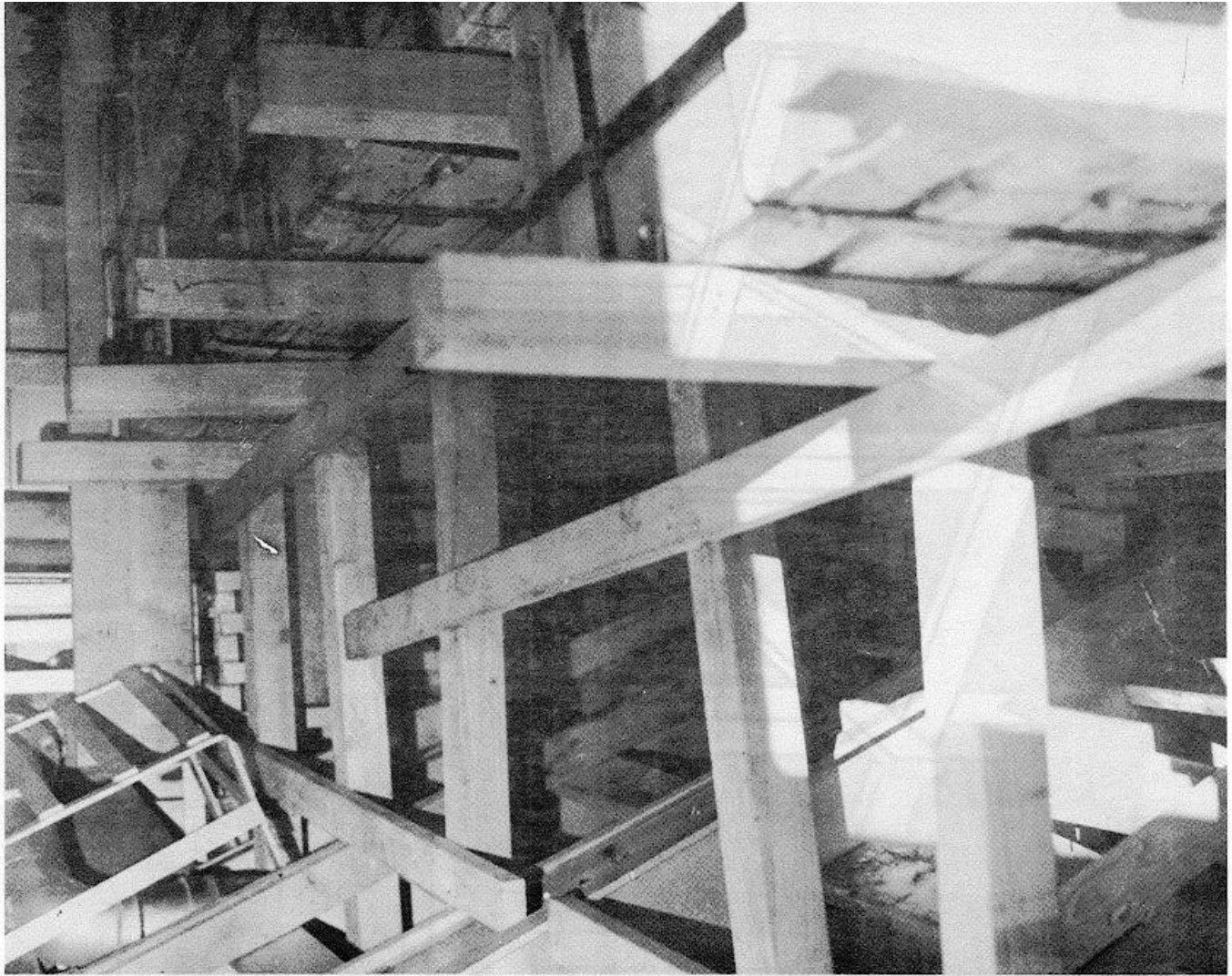
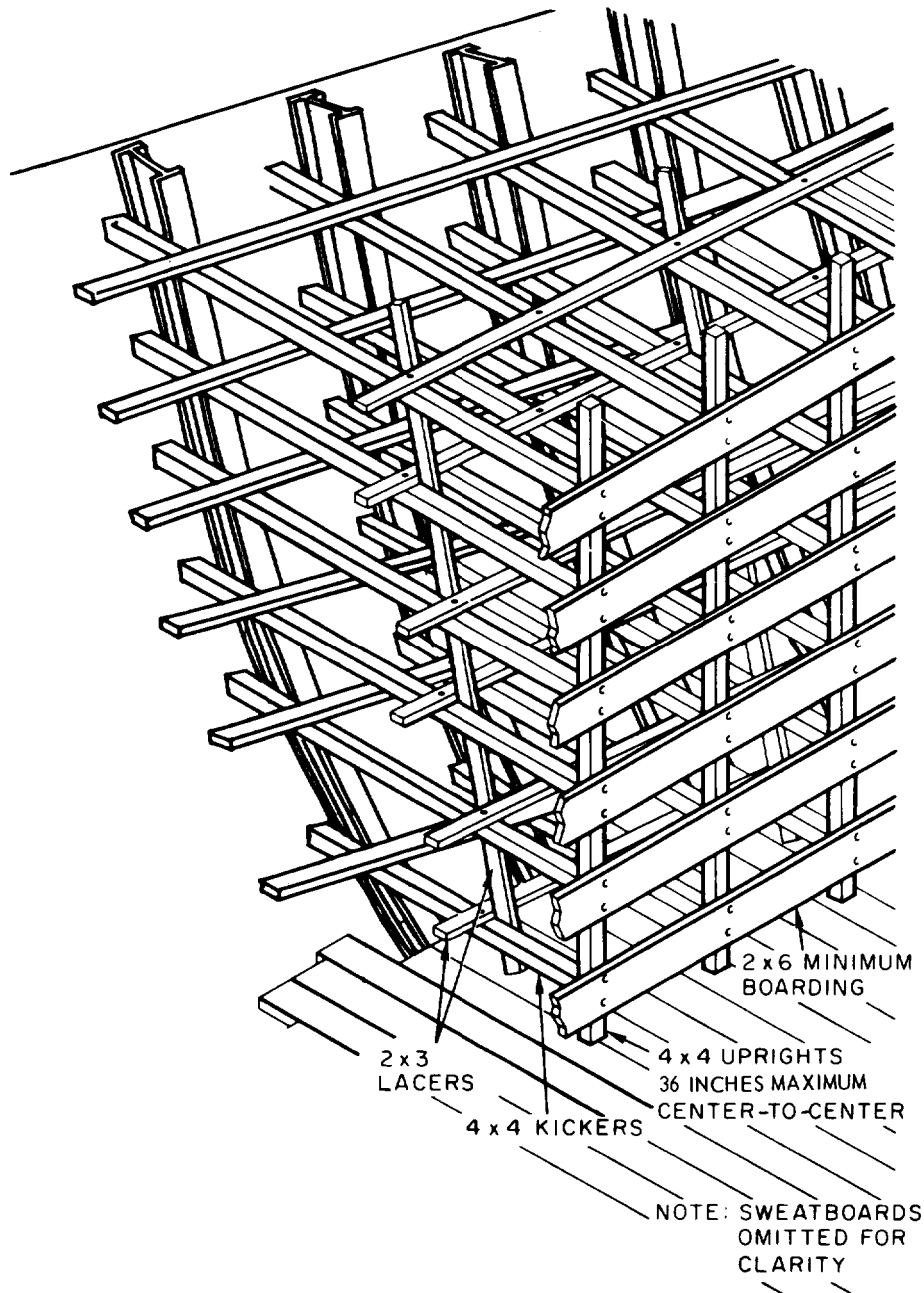
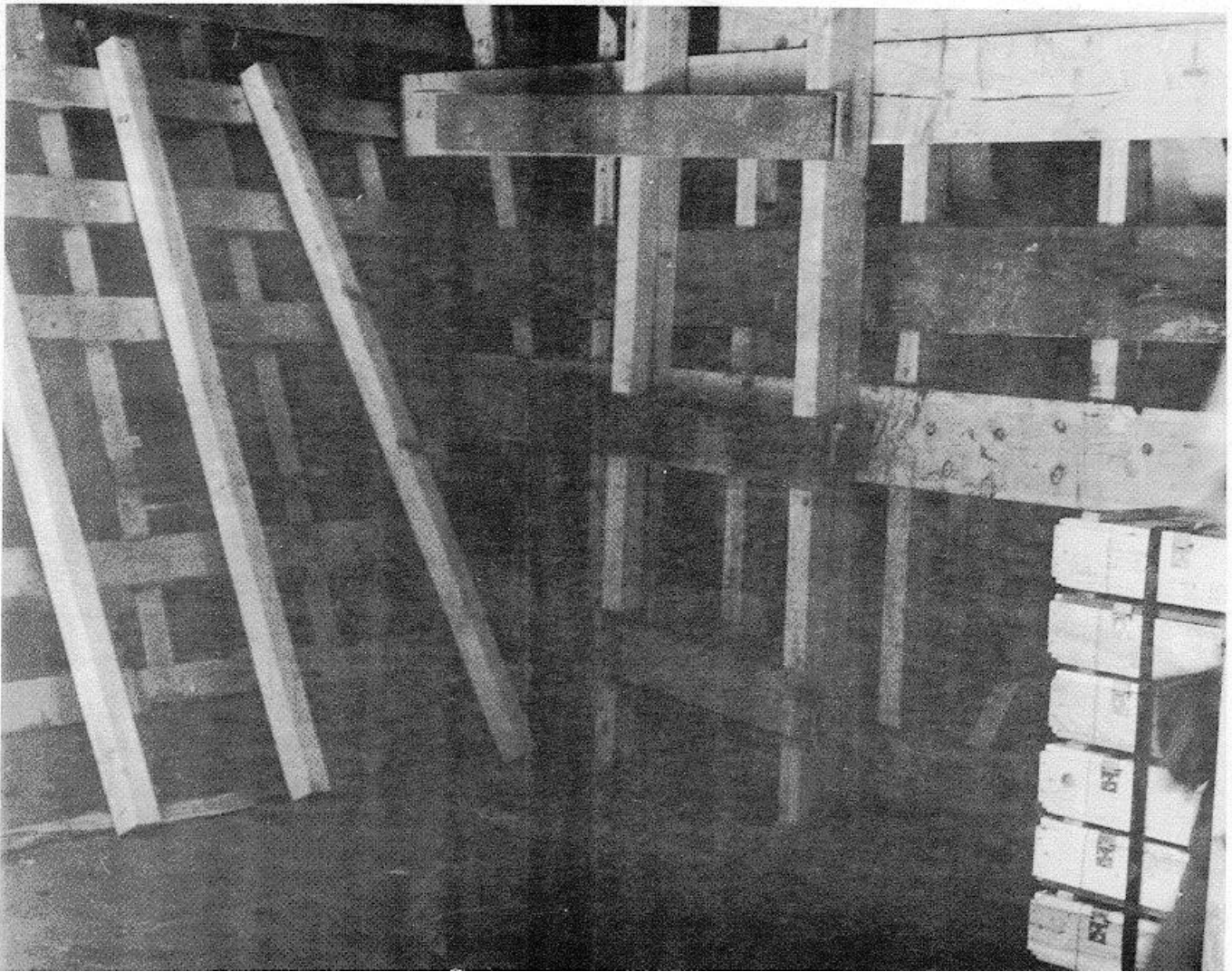


Figure 8-5. Typical block-stow securing (hull blocking technique).



**Figure 8-6. Construction details for basic block-stow securing prepared in advance (hull blocking technique).**

c. Prior to dunnaging operations, lumber of the required sizes is pre-positioned around the perimeter of the compartment as shown in figure 8-7. Thus, after stowage begins, carpenters will have lumber readily available while installing the securing structures behind the stowed cargo. It is important to note that dunnaging need not keep pace with stowage of unit loads when the block-stow technique is used. The compartment is loaded first with cargo in block fashion, and dunnaging operations proceed in the wings behind the stowed unit loads.



**Figure 8-7. Pre-positioning of dunnage lumber.**

*d.* Figures 8-8, 8-9, 8-10, and 8-11 sequentially illustrate the block-type stowage and dunnaging technique. Loading progresses from the center of the compartment toward the hull, almost eliminating voids within the stow. It is not necessary to maintain contact with the sweatboards or hull, as required with sweatboard-to-sweatboard loading. Instead, the unit loads are secured at the hull after being emplaced in tight, block-like fashion parallel to the ship's center line. As loading progresses toward the wider central area of the compartment, the stow will follow the hull contour as additional pallets per row are added. Thus, the entire stowage area is utilized efficiently. Securing at the hull is identical, with pallets continuously stowed in tight, vertical alignment.

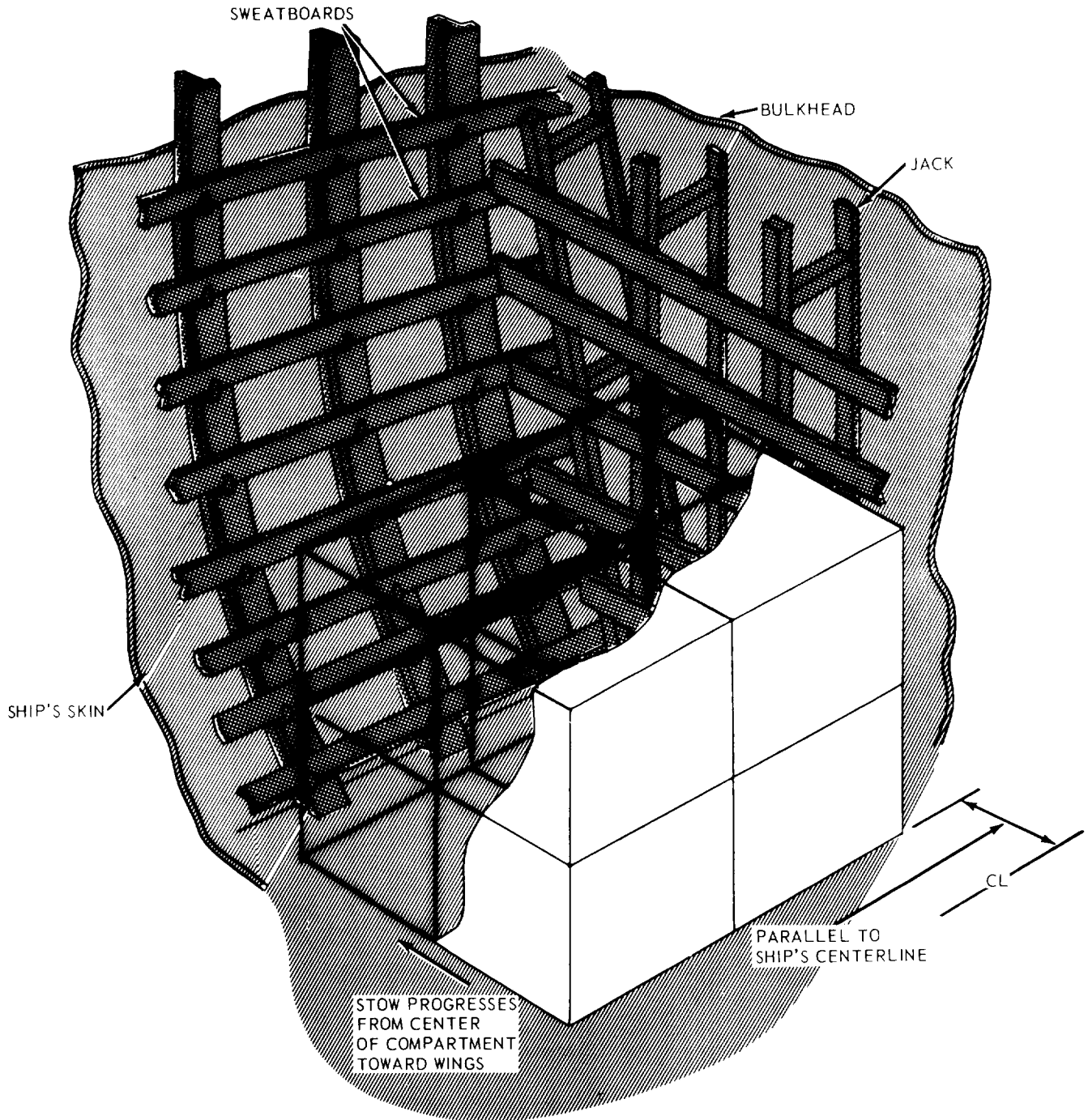


Figure 8-8. Emplacement of initial unit loads for block stowage.  
8-9

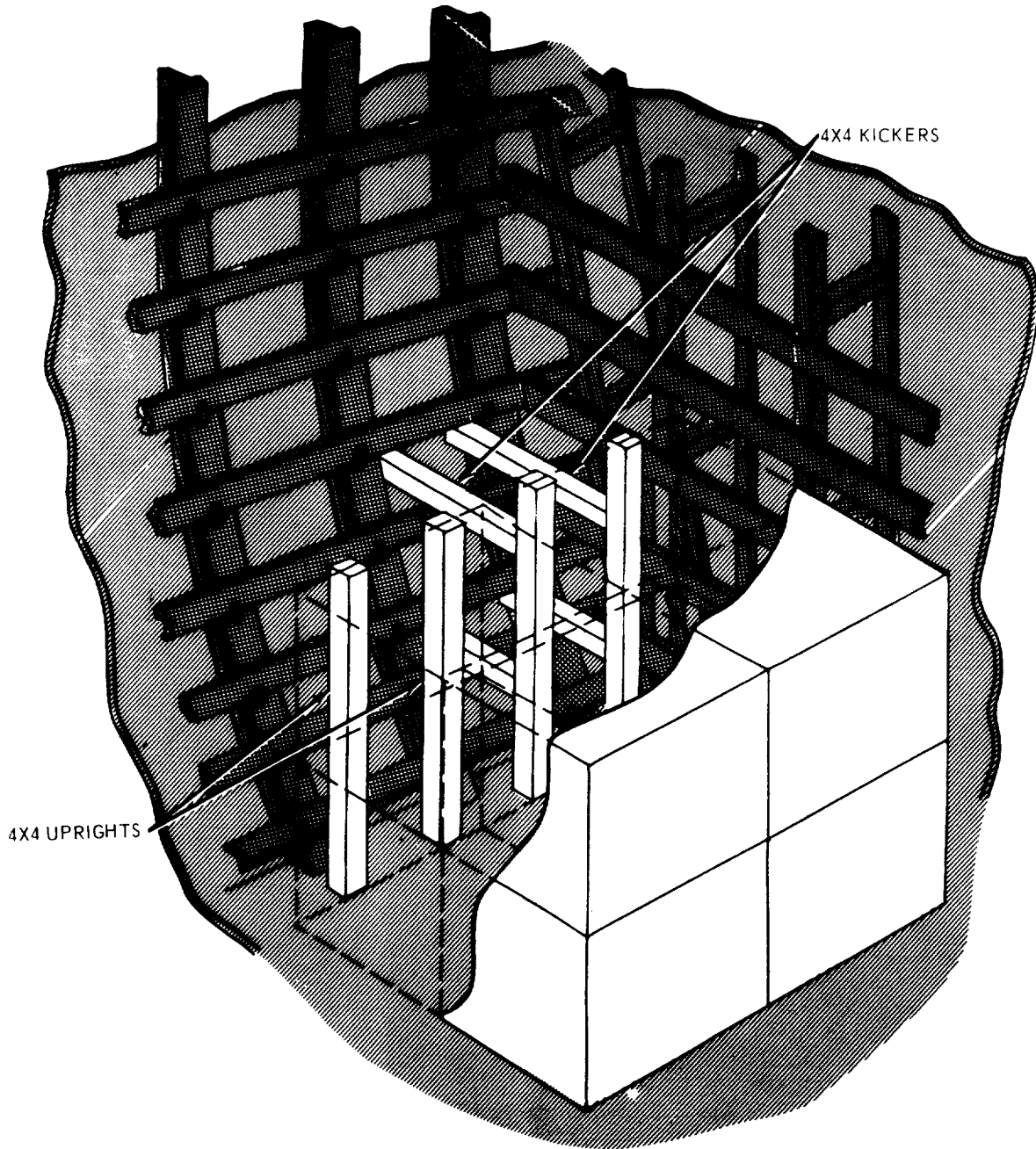


Figure 8-9. Installation of uprights and kickers for block stowage (hull blocking technique).  
8-10

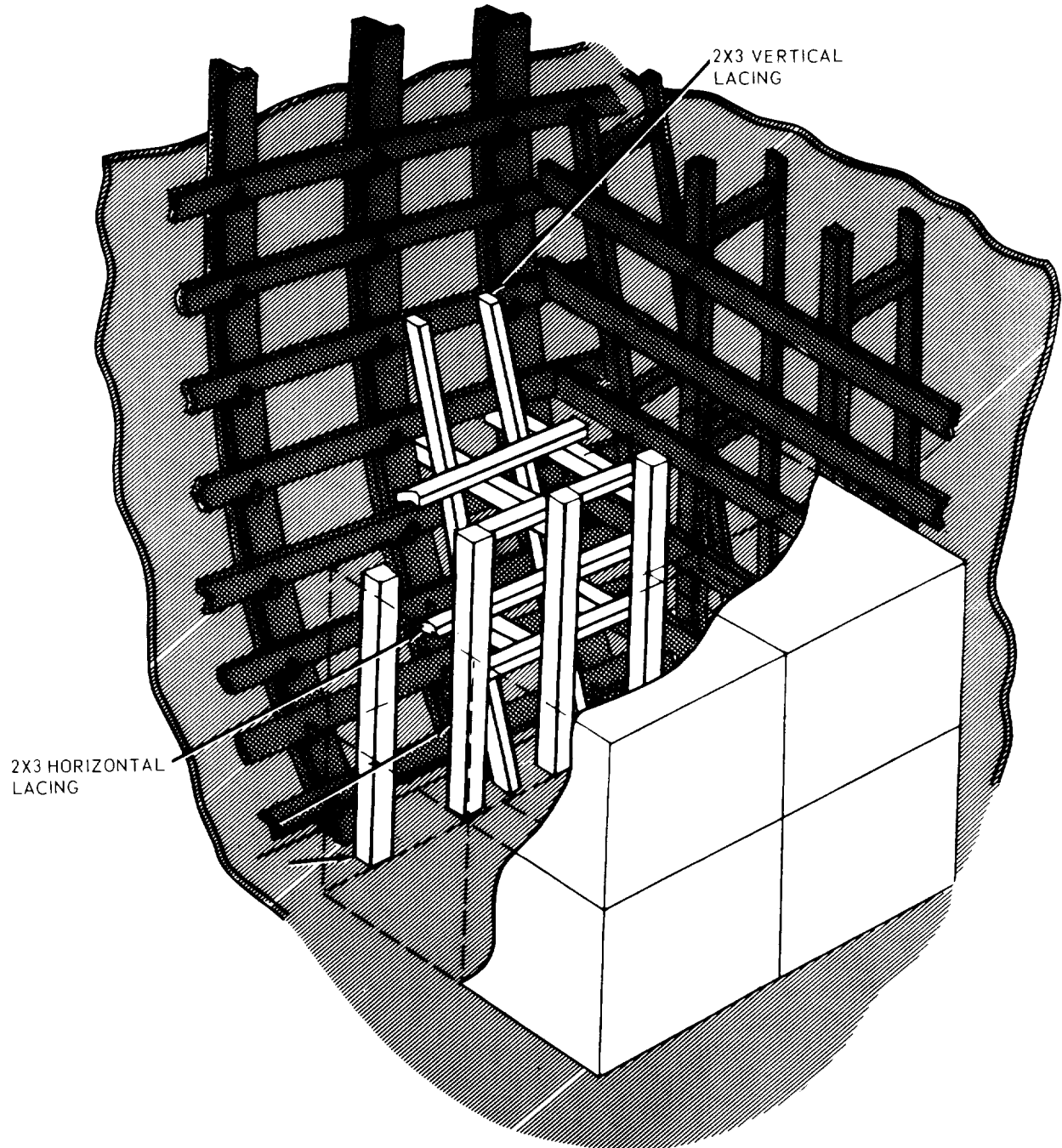
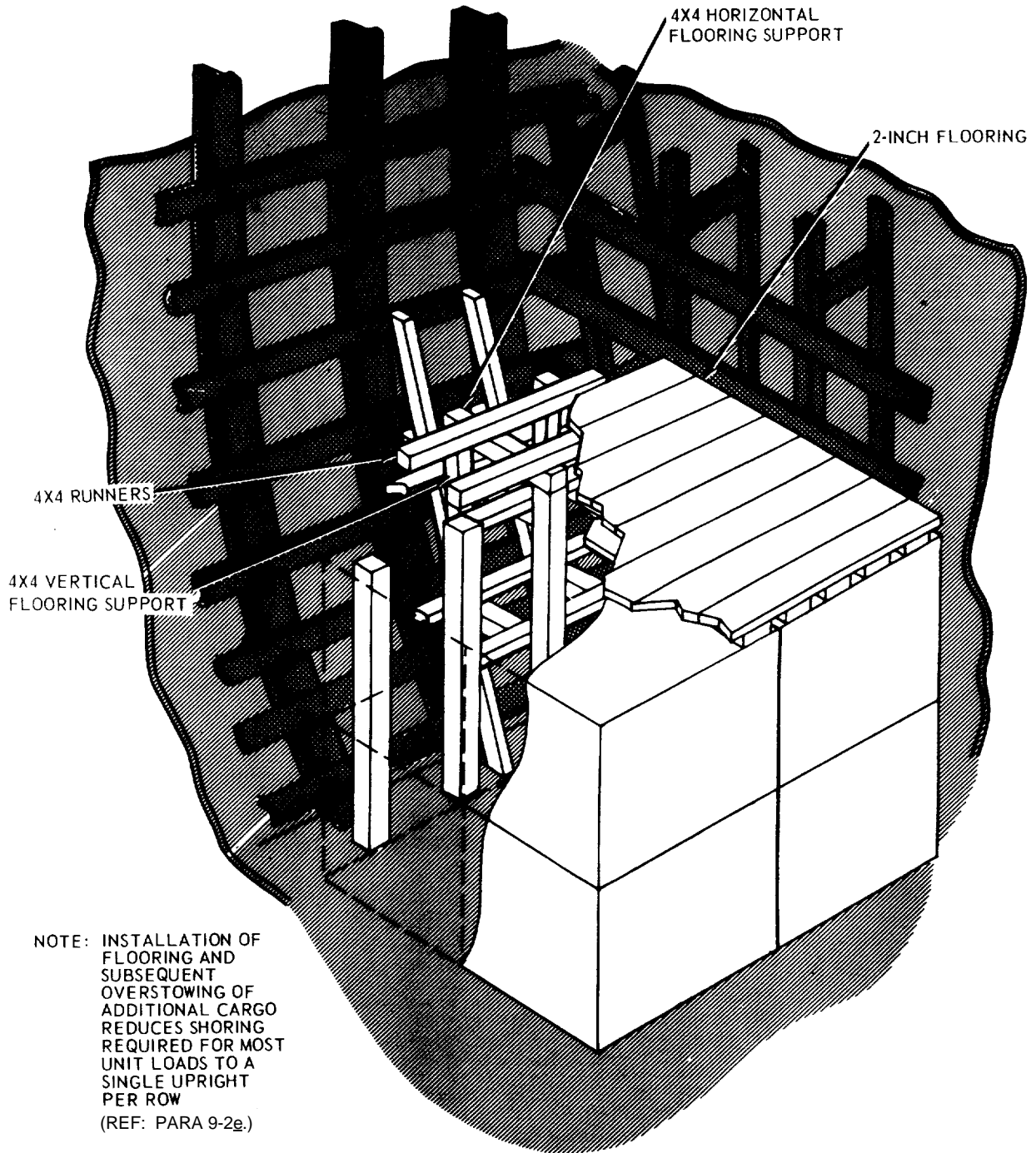


Figure 8-10. Addition of lacing for block stowage (hull blocking technique).





**Figure 8-11 Installation of flooring support structures (hull blocking technique).**

e. Installation of uprights and kickers is shown in figure 8-9. Normally, voids occurring in the wings (next to the hull) and voids running athwartships will be secured with two uprights of 4 by 4 inch stock and two 4 by 4-inch kickers per unit load cut-to-fit and contacting the hull plate next to the structural ribs. Under certain circumstances, a single upright and kicker per unit load are permitted. For example, narrow voids in the wings can be shored with a single upright if one end of the outboard pallet contacts the hull structure or sweatboards (fig 8-6). Also, in the event that flooring is installed over the stowed cargo and the overstay provides sufficient weight to serve as a tomming (downward) force, the cargo stowed below may be secured with a single upright and one kicker per

unit load, provided the cargo (dimensions do not appreciably exceed those of the normal 40 by 48 inch palletized load, and the load is not unusually heavy. In all cases, the primary consideration is to eliminate any possibility of the cargo shifting into the void.

f. Figure 8-10 illustrates the addition of 2 by 3 inch minimum vertical and horizontal lacing to stabilize the securing structure. Lacing is installed in the manner indicated previously in figure 8-4 and (secured to an overhead structure to prevent vertical displacement. In the compartment shown, it is desirable to block-stow by levels; that is, a full floor is laid over the cargo after it has been stowed two high in order that the following tier can be extended once again to the hull. This technique also finds application in bypassing the turn of the bilge or other low-level obstructions. As shown in figure 8-11, 4 by 4-inch vertical supports, often referred to as "stiff legs," are installed near the sweatboards. Horizontal 4- by 4-inch crossmembers are secured to the uprights contacting the cargo and are secured to the uprights at the opposite end to the stiff legs. If the void at the wings is relatively large, optional flooring runners are laid fore and aft over adjacent horizontal supports, and a lower course of 2 by 6-inch stripping is emplaced, spaced about 3 inches apart. Finally, 2 by 10-inch upper course flooring is installed, creating a solid support for the next tier of cargo. If the upper course is nailed to the lower course, 2 by 6-inch lumber is adequate. Cargo is again extended to the hull in resuming the stowage pattern. Figures 8-12 through 8-17 illustrate in detail the process of block-stowing cargo by levels.

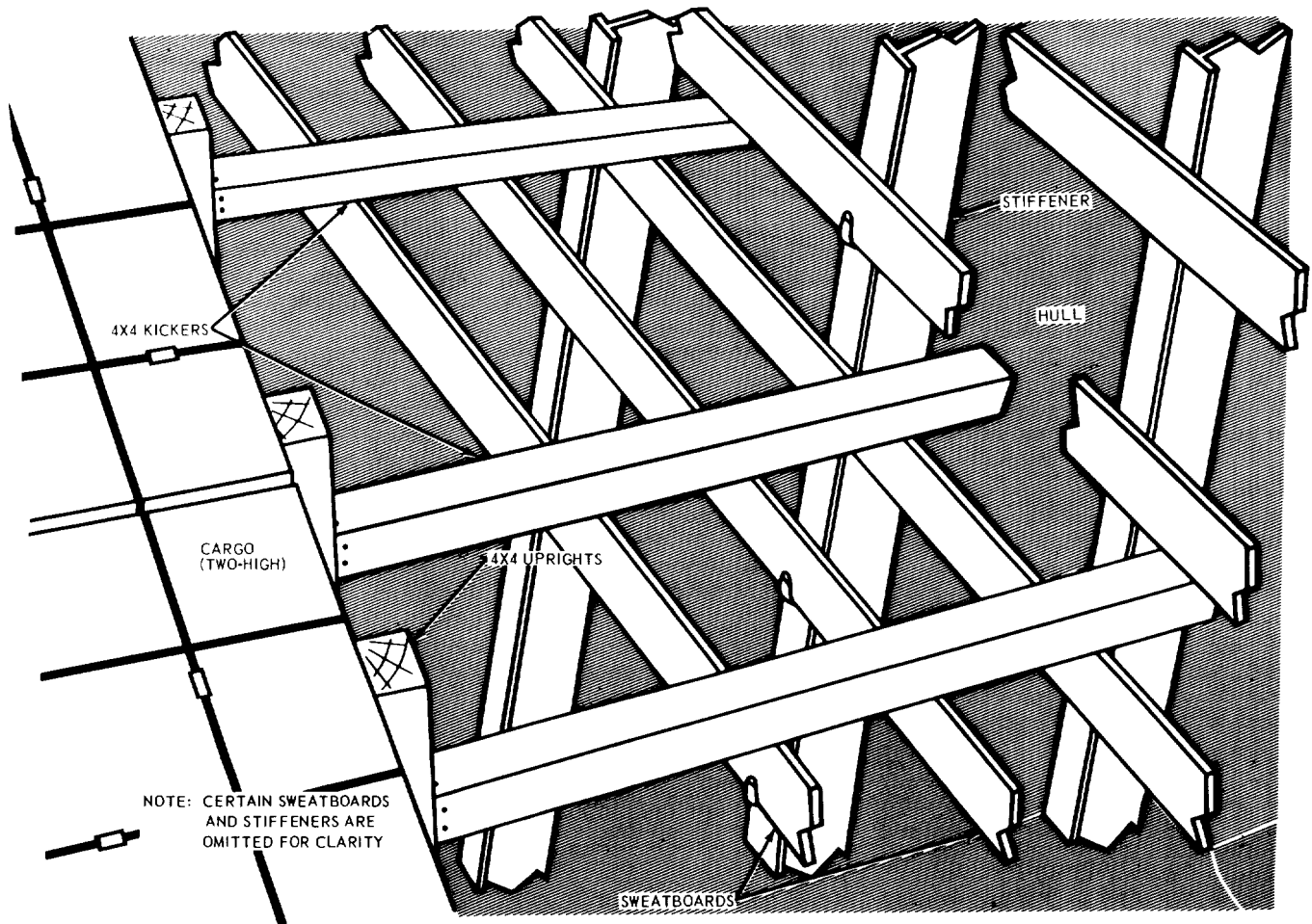


Figure 8-12. Bracing uprights to the hull (hull blocking technique).



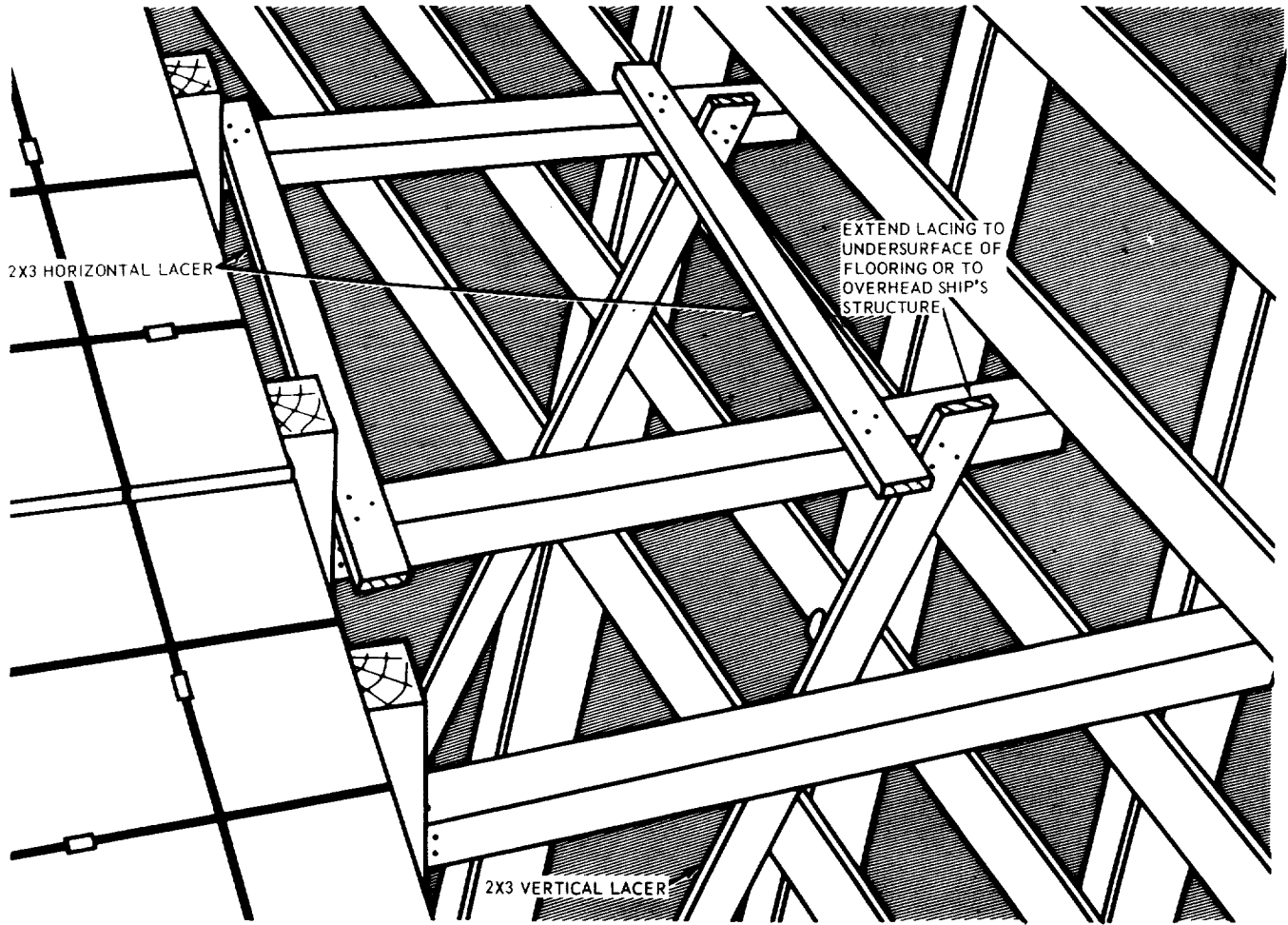


Figure 8-13. Installation of lacing (hull blocking technique).

NOTE: INSTALLATION OF FLOORING AND SUBSEQUENT  
OVERSTOWING OF ADDITIONAL CARGO  
REDUCES SHORING REQUIRED FOR MOST UNIT  
LOADS TO A SINGLE UPRIGHT PER ROW

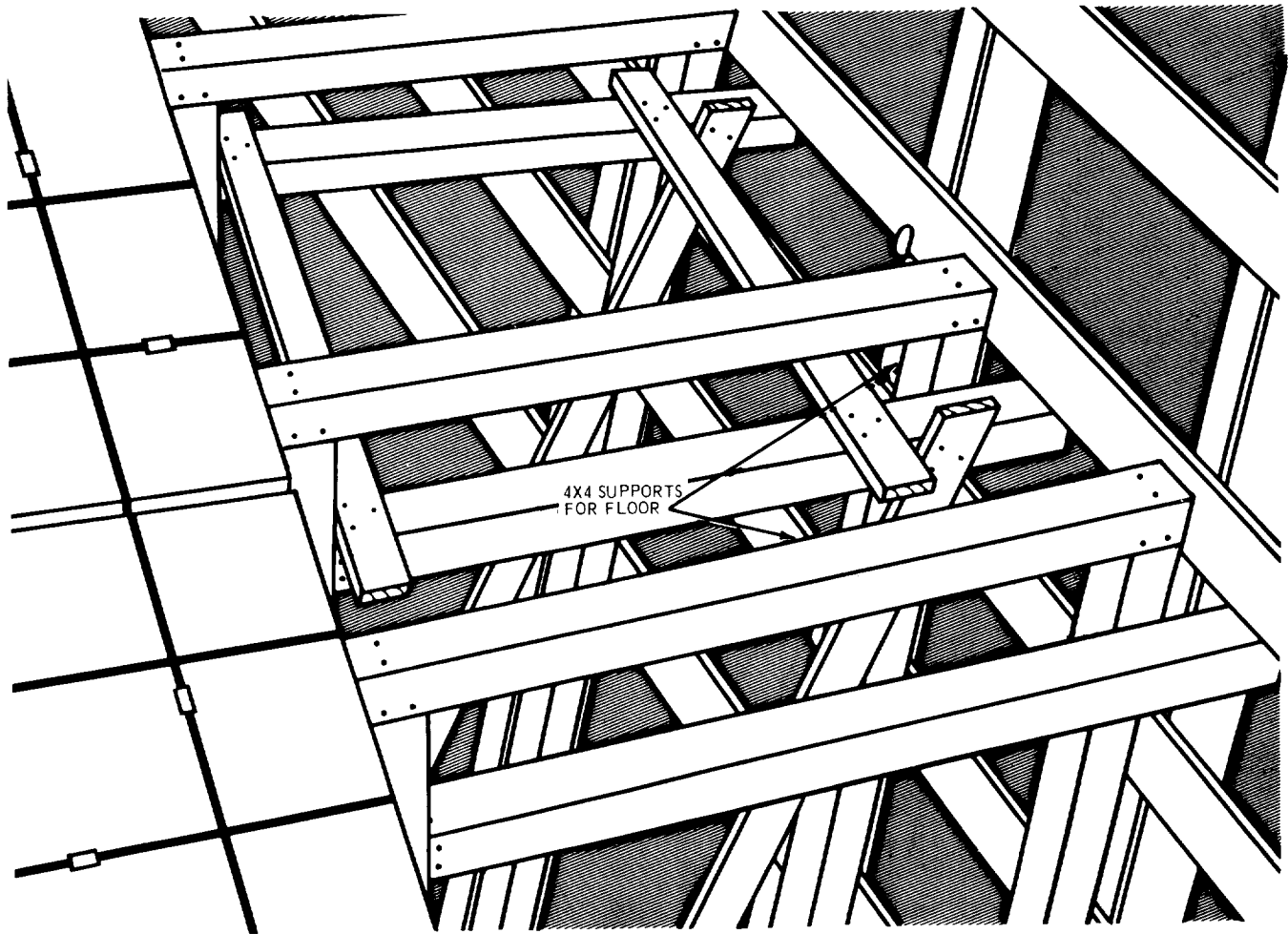


Figure 8-14. Construction of flooring supports (hull blocking technique).

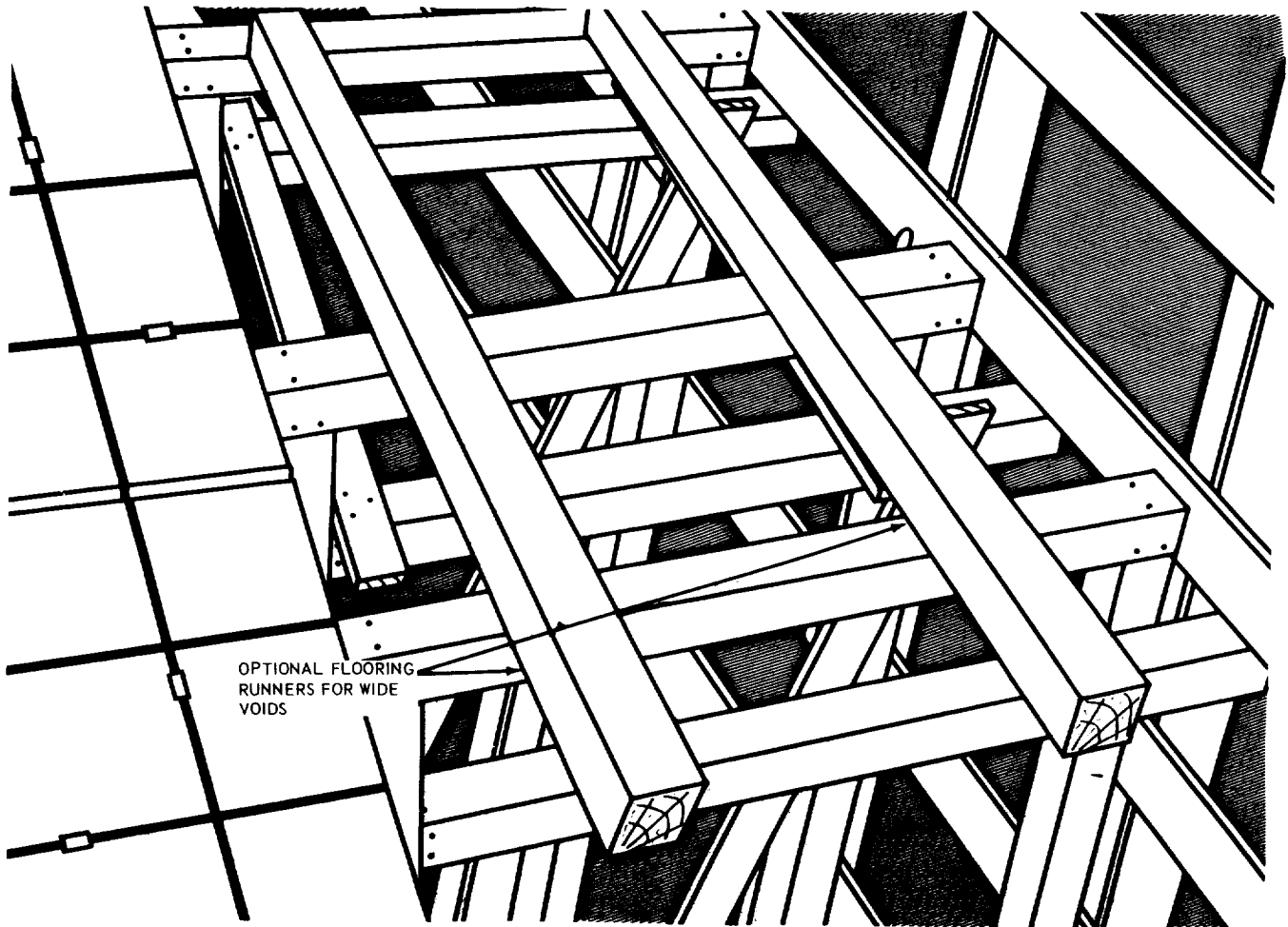


Figure 8-15. Runners for support of flooring (hull blocking technique).  
8-16

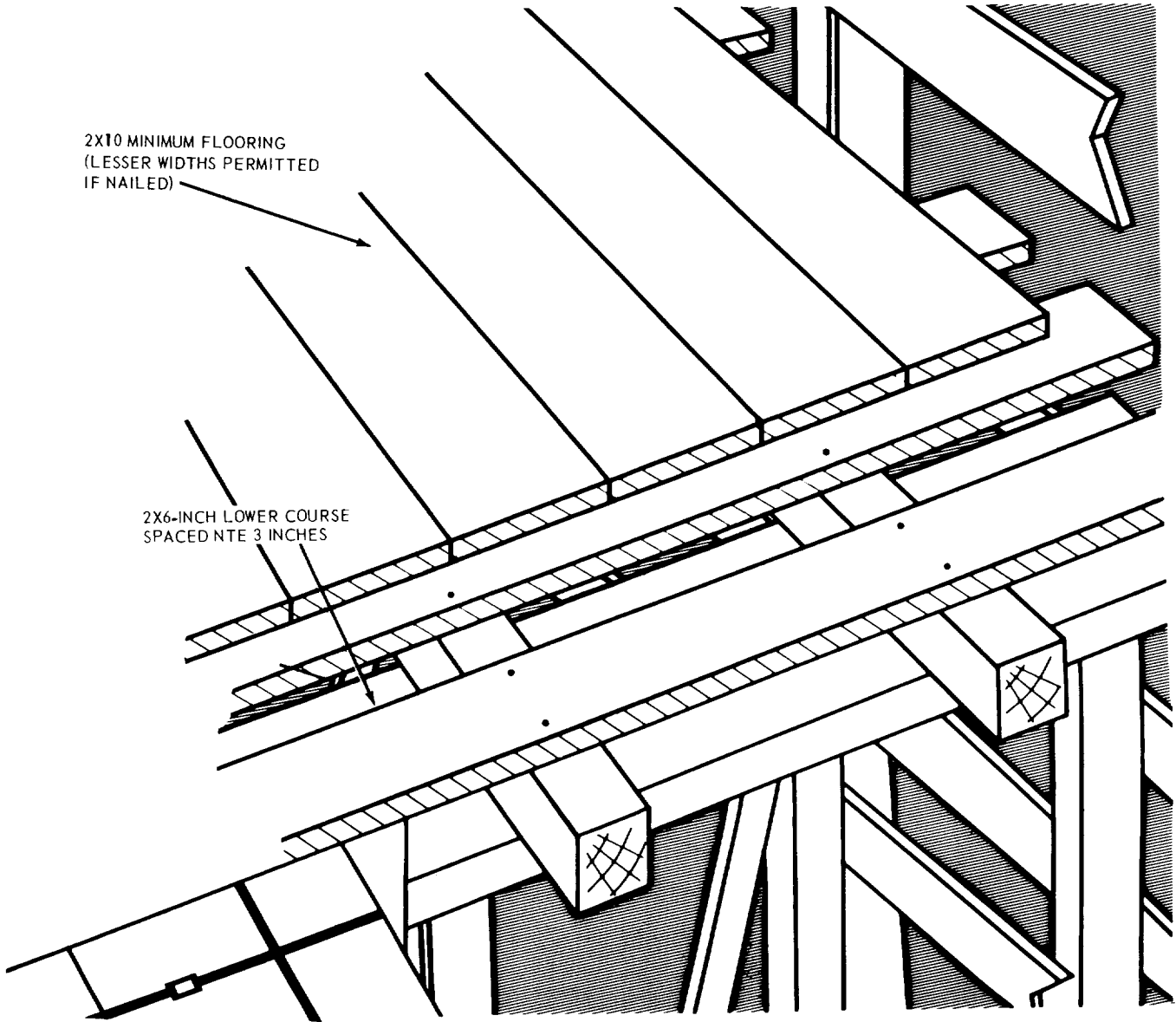


Figure 8-16. Installation of flooring over lower course stripping (hull blocking technique).

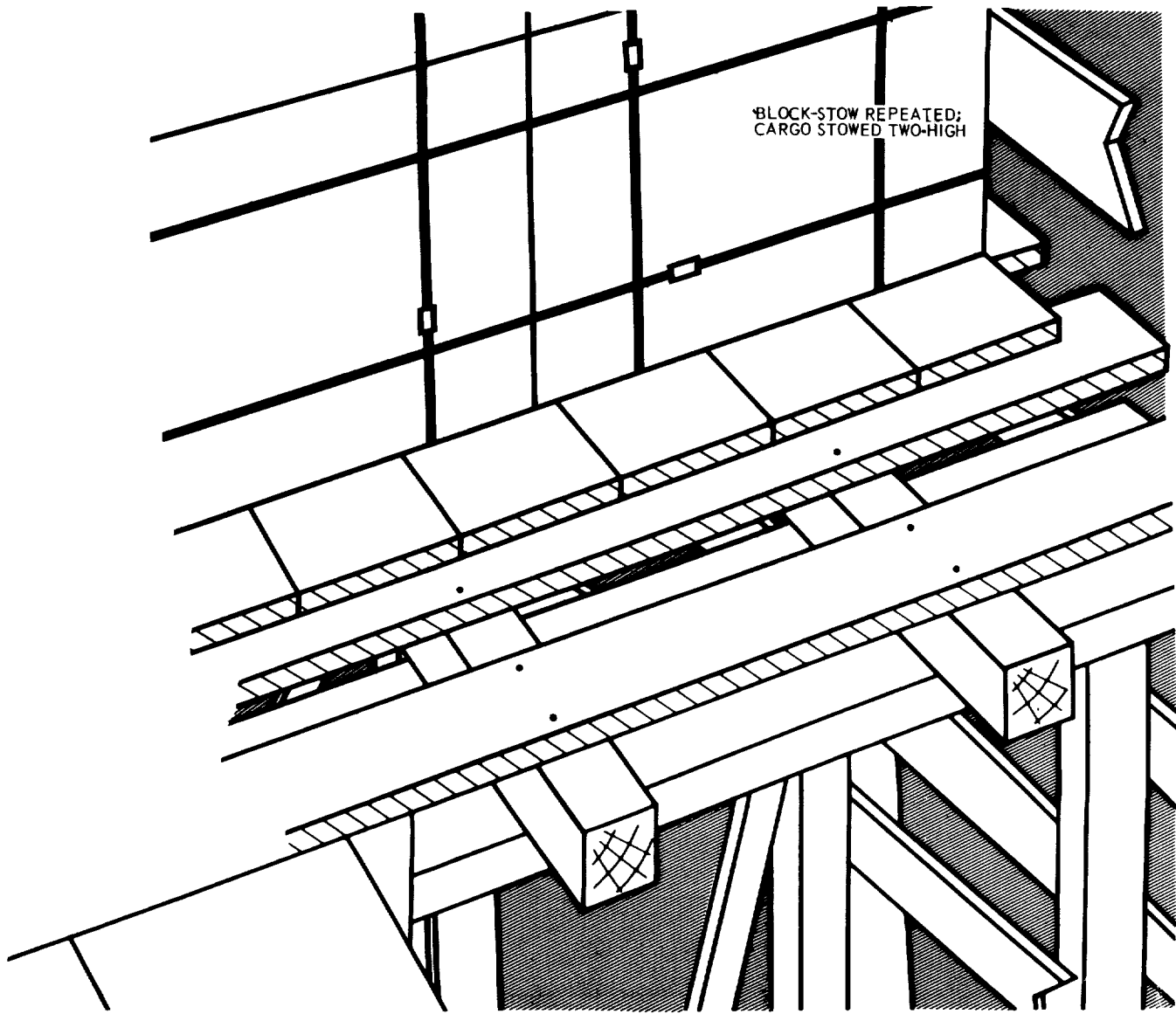


Figure 8-17. Resumption of the block-stow pattern (hull blocking technique).

### 8-3. Block Shoring of Cargo Voids

The occurrence of some voids within block-stowed cargo is unavoidable, due to the nonuniform sizes and configurations of palletized ammunition and explosives. Stowage should be arranged to minimize the number and size of voids and limit their occurrence to central areas of the compartment.

a. Voids are shored simultaneously with loading to ensure that all such areas are adequately braced. Palletized units vary in size, and the preload prediction of location and configuration of all resulting voids is difficult. Void shoring differs with the type of cargo being stowed, and the final construction of the securing structure can be determined only after the emplacement of the cargo and evaluation of resulting voids.

b. Voids occurring in the block stowage of rectangular palletized loads of ammunition are typically small in size and rectangular or square in configuration. The shoring of such voids is illustrated in figure 8-18. Pallets are stowed in the block-stow manner, arranged to restrict voids to the central areas of the compartment. Uprights of 4 by 4-inch stock are positioned at each corner of the void and are braced to form a secure full-block structure with 4 by 4-inch kickers. In many cases, the cargo, while all palletized unit loads, may not be homogenous in size within the same compartment. Such loadings often generate relatively long voids, narrow in width, and occurring between adjacently stowed rows of unit loads different in size. These voids are indicated in figure 8-18 and are shored

with a structure made of 4-by 4-inch uprights and 4-by 4-inch horizontal members. Generally, the full width of the void may be accommodated by securing additional uprights to the horizontal members on opposite sides. Securing structures are often prefabricated, since construction details will not vary significantly for different unit loads. Figure 8-19 illustrates a typical stow of palletized cargo of various sizes within a compartment and the installation of appropriate void-blocking structures.

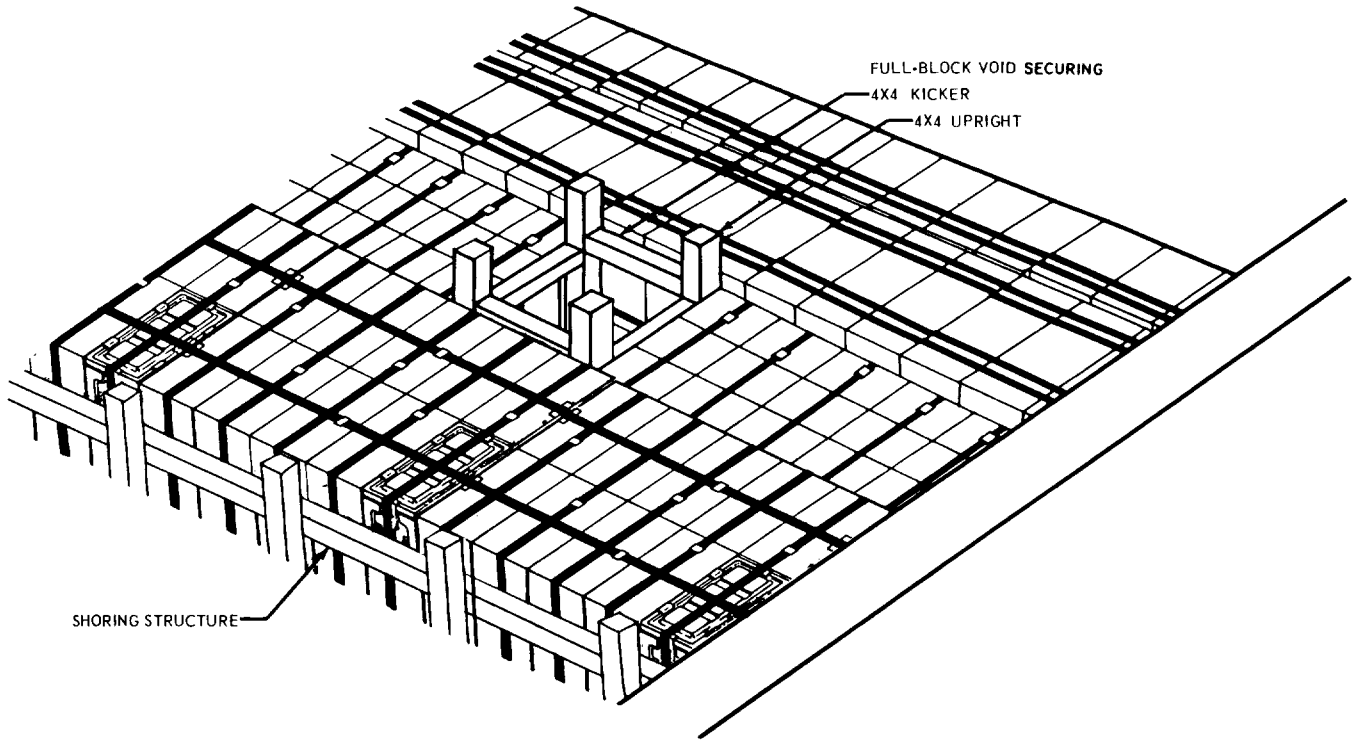
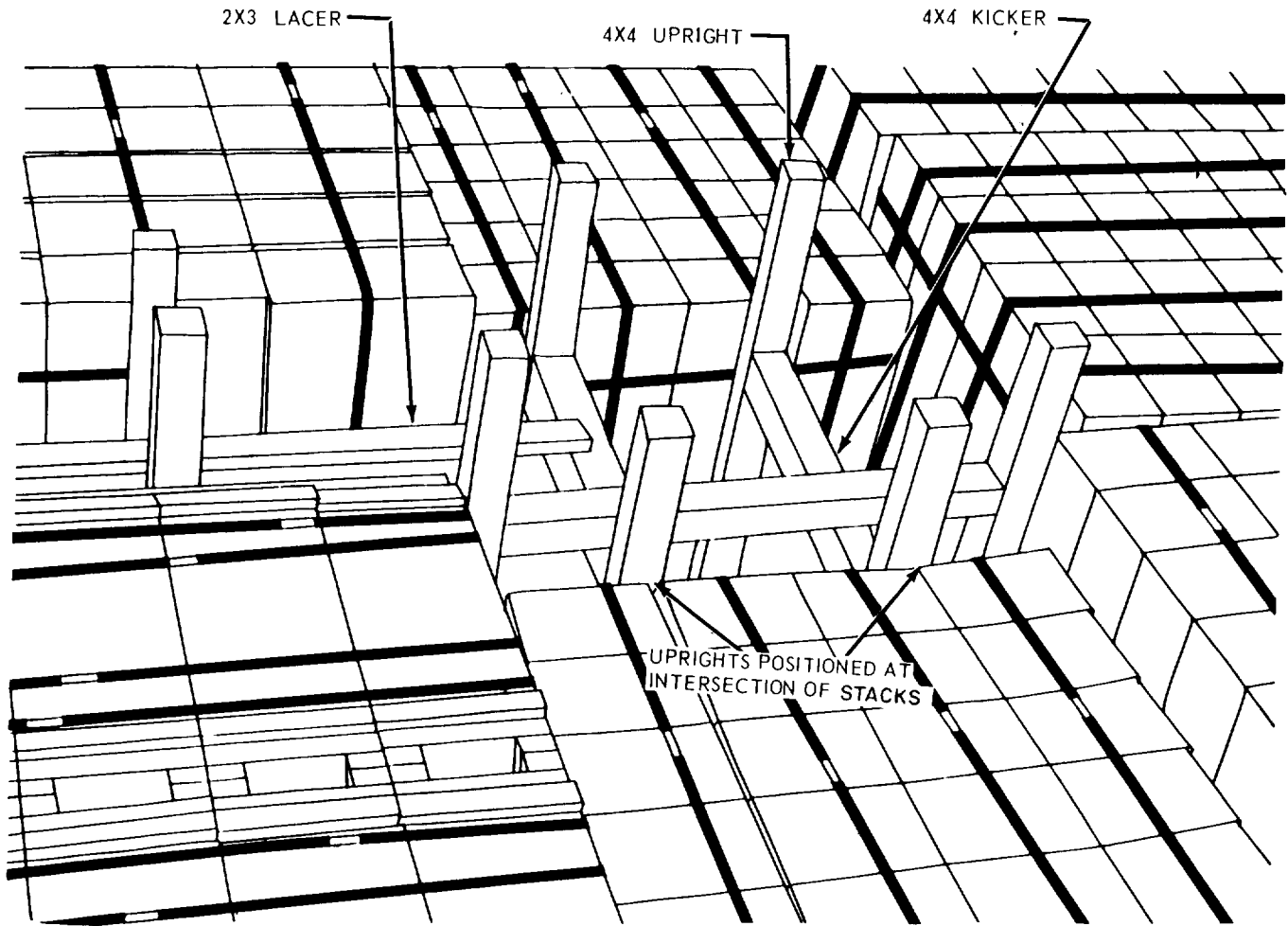


Figure 8-18. Shoring small voids in the block-stow pattern.



**Figure 8-19. Final void shoring in progress.**

c. Figure 8-20 illustrates the construction details of a narrow securing structure and full-block void structure utilized in combination. Two 4 by 4 inch uprights should be made to bear against each palletized load adjoining the void, and these are securely braced to each other by 4 by 4-inch kickers. When palletized boxed ammunition is secured, uprights should be positioned, if feasible, at the intersection of the tiers of boxes to ensure all interior boxes are braced adequately. The narrow void-shoring structure, also constructed of 4 by 4 inch stock, is laced to the block structure for stability.



**Figure 8-20. Construction details for narrow and full-block void shoring structures.**

*d.* Securing of voids in stowage of overhanging unit loads is shown in figure 8-21. All uprights and kickers are constructed of 4 by 4-inch stock and are positioned on the straight, supported sides of the unit load rather than at the curvature of the overhang.



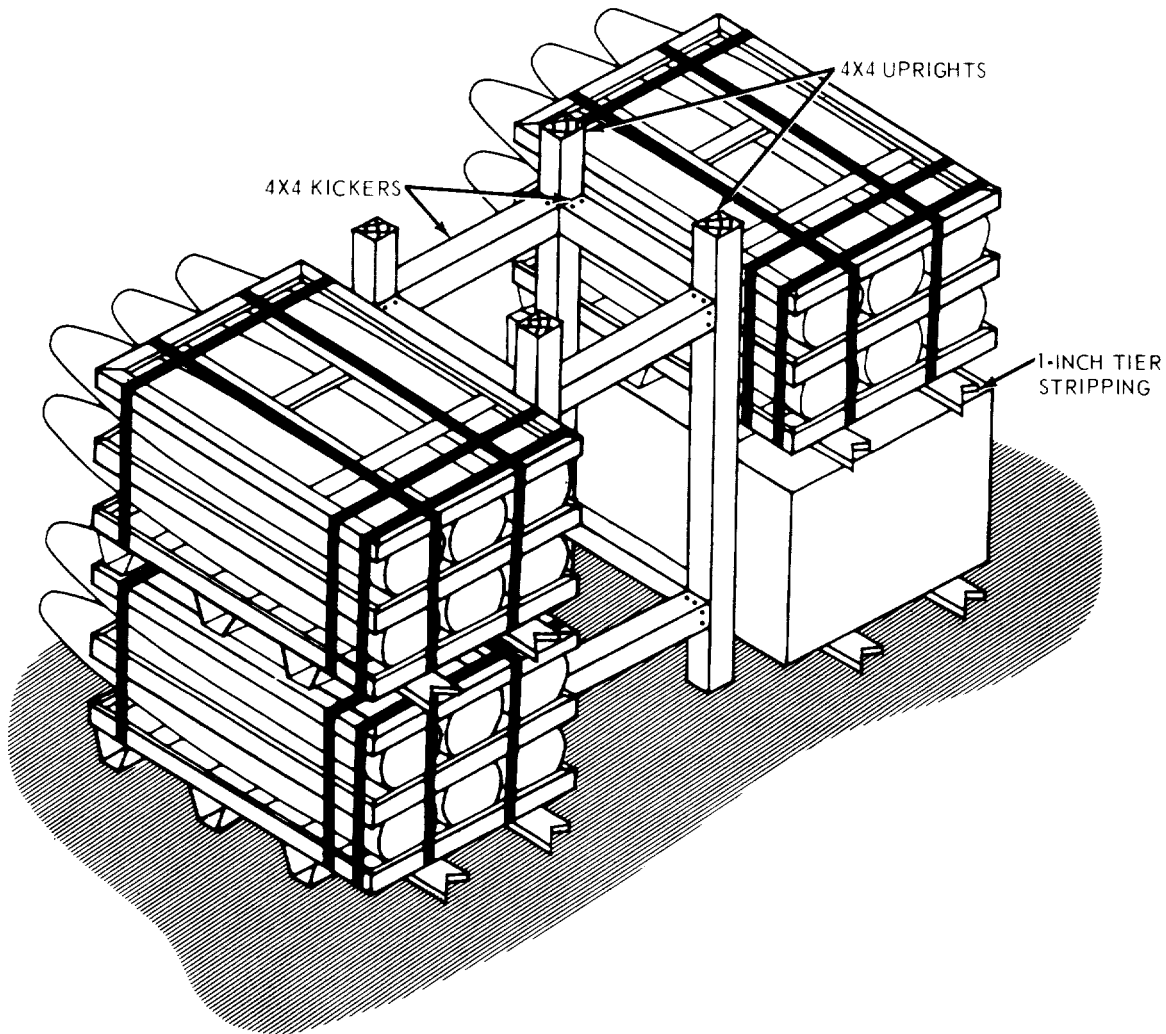


Figure 8-21 Void shoring for unit loads that overhang the pallet.

#### 8-4. Sweatboard-to-Sweatboard Stowage Technique

Sweatboard-to-sweatboard stowage utilizes the most space within a hold, but it also results in a greater number of small voids than block stowage. These features become more pronounced in compartments with severe hull curvature, while in areas approaching a rectangular shape the technique resembles block stowage. It should be noted that the increased space utilization that the sweatboard-to-sweatboard stowage method provides in compartments with severe hull curvature requires considerably more effort (in terms of manpower and time) than does a straight block stow. Use of side-shifting forklifts is highly desirable to facilitate handling pallets in confined areas. Unlike block stowage, sweatboard-to-sweatboard stowage should be arranged so that voids in one tier do not occur above or below those in the immediate upper or lower tier but instead are staggered from tier to tier. It is important that voids be made to occur near the central areas of the ship. Voids can be safely shored in various degrees, but the ship's master has the final say concerning the manner in which the voids are dunnaged, and his decision will determine the extent of shoring that blockers and bracers will employ. The void-shoring techniques described in subsequent sections reflect the preferred methods currently in use at shiploading activities employing the sweatboard-to-sweatboard stowage technique.

a. Regardless of the commodity or the configuration of the unit load, certain fundamentals common to each kind of unit load should be strictly observed when sweatboard-to-sweatboard stowage is employed. Strip sheathing is fastened over the sweatboards in the manner shown in figure 8-22. If the sheer angle is severe, two courses of 1- by 6-inch strips or relatively short pieces of 2 by 6-inch strips may be used to sheath the sweatboards. Otherwise, long lengths of 2- by 6-inch strips are preferred in the holds where sheer is not a factor.

The spacing between strips should be the width of the unit load that is stowed, so that it bears against the strip sheathing, and so that its skids are as nearly parallel to the ship's center line as practicable. To maximize the strength of the blocking and bracing, every effort should be made to locate the sheathing on the sections of the sweatboards that are supported by the ship's ribs. The rib spacing and the width of the unit load may not correspond, thus causing some of the sheathing to be located between the ribs. For every row of unit loads, an attempt should be made to have at least one piece of sheathing bear against the rib area. It becomes evident that unless the hull face is parallel with the center line of the ship and perpendicular to the deck, only one corner of the load can be brought to bear at the strip sheathing. However, adequate blocking can be provided by the strategic stowage of subsequent loads. Figure 8-23 illustrates this condition and makes evident the necessity for paralleling the unit load with the ship's center line; that is, a stowage that is uniform and geometrically compatible with the ship's hold.

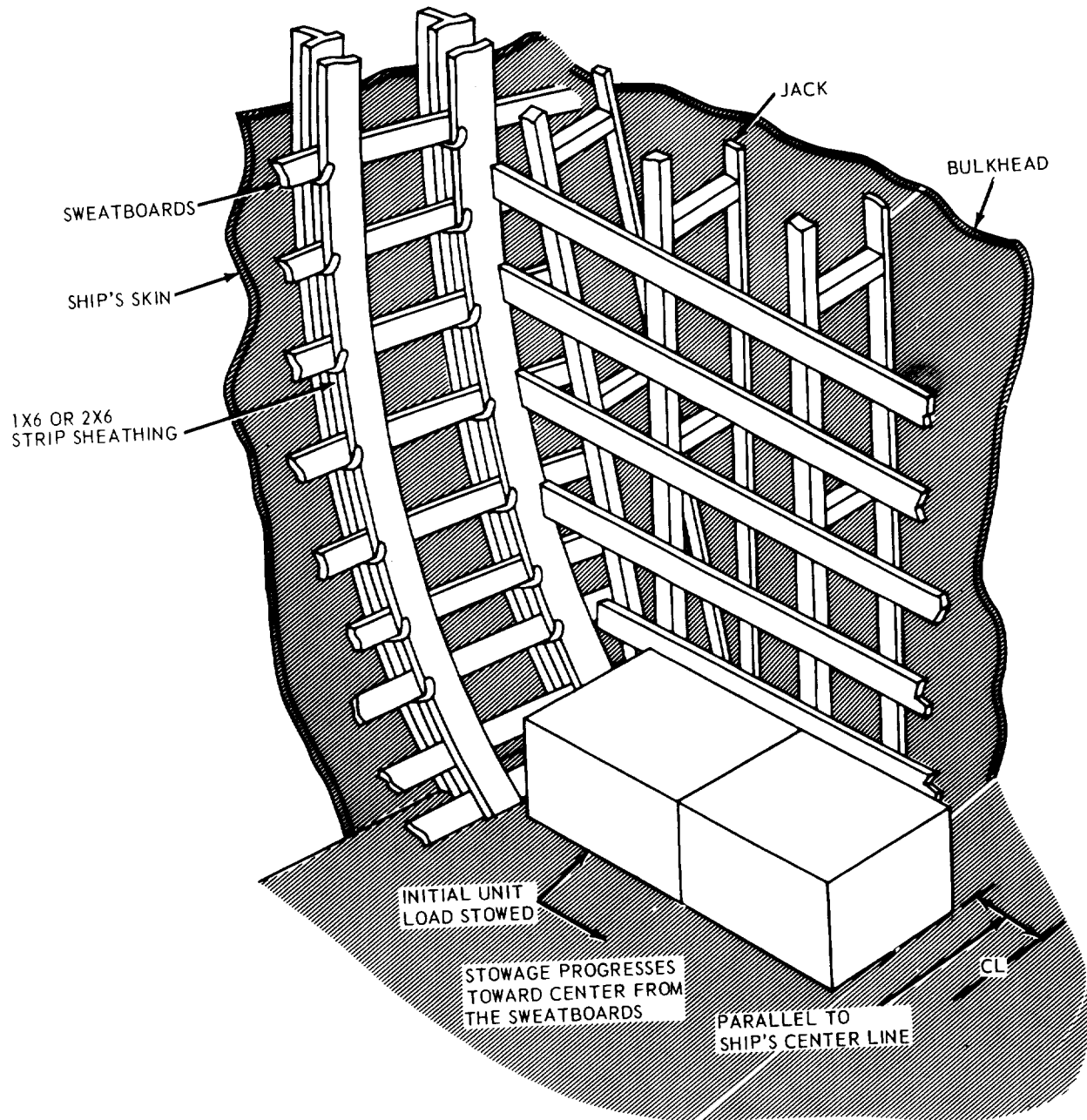


Figure 8-22. Strip sheathing with loads emplaced.

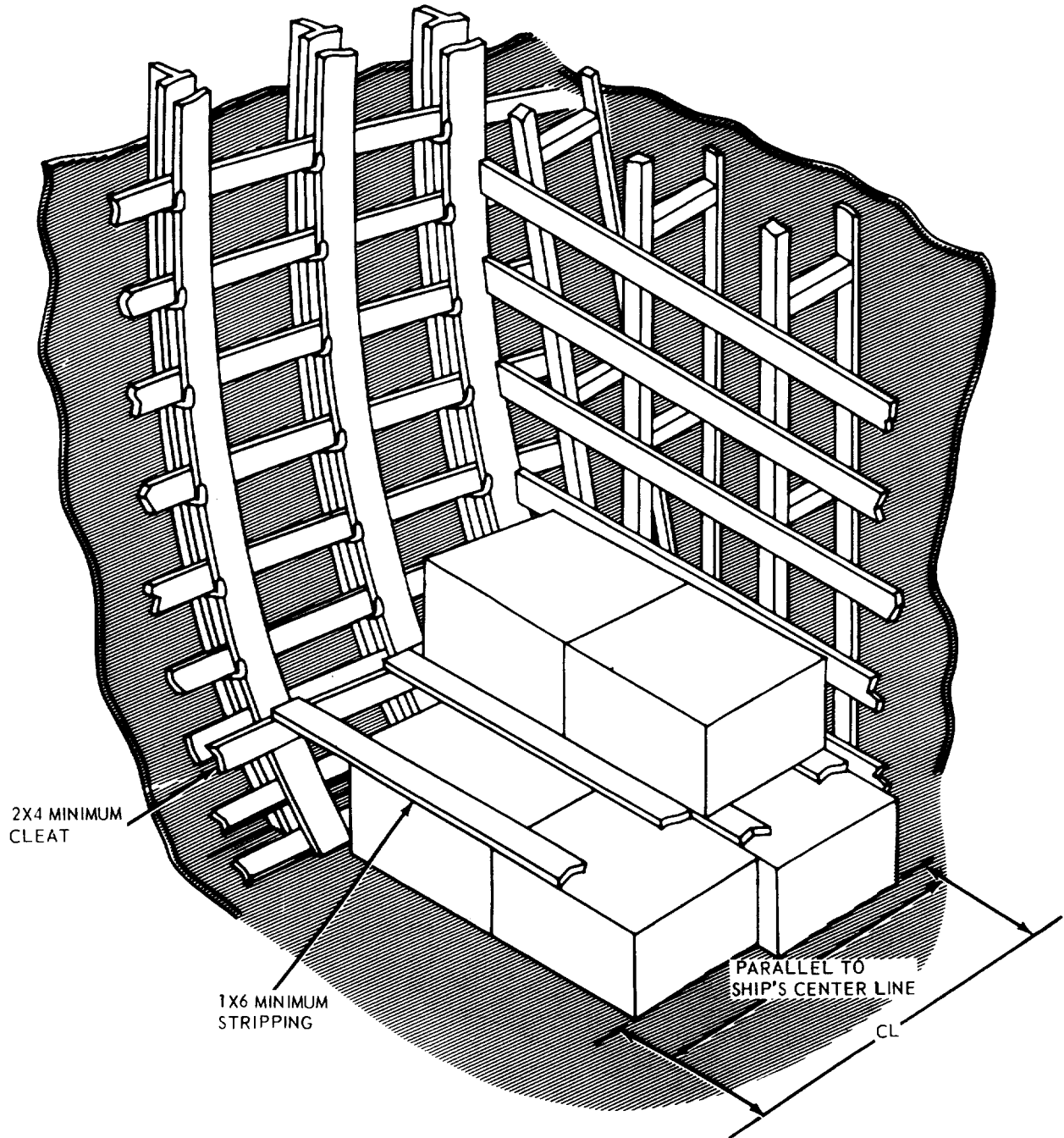


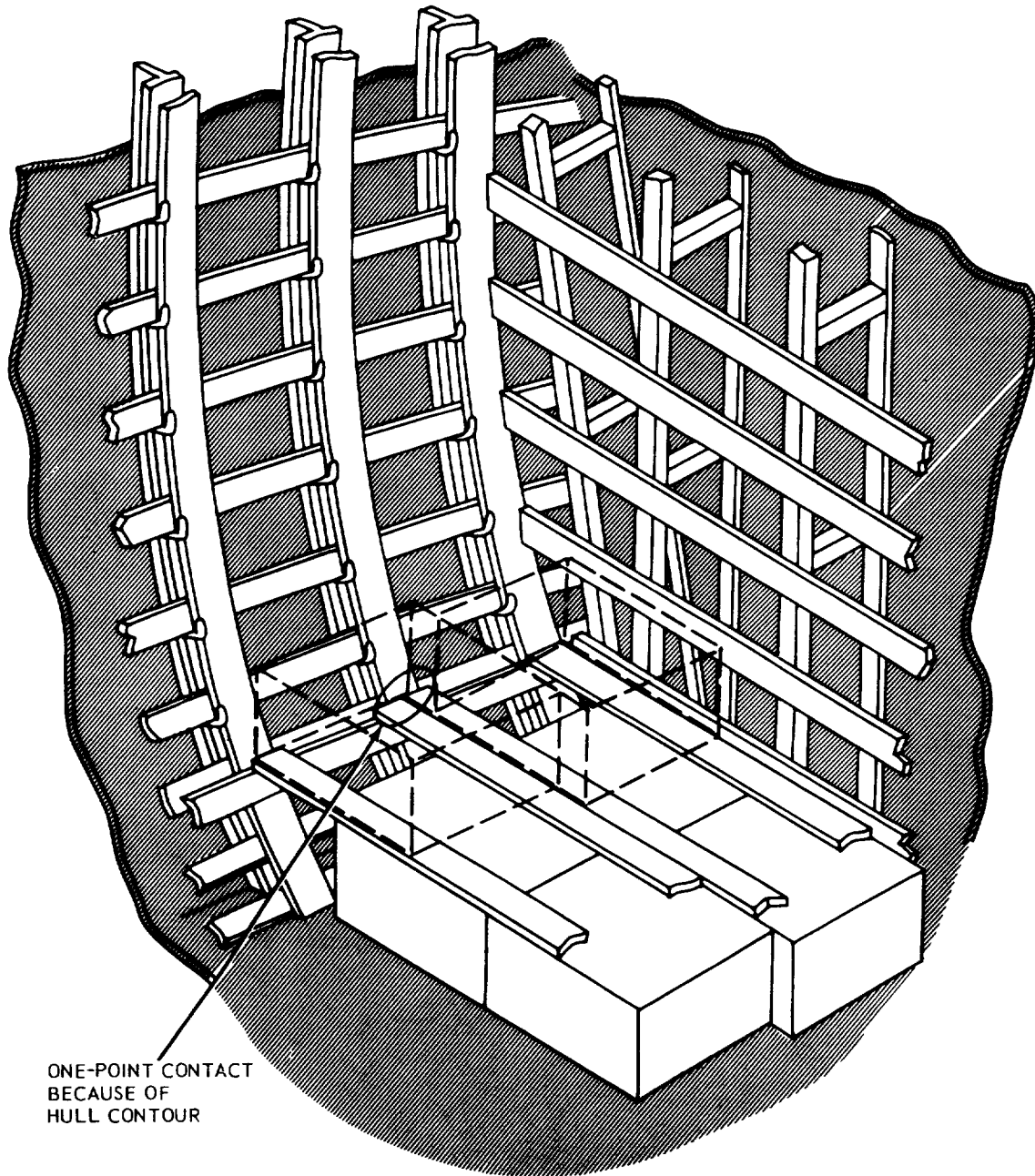
Figure 8-23. Stowing of subsequent loads (sweatboard blocking technique).

b. Figure 8-23 shows the subsequent stowage of the next adjoining row of unit loads. To ensure tight stowage, it is essential that the unit load be positioned to bear both on the strip sheathing and tightly against the initial unit load. The only dunnage required for the bottom tiers at this point is the strip sheathing, which is spaced the widths of the unit loads and reinforced where required. Subsequently, each succeeding row can then be stowed athwartships tightly against the preceding row. Based on the assumption that the stowage extends to the opposite side of the hold, the dunnaging at the sweatboards should be identical to that just described. It is important to note that since tight stowage extends from the sides of the ship toward the center, no more than one central void should occur per row. The overstowed unit loads comprising the elevated tiers are subject to the same conditions as the lower, but lateral displacement from the unit loads in the lower tier is caused by the vertical angle of the hull. Obviously, as the vertical hull angle approaches the perpendicular, as it does in certain holds, the displacement of the unit loads between tiers will be reduced. When this displacement reaches zero, the cargo is essentially block stowed, with only small, randomly spaced voids occurring within the stow. These are shored with either full-block structures or void tables.

c. Pairs of 1-by 6-inch boards are placed between tiers along the entire row. A 2 by 4-inch cleat is fastened to the strip sheathing at a level even with the top of the unit load to provide a solid bearing surface for the tier stripping, and this is the foundation for the unit loads comprising the next tier. The tier stripping is nailed to the cleats. Tier stripping in certain cases need not extend the full length of the row. For example, if the unit loads are rectangular and present a uniform bearing surface to adjacent loads, then tier stripping is needed only to span from the aforementioned cleats across the top of the end load. In holds where the hull angle is more nearly perpendicular, tier stripping is not required.

d. Figure 8-24 illustrates the tight stowage that can be obtained by using the one-point technique of unit-load positioning at the sweatboards. The bulkheads constructed across the fore and aft ends of the stowage prevent cargo movement in these directions. While it may appear that lateral forces could cause movement of unit loads at the strip sheathing, closer examination reveals that this is not the case. Any forces athwartships are blocked at the bearing points of the loads at the sweatboards. The bearing points essentially are reduced to pivot points, which restrict load movement to a rotational rather than a straight-line movement. Rotational movement is blocked by the adjoining loads and the bulkheads. Therefore, the effectiveness of this stowage is dependent upon the following:

- (1) Dunnaging at the ship's sweatboards.
- (2) Dunnaging at the fore and aft ends of the stowage.
- (3) Stowing the cargo so that bearing surfaces between unit loads are maximum.
- (4) Effective shoring of all voids between unit loads to prevent athwartship movement.



**Figure 8-24. One-point technique of unit-load positioning (sweatboard blocking technique).**

e. When the stowage of the unit loads in the lower tier is complete, all voids in that tier must be considered for dunnaging. Voids in lower tiers that exceed one-third the length of the unit that overstows the void shall be dunnaged. Smaller voids need not be dunnaged, since the overstowed unit load will be adequately supported by the unit loads below, and athwartship movement by the loads in the lower tiers will be restricted by the weight of the overstowed unit loads and blocked by effective dunnaging at the sweatboards. The exception is the top tier, where all voids must be dunnaged, regardless of size. Additional shoring at the strip sheathing is required for the top tier because overstay weight, which restrains lateral movement of unit loads in the tiers below, is nonexistent here. Shoring at the top tier will vary with the hull angle as illustrated in figures 8-25 and 8-26.

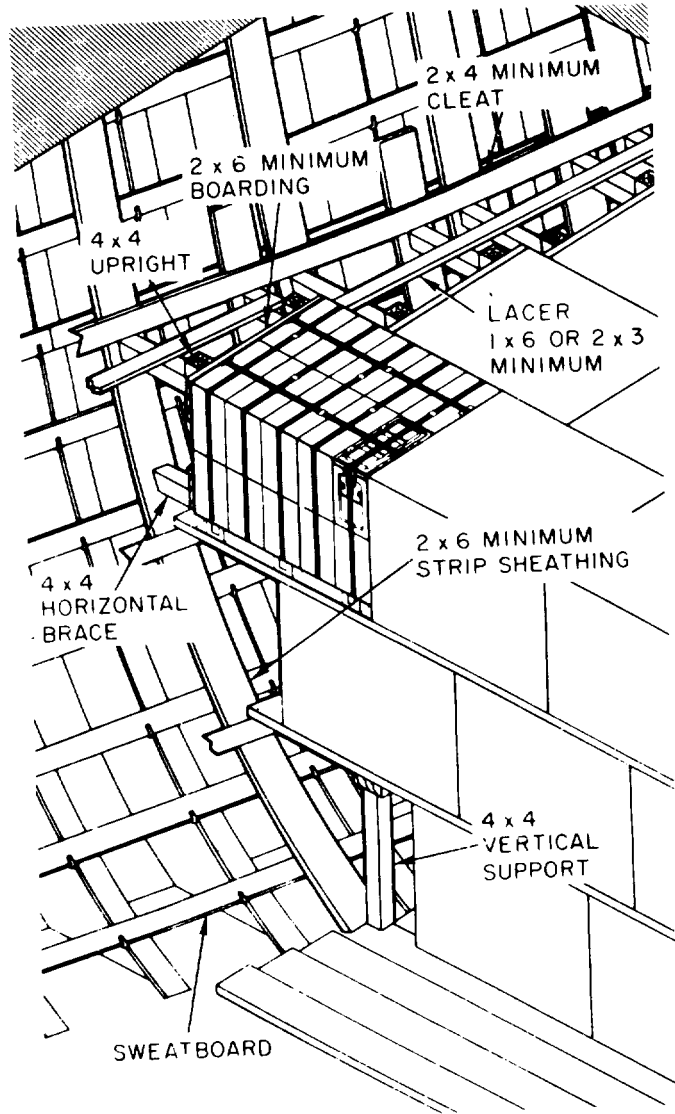


Figure 8-25. Top tier bracing at sweatboards, small hull angles (sweatboard blocking technique).

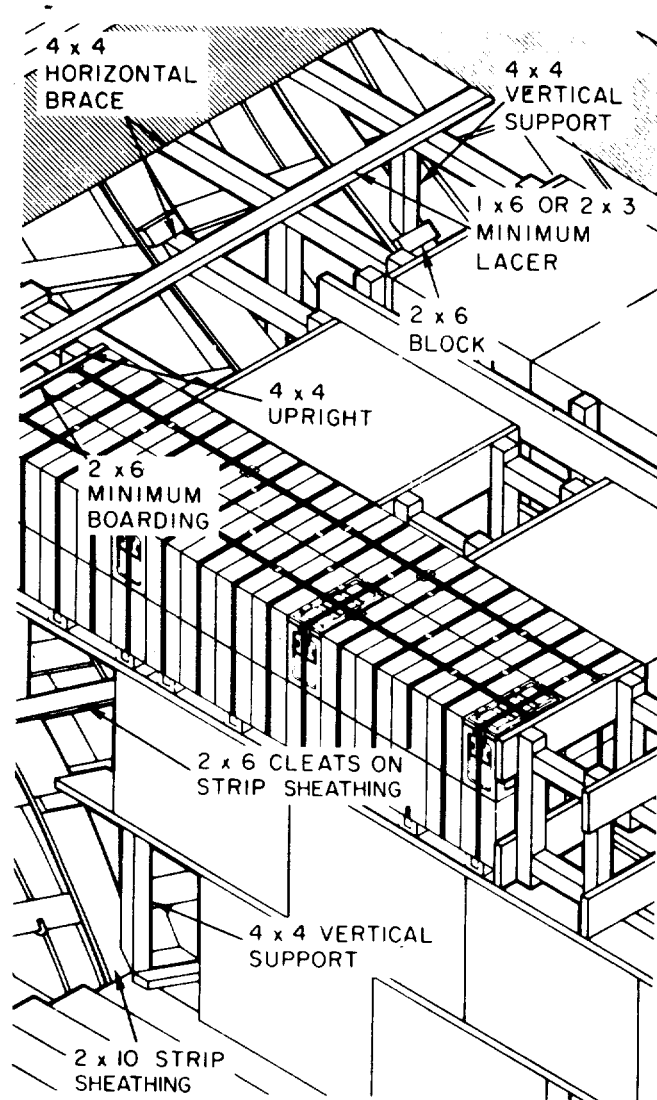


Figure 8-26. Top tier bracing at sweatboards, severe hull angles (sweatboard blocking technique).

**8-5. Sweatboard-to-Sweatboard Shoring of Cargo Voids**

a. Figure 8-27 shows one method of shoring voids. It should be noted that the supports in the lower tier voids are simply prefabricated void tables made up of two 2 by 6-inch plates fastened to two 4 by 4-inch uprights. A method of fabricating tables is shown in figure 8-28. The height and depth of the table, of course, are equal to those of the unit loads in the tier. Tables are not used in voids in the top tier, where overstow weight is absent; instead, a fullblock structure is used to eliminate movement of the unit loads. Details of this structure are shown in figure 8-29. The width is such that it bears tightly against each unit load. The height and depth are equal to those of the unit loads.

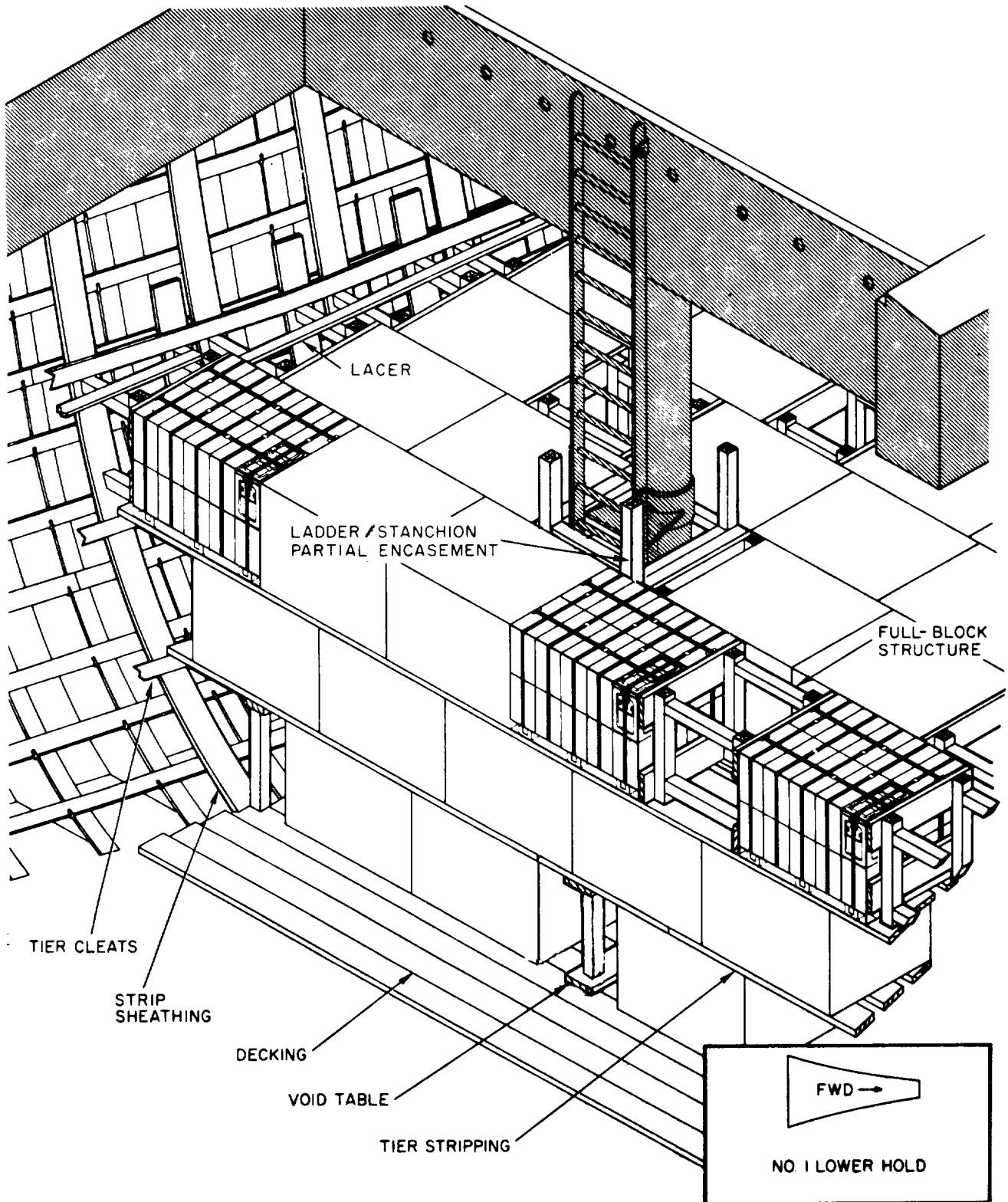
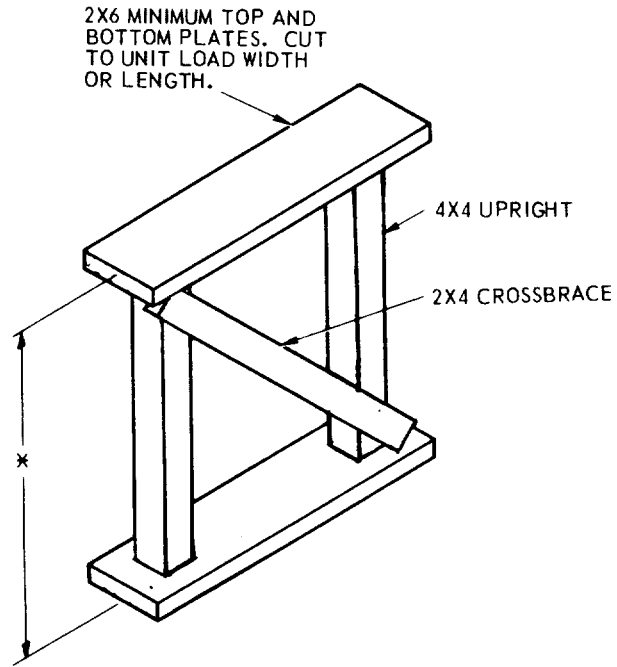


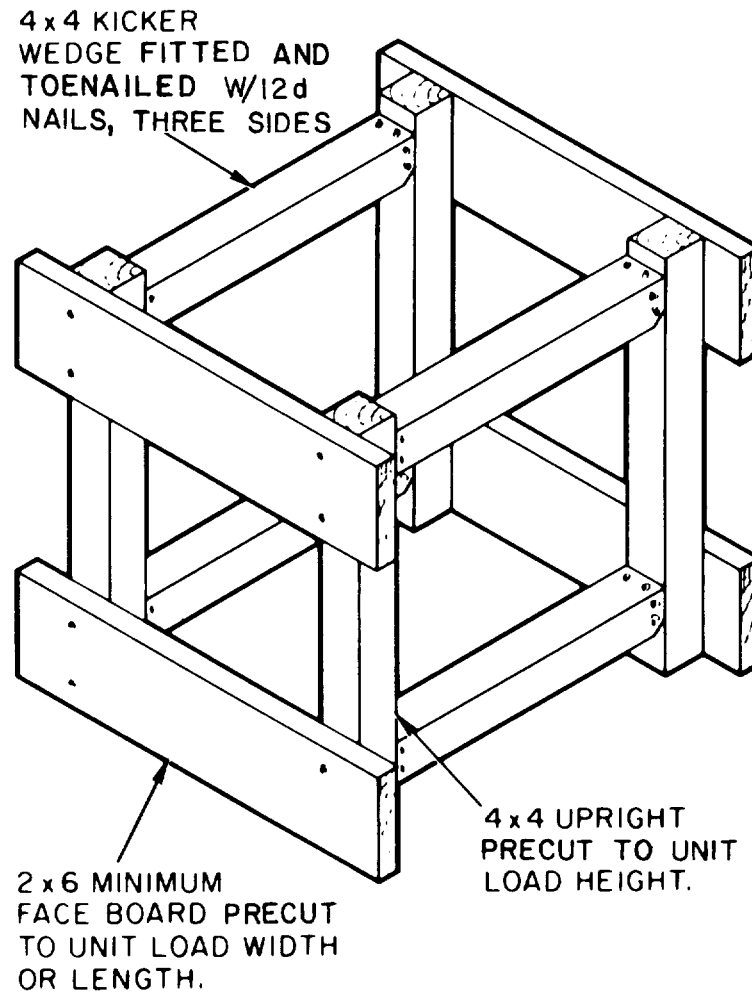
Figure 8-27. Sweatboard-to-sweatboard stowage of 20-mm cartridges, lower hold No. 1 (sweatboard blocking technique).





\* UNIT LOAD HEIGHT

Figure 8-28. Construction details for prefabricated void table.  
8-30



**Figure 8-29. Full-block structure for tier voids, two-face-board construction.**

*b.* Construction of a full-block structure begins with the assembly of the two-face-board frames that bear against cargo in the athwartship direction. Two by six-inch face boards, cut to the width or length of the unit loads, are nailed to two 4 by 4 inch uprights, so as to bear against the top and bottom of the unit loads. The two frames are then wedged against the unit loads with four kickers nailed in place to each upright. The fourth side of the void is formed by the unit loads in the next row of cargo. This sequence is illustrated in figure 8-30. Smaller voids, which are too small for the construction of a full-block structure, may be shored with random pieces of lumber, cut to fit. The use of wedges, even nailed, is not considered an acceptable method to tighten the top layer of cargo stow.

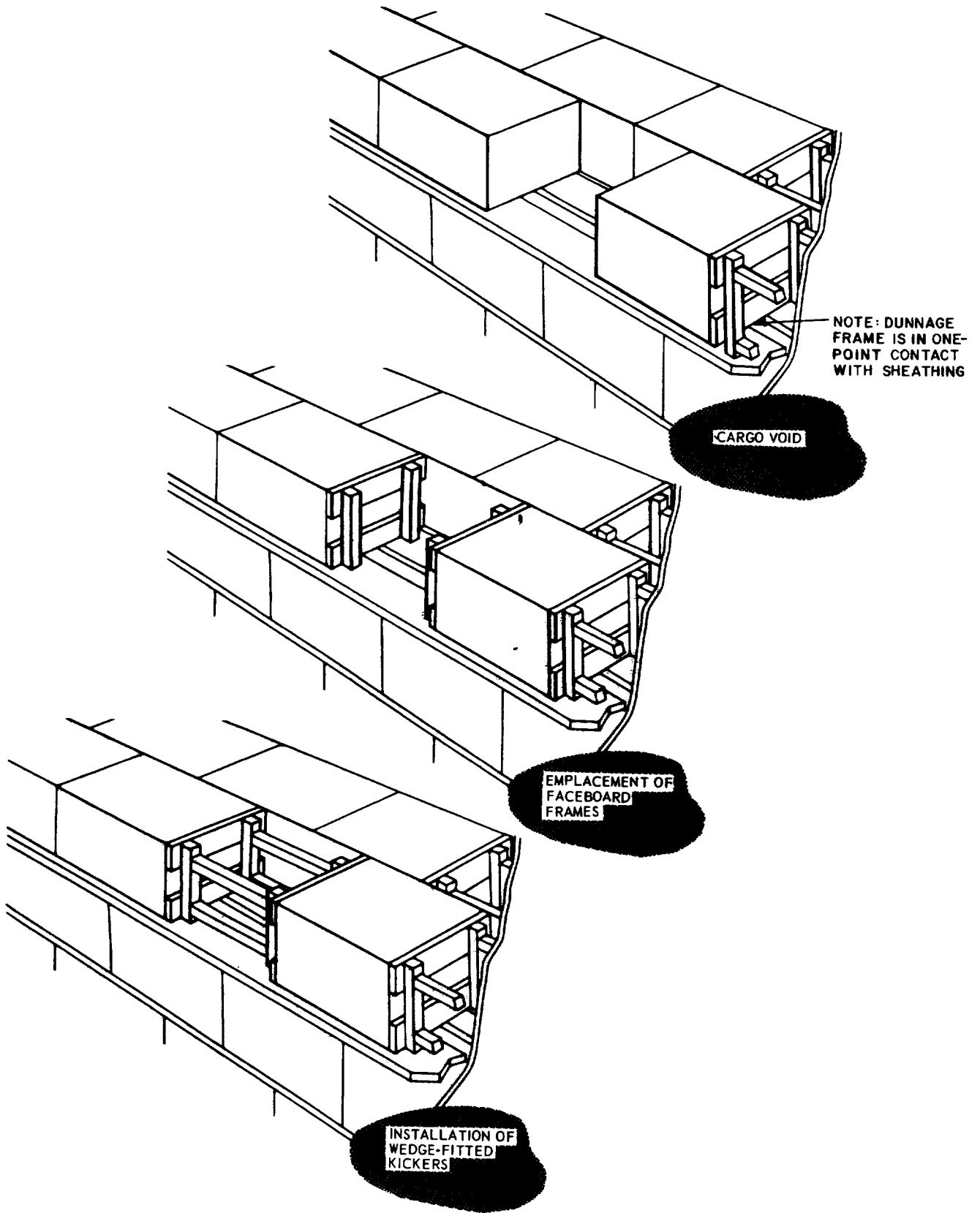


Figure 8-30. Sequential shoring of cargo void (sweatboard blocking technique).  
8-32

c. Voids that occur at the sweatboards are shored in a similar fashion: a two-face-board frame is placed against the unit load and supported with kickers to the sheathing, as shown in figure 8-31. The number of kickers will vary with the severity of the hull camber and sheer, since at least one point of the face-board assembly will already be in contact with sheathing. For any situation, however, the bearing area against the sheathing should be equal to at least the equivalent of four kickers. The kickers, in turn, should be toenailed to the sheathing and secured against upward movement by the addition of a 2 by 4-inch cleat. Ideally, the sheathing and kickers should be placed opposite the ship's stiffeners for maximum strength. The size of many unit loads prevents this, and frequently sheathing and shoring material must be secured against the sweatboards in between the stiffeners. To provide added strength to the sweatboards in this area, a 2 by 6-inch minimum board should be nailed to the sweatboard prior to the installation of sheathing. This reinforcement technique, part of the void shoring process, is normally required in the top layer only.

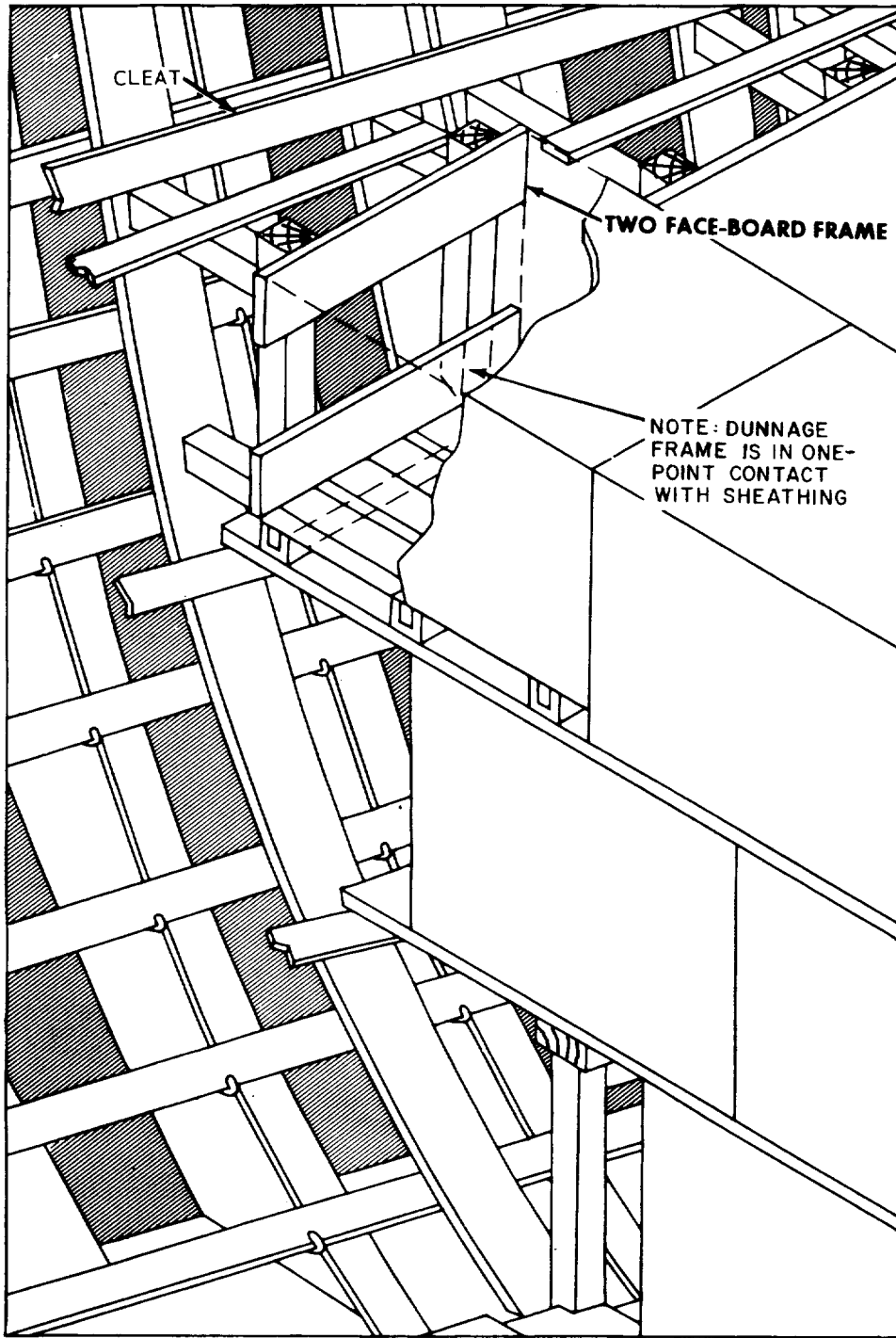


Figure 8-31 Shoring voids at the sweatboards (sweatboard blocking technique).

d. When a ship's structure in the cargo hold (such as a ladder or kingpost) is encased, the sweatboard-to-sweatboard stowage pattern may be modified to permit tight stowage against the encasement structure. In this case, stowage would begin in the normal manner at the port and starboard sweatboards and work in toward the center of the hold. Cargo should also be placed tightly against the encasement structure at this time. The overall stowage then progresses from both the encasement and sweatboards toward each other. Any void that occurs at the center will be shored with a full-block structure.

e. Again, it is stressed that the preference of the ship's master is final, and he may require full-block construction for all voids. If this be the case, construction will vary with the configuration of the unit load and the width of the void, but the requirement for full blocking, providing bearing surfaces for the full depth of the unit loads bounding the void, must be satisfied. Figure 8-32 shows a typical full-block structure in the top tier of 750-pound bomb unit loads. Figure 8-33 shows a void between unit loads of a top tier that is in the process of being fully blocked. Construction details for another type of full-block structure is shown in figure 8-34.

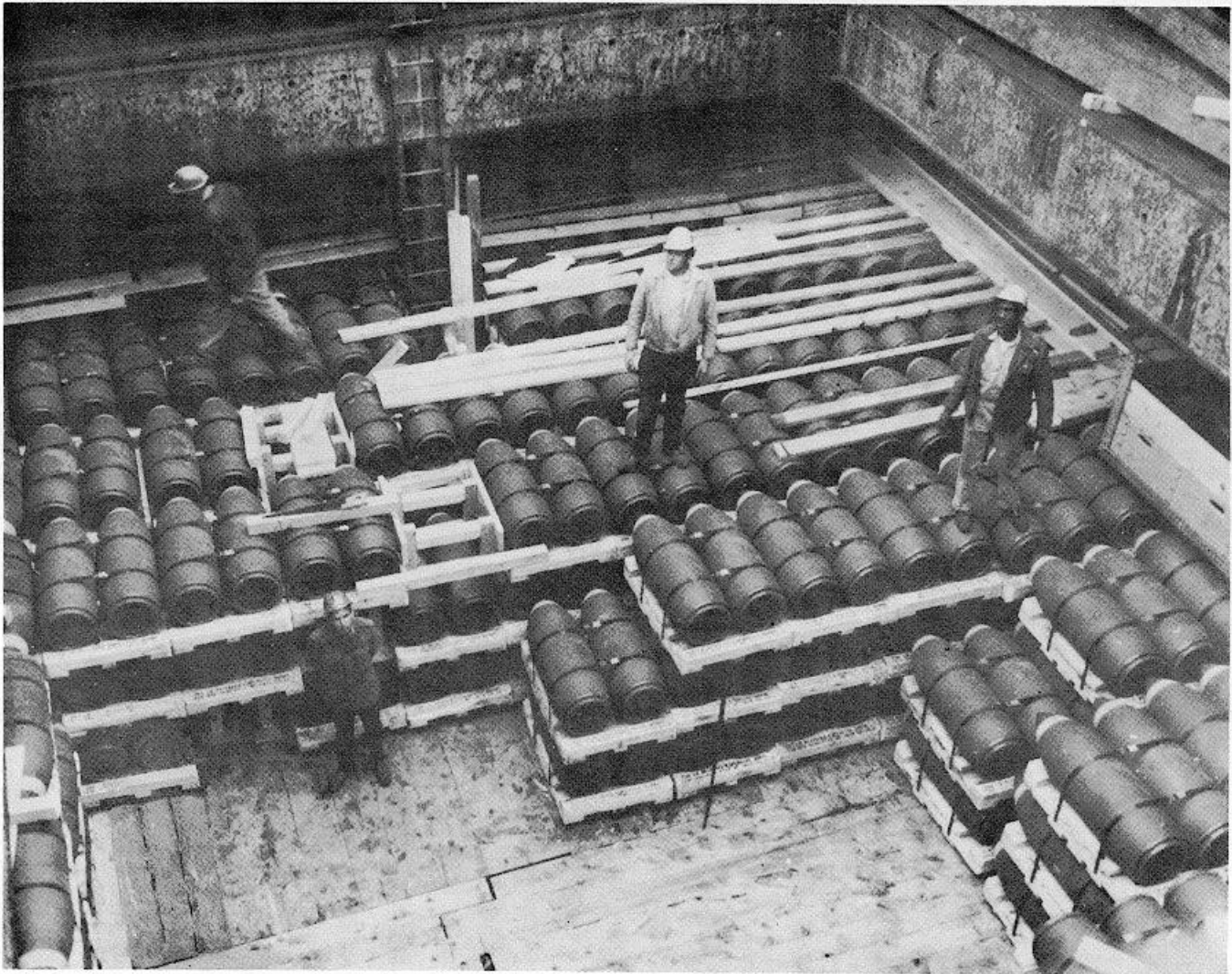


Figure 8-32. Full-block structure used with 750-pound-bomb unit loads.

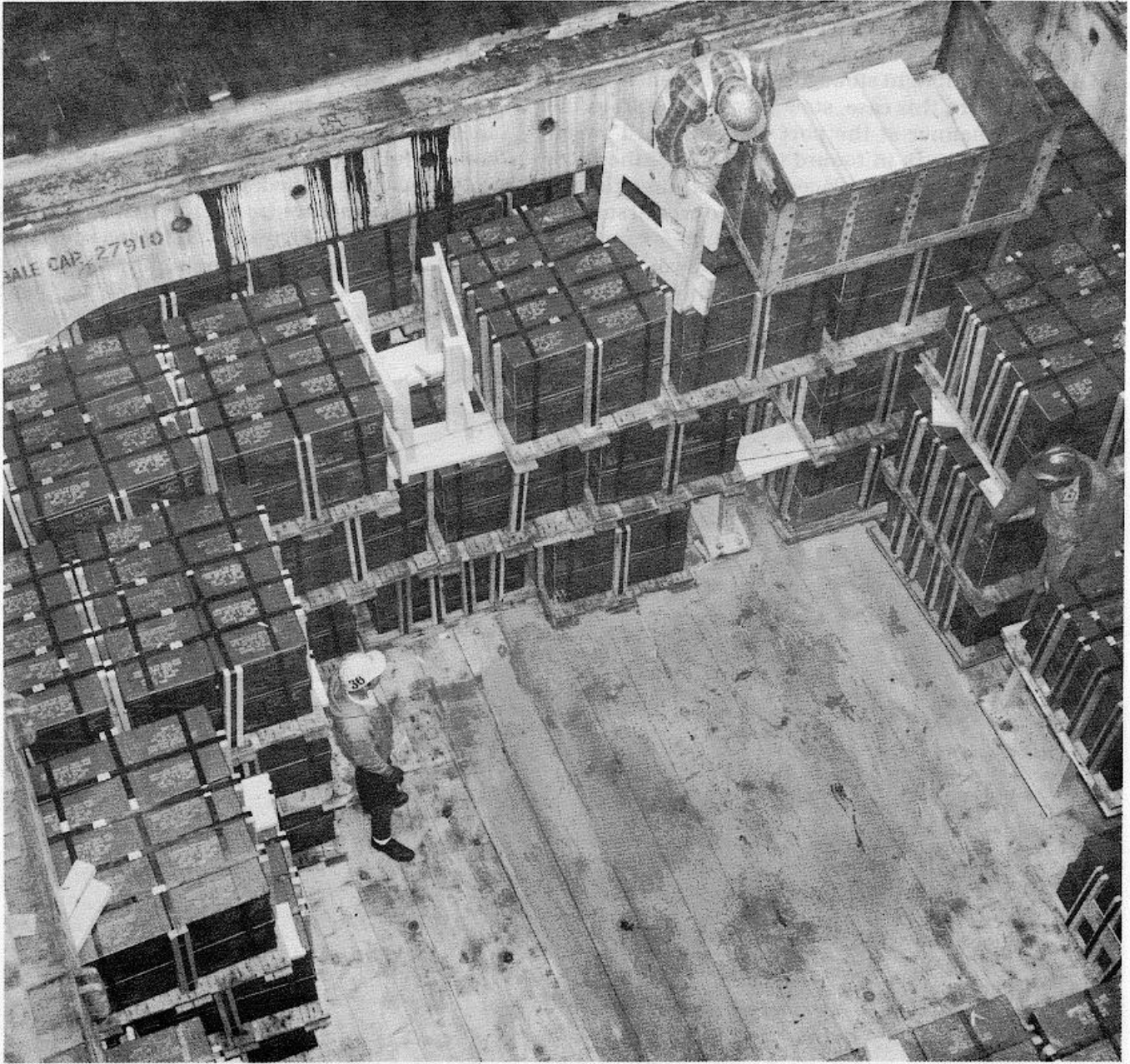


Figure 8-33. Top tier void in process of being blocked.  
8-36

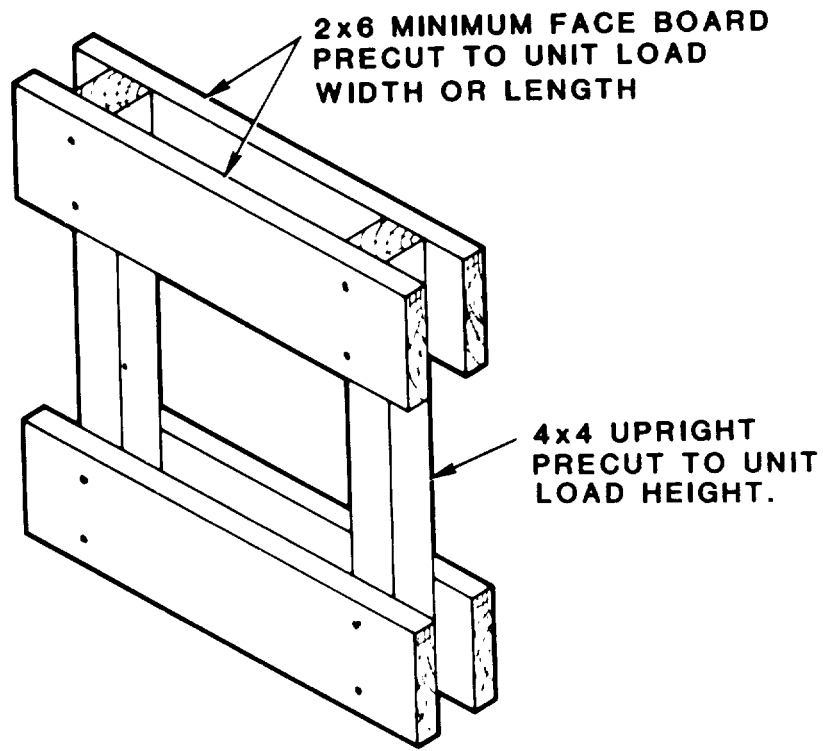


Figure 8-34. Full-block structure for narrow tier voids.  
8-37



## CHAPTER 9 SECURING OF SPECIFIC LOADS

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### 9-1. Introduction

Military explosives and ammunition loaded aboard merchant-type vessels may be unitized on metal or wood pallets or skids, unitized in groups of containers, or shipped as single items as described in paragraph 4-4. The explosive loads are classified generally as follows:

- a. *Rectangular Unit Loads.* Items unitized on wood pallets, metal pallets, or skids.
- b. *Round, Single-Item Loads.* Large items loaded individually.
- c. *Overhanging Unit Loads.*
- d. *Single Containers and Unitized Loads of Containers.*

Basic principles of block stowage or sweatboard-to-sweatboard stowage can be applied to all of the foregoing classifications; however, minor procedural modifications are often necessary in the stowage of these typical loads in the holds of merchant ships. Contour of the hull, particularly in lower compartments of forward and aft holds, is a significant consideration in selecting the most efficient stowage method for a given compartment. By a comparison of the size and

configuration of the unit loads with characteristics of the available stowage area, optimum use can be made of the two securing techniques. This principle is introduced in the text and illustrations by providing alternate stowage methods for the same item. This section applies the general methods described in previous chapters for securement of specific loads of explosives in C3 and C4 hulls. Procedures defined for a given item can vary with different compartments; however, the basic method will be applicable to similar commodities within that particular classification.

### 9-2. Securing Rectangular Unit Loads

- a. *500-Pound Fire Bomb, MK 77 MOD 4, Palletized Unit Load.*

(1) Stowage of palletized unit loads of 500pound fire bombs, MK 77 MOD 4, is limited to areas that have adequate height clearance, since this load is about 8 feet high. Figure 9-1 shows this commodity stowed in between deck 3, where there is not enough clearance for two tiers. However, there is sufficient clearance for overstowing with other kinds of loads.

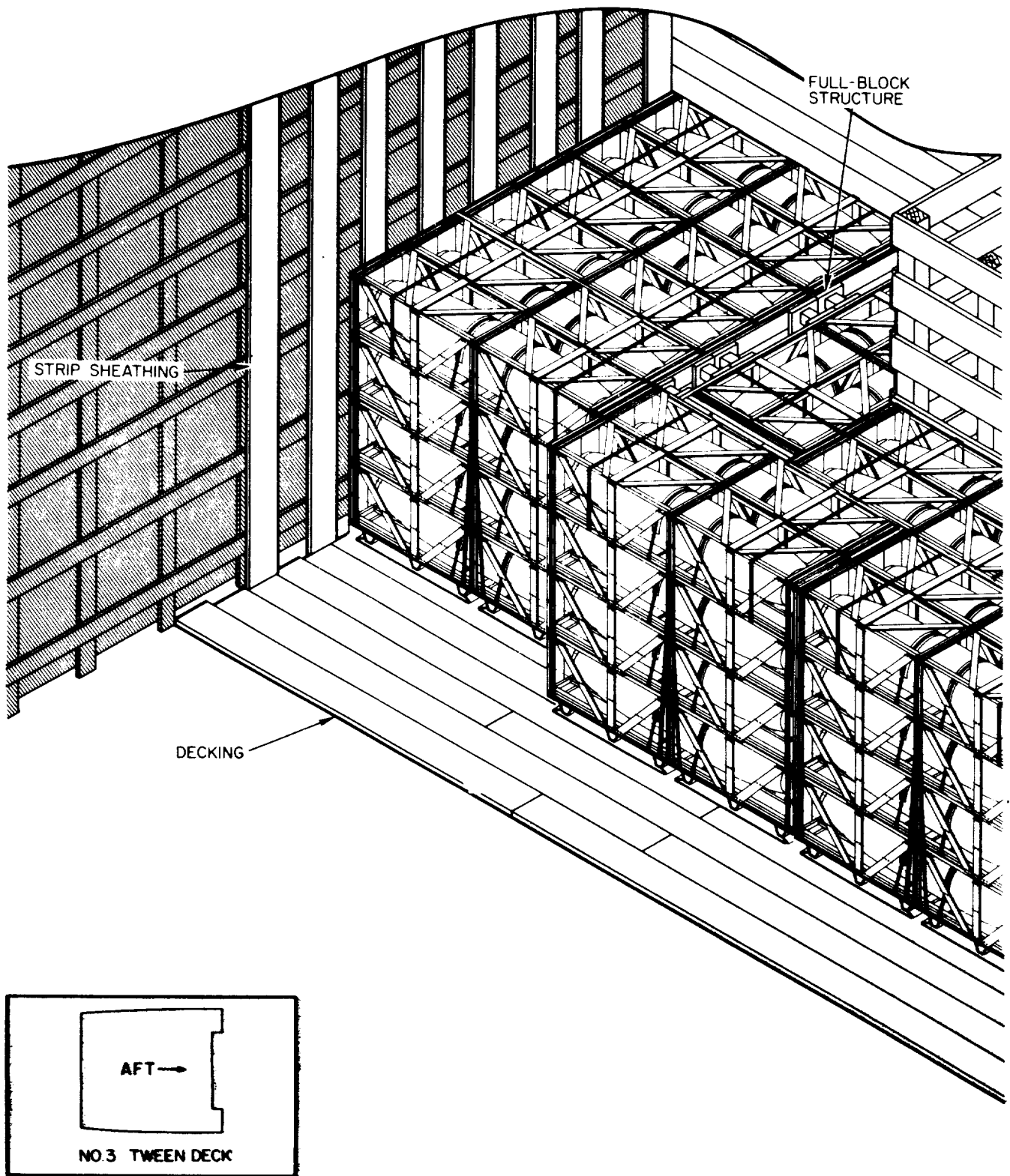


Figure 9-1. Stowing and securing of 500-pound fire bomb, MK 77 MOD 4, between deck compartments (sweatboard blocking technique).

(2) The loads can be placed to bear fully against the strip sheathing and the heat bulkhead, as shown, to provide a tight stow with relatively little dunnaging. Stowing one load fore and aft in the corner created by the heat bulkhead and filling the resultant void between this load and the three stowed along the sweatboards with a full-block structure will result in a solid stowage. Although the stowing of subsequent loads will produce rows that are offset somewhat, this condition is not uncommon and does not result in a marginal stowage. When the final row is stowed, compensation for this displacement can be provided by construction of a full-block structure or an end bulkhead, whichever is appropriate. The decking shown in figure 9-1 is TM 55-607/NAVSEA OP 3221 Rev 2 required because metal pallets are used, and metal-to-metal

contact between loads and the ship's deck must be avoided.

b. *500-Pound Fire Bomb, BLU-32/B, Palletized Unit Load (Air Force).*

(1) The 500-pound fire bomb, BLU-32/B, can be stowed readily in most holds of the ship, including those having severe camber and sheer angles as in the forward area of lower hold number 5 (or the aft portion of lower hold number 1), as shown in figure 9-2. Acceptable stowage configurations for this load in lower hold number 5 with the sweatboard-to-sweatboard technique are shown in the two insets. The basic illustration depicts the loads stowed as in inset B.

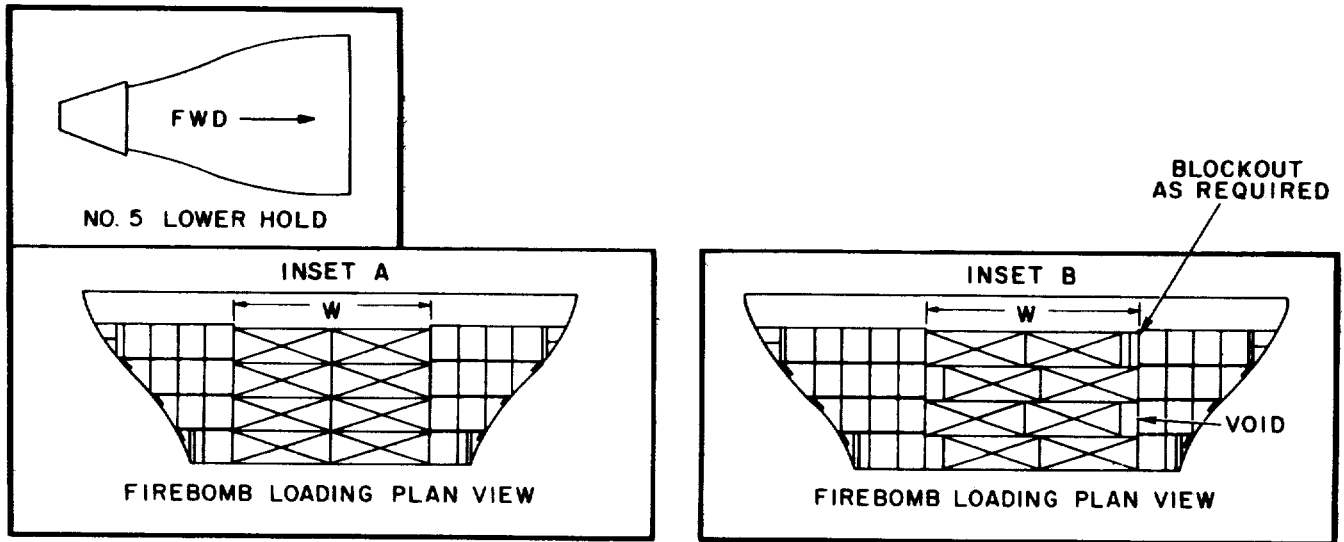
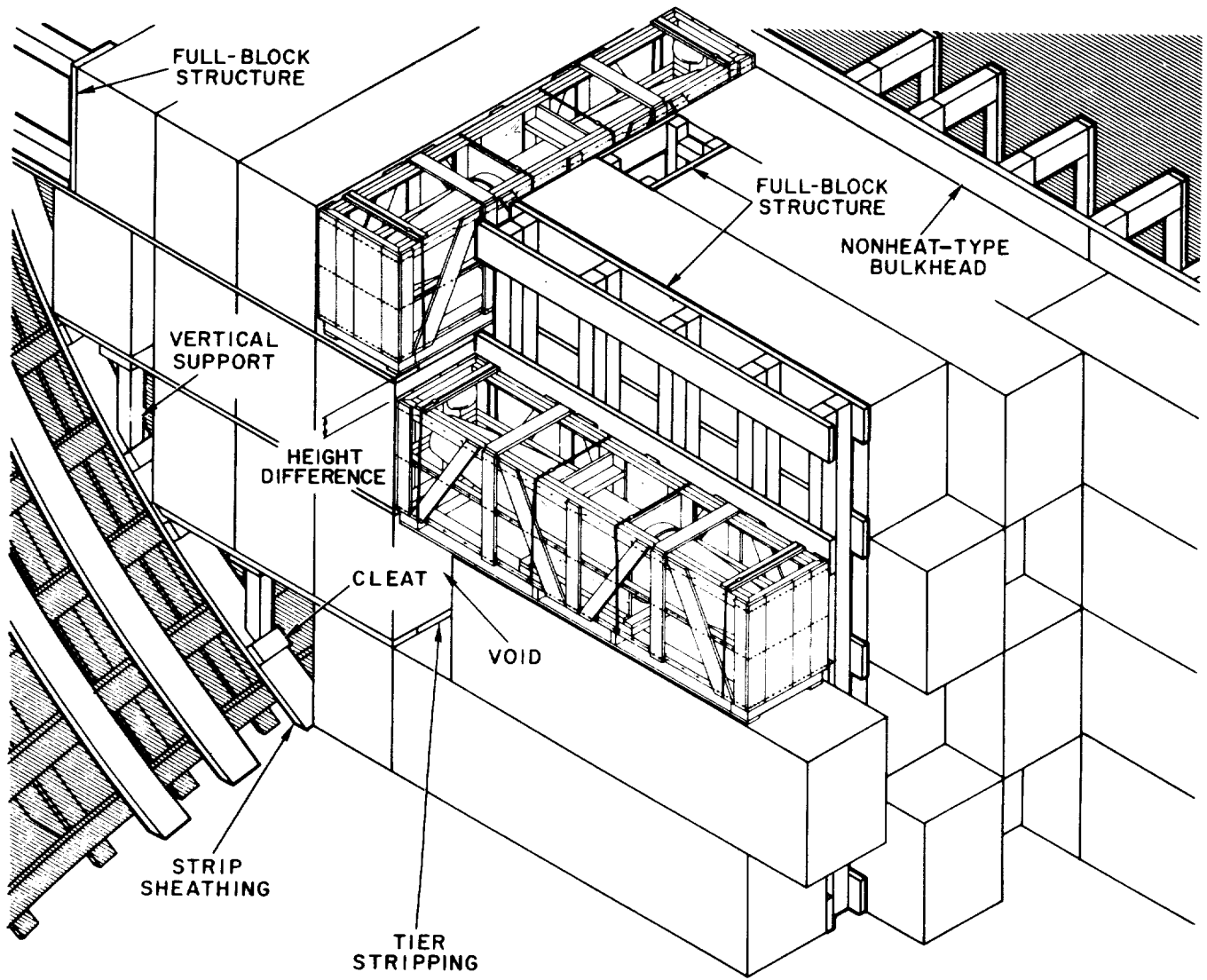


Figure 9-2. Sweatboard-to-sweatboard securing of 500-pound fire bomb, BLU-32/B, in lower hold No. 5, C3 hull (sweatboard blocking technique).

(2) The number of loads to be stowed and the distance port-to-starboard of the stowage area determine which configuration should be used. In either instance, it can be seen that a given number of loads at both sides of the hold are stowed longitudinally fore and aft and that the inboard stowage area contains loads that are stowed longitudinally athwartships. Each case makes optimum use of space and results in a tight stow.

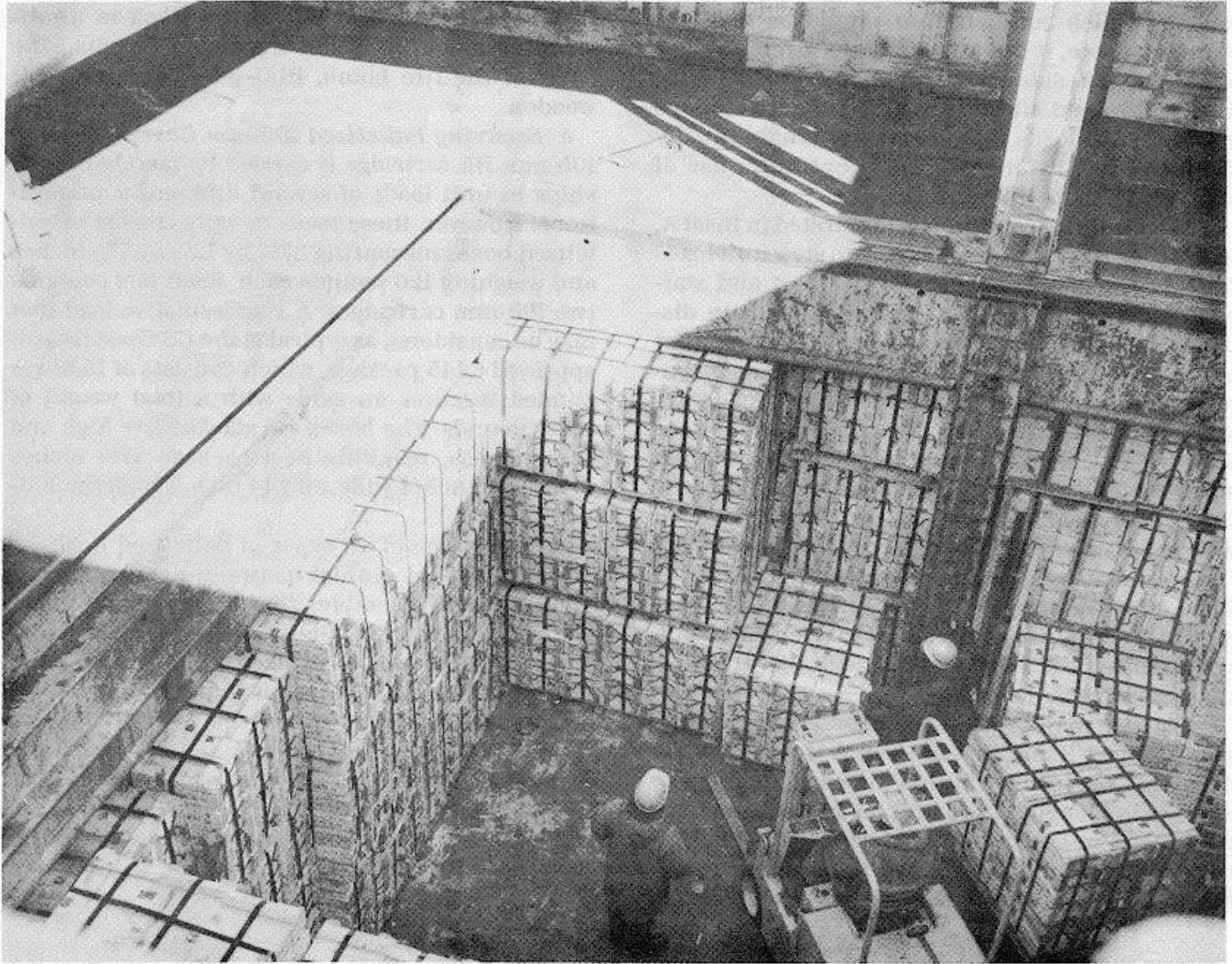
(3) The ideal condition is illustrated in inset A, figure 9-2. Here, the procedure is to stow unit loads from predetermined points at the port and starboard sides of the hold, which will result in distance "W" being nearly equal to the length of either one or two unit loads, whichever is more convenient. Then, in the inboard area, unit loads are stowed athwartships. Notice that no voids are shown between unit loads in inset A, although small voids actually may exist in all tiers except the top tier. Any void in this tier regardless of how small will be fully blocked. It is feasible that a void in this instance may only be inches in width and can be filled effectively by use of appropriate thicknesses of 2by 10 or 12-inch boards cut to size. As a result, the height of the inboard stowage is slightly lower than the outboard stowage.

(4) The major difference between the loading plan in inset B and that of inset A (fig 9-2) is the distance "W". In inset B this distance appreciably exceeds the length of two unit loads. Consequently, voids exist in each tier, but if voids in tiers other than the top tier are no larger than one-third the length of the unit load, they need not be blocked.

All voids in the top tier will be blocked. This condition is clearly shown in inset B and the basic illustration. Wherever the ship's deck is unobstructed, decking is not necessary because the skids of the fire bomb, BLU-32/B, unit load are wooden.

*c. Securing Palletized 105-mm Cartridges.* The 105-mm HE cartridge is carried by merchant-type ships in unit loads of several different configurations. However, these loads usually consist of palletized boxes measuring 37Y4 by 121/s by 73/4 inches and weighing 120 pounds each. Each box contains two 105-mm cartridges. A representative load that may be considered as typical is the US Coast Guard approved C445 package, which consists of 15 boxes banded together on skids with a total weight of 1,840 pounds. The boxes are stacked five high and three across, resulting in a package 37V4 inches long, 363/8 inches wide, and 44 inches high (including the skids).

(1) Stowage of all types of palletized boxes of ammunition in amidship between-deck compartments closely resembles that illustrated in figure 9-3. The efficiency of the stow is evident, as maximum available cube is utilized without significant voids. Positioning of pallets is important in achieving a secure stow and requires that the unit loads be stowed with careful horizontal and vertical alignment of rows and tiers. Each unit load should bear tightly against adjoining loads in the stow. Random small voids within the stow are secured with full-block structures or void tables.



**Figure 9-3. Stowage of palletized unit loads in tween-deck compartment.**

(2) Prestow requirements for the stowage of 105-mm ammunition unit loads in a rectangular hold or compartment are minimal. Partial 1-inch minimum strip sheathing or boarding is installed TM 55-607/NAVSEA

OP 3221 Rev 2 along the hull as shown in figure 9-4 to protect against protrusion, for instance, padeyes or sweatboard hangers. Heat or nonheat bulkheads or encasement structures are constructed as required.

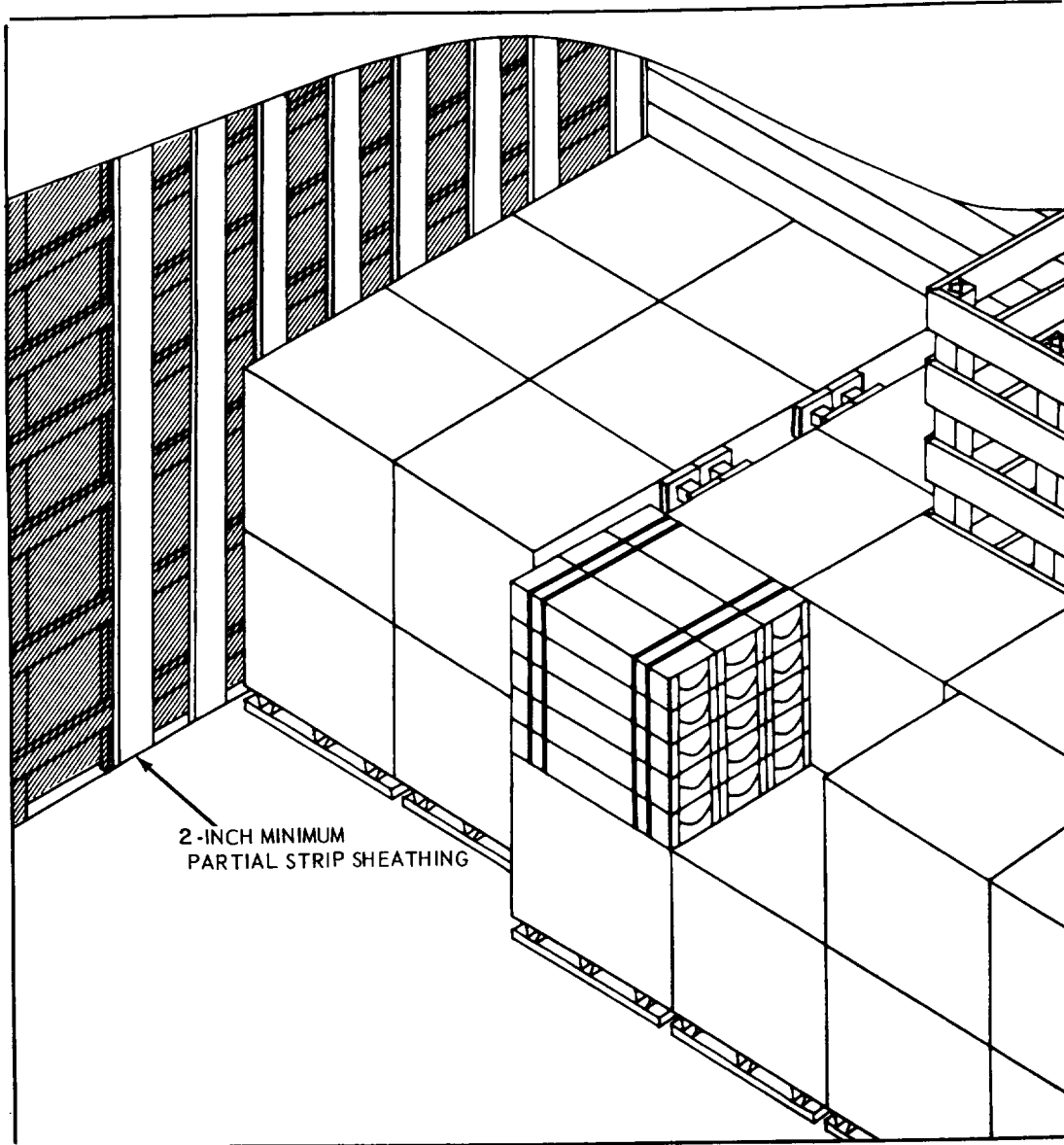


Figure 9-4. Strip sheathing and bulkhead requirements for 105-mm unit loads (sweatboard blocking technique).

(3) Block-stow securing of 105-mm palletized unit loads at the hull in a compartment with mild sheer is shown in figure 9-5. Uprights of 4by 4inch stock bear against the unit loads and are braced to the hull plate or ribs with 4by 4-inch kickers cut to fit. Since one end of the unit load contacts the sweatboards, only one upright per row is necessary. Full construction details are shown in figure 8-4. As cargo is worked toward the wider central portions of the compartment, outboard pallets are stowed farther out toward the hull than those of the preceding row. Consequently, a void in the fore-

and-aft direction can result. To prevent ammunition boxes from being secured exclusively with the pallet banding, fore-and-aft shoring should be installed as shown in figure 9-6. While the illustrated item is the 81-mm cartridge unit load, the shoring technique is applicable to all boxed palletized ammunition. A 4-by 4-inch upright is positioned in contact with the outboard boxes and is braced to the nearest structural rib, as shown.

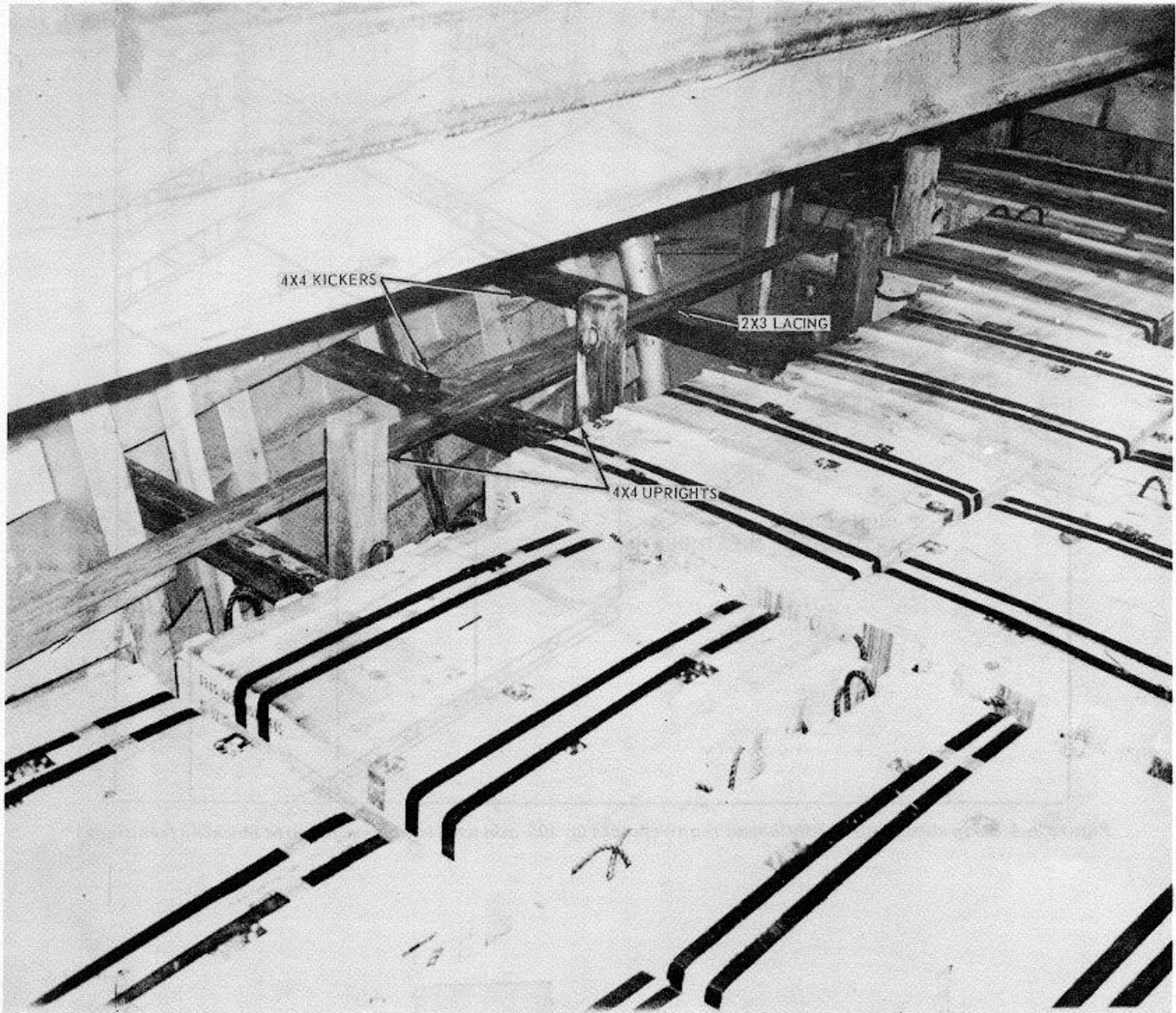


Figure 9-5. Securing of 105-mm palletized unit loads at the hull (hull blocking technique).



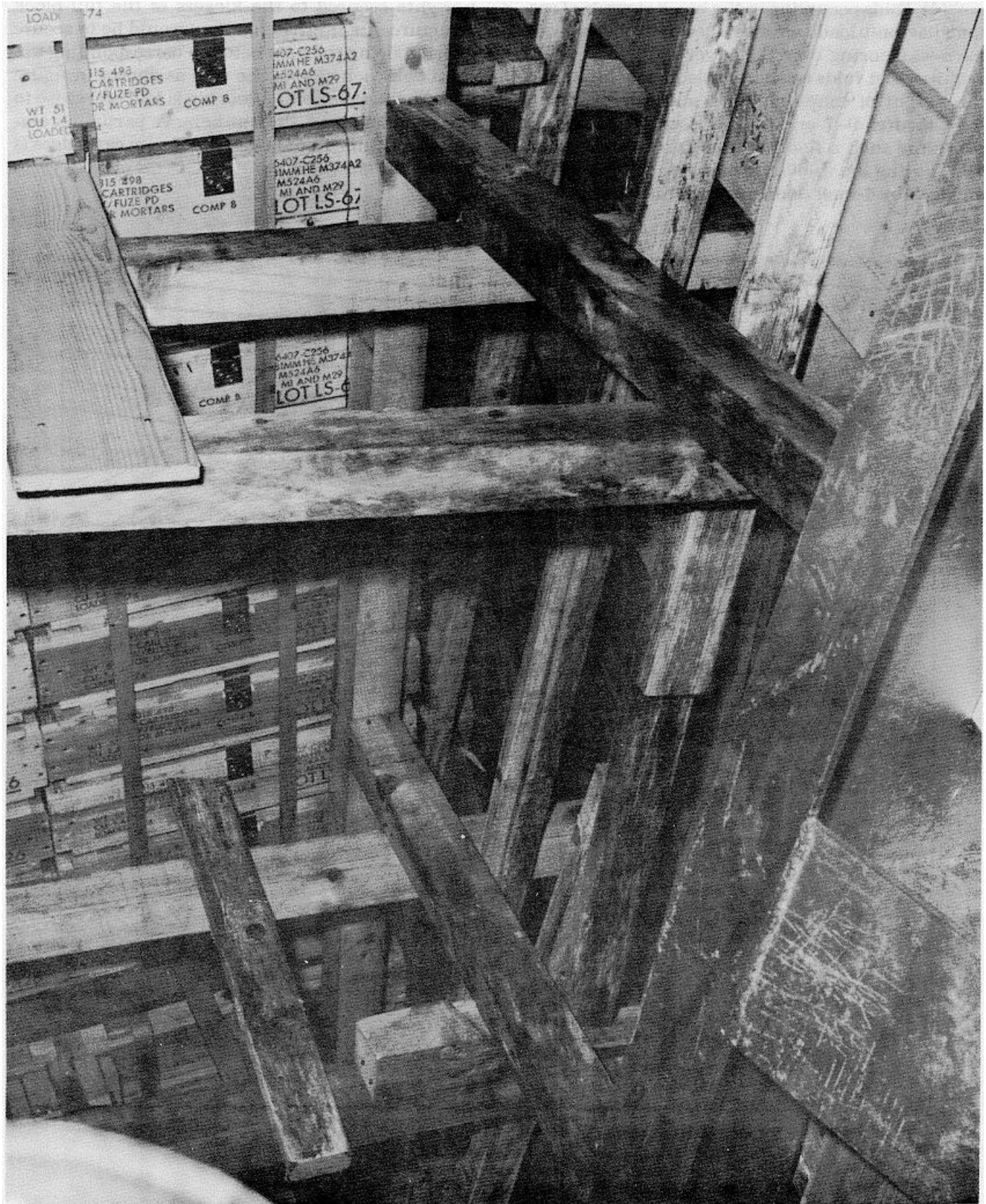


Figure 9-6. Fore-and-aft shoring of palletized boxed ammunition (forward hold 1, aftward view, hull blocking technique).

(4) Voids occurring in the block stowage of rectangular unit loads are usually relatively long and narrow. Flooring over the lower levels of stowage requires that voids be shored adequately to support the weight of cargo-handling machinery passing over. Figures 9-7 and 9-8 illustrate methods for providing such a flooring foundation, while laterally shoring the void between rows. In figure 9-7 a single 4by 4-inch flooring runner is supported by uprights secured to the kickers of

the full-block structure. An alternate method would be to secure short flooring runners between corresponding uprights on each side of the void as shown in figure 9-8. The first course of flooring is laid crosswise to the orientation of the runners. A partially completed machine floor laid over 105-mm cartridges is shown in figure 9-9.

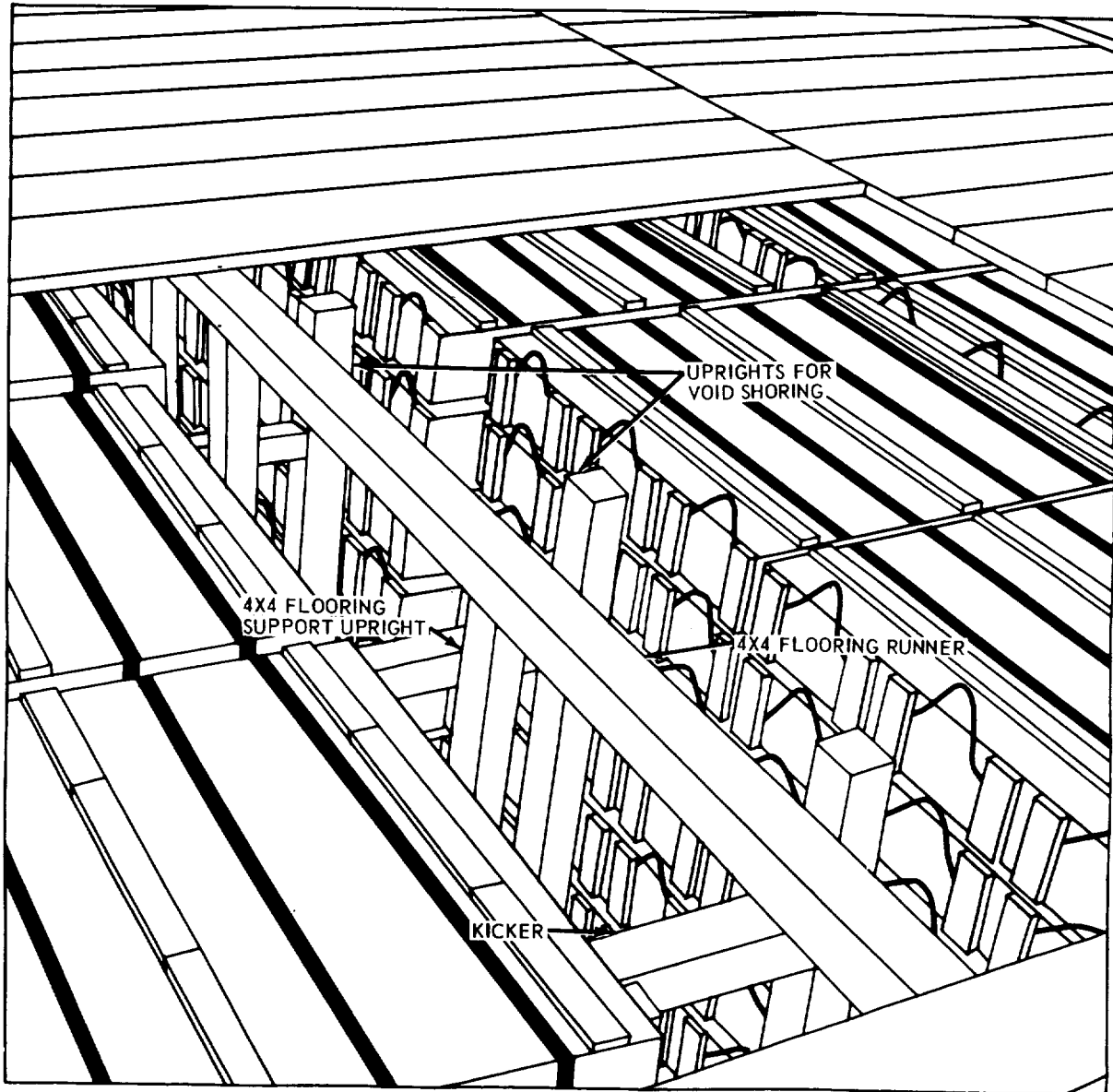


Figure 9-7. Construction of void shoring and flooring support structure for 105-mm unit loads.

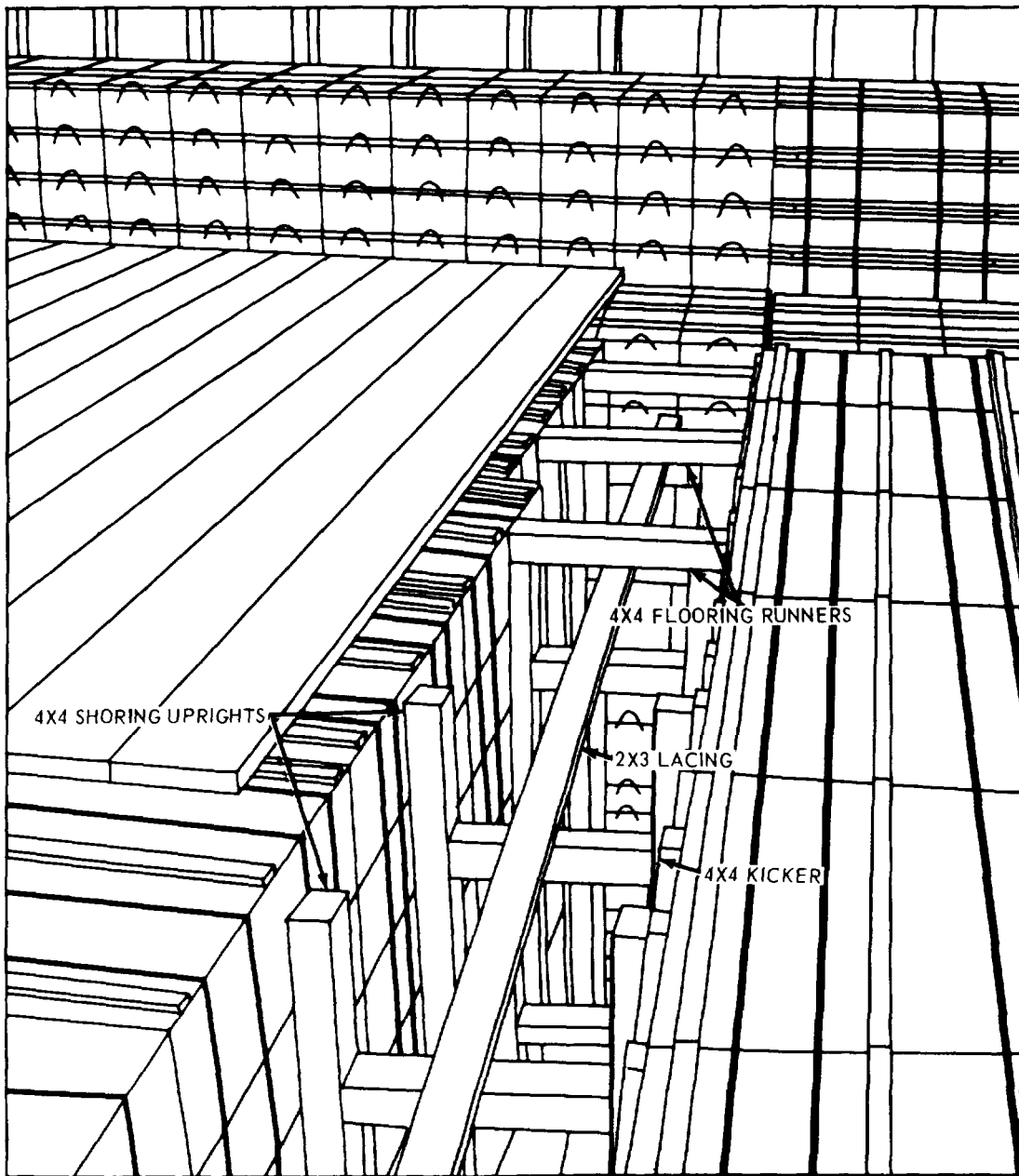
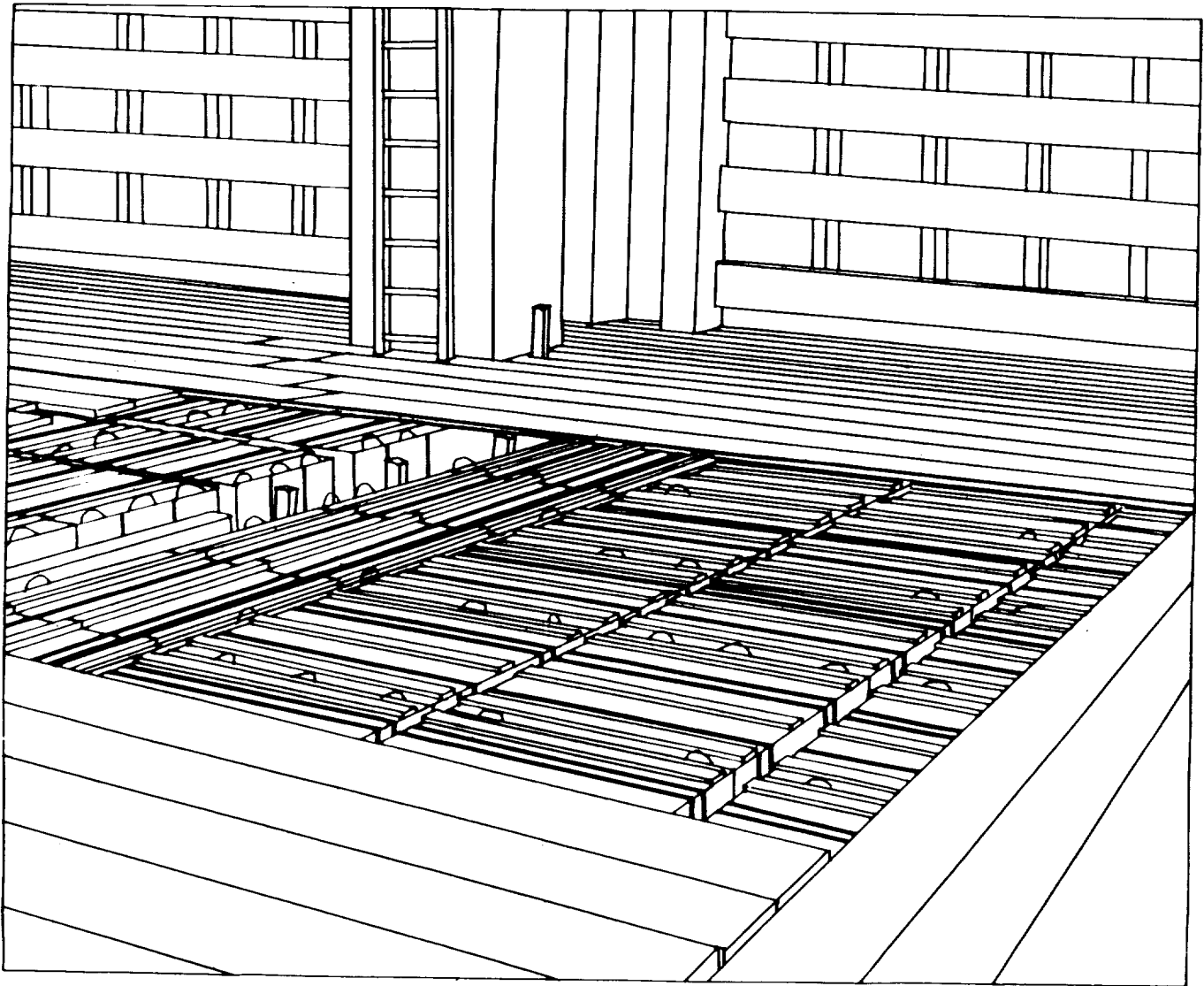


Figure 9-8. Alternate method of securing voids in stowage of 105-mm cartridges.



**Figure 9-9. Construction of a full floor over 105-mm HE cartridges.**

(5) Unit loads of 105-mm cartridges can be stowed in lower holds bisected by the shaft alley, as illustrated in figure 9-10. Construction procedures for

loading adjacent to low overhead structural members are also indicated.

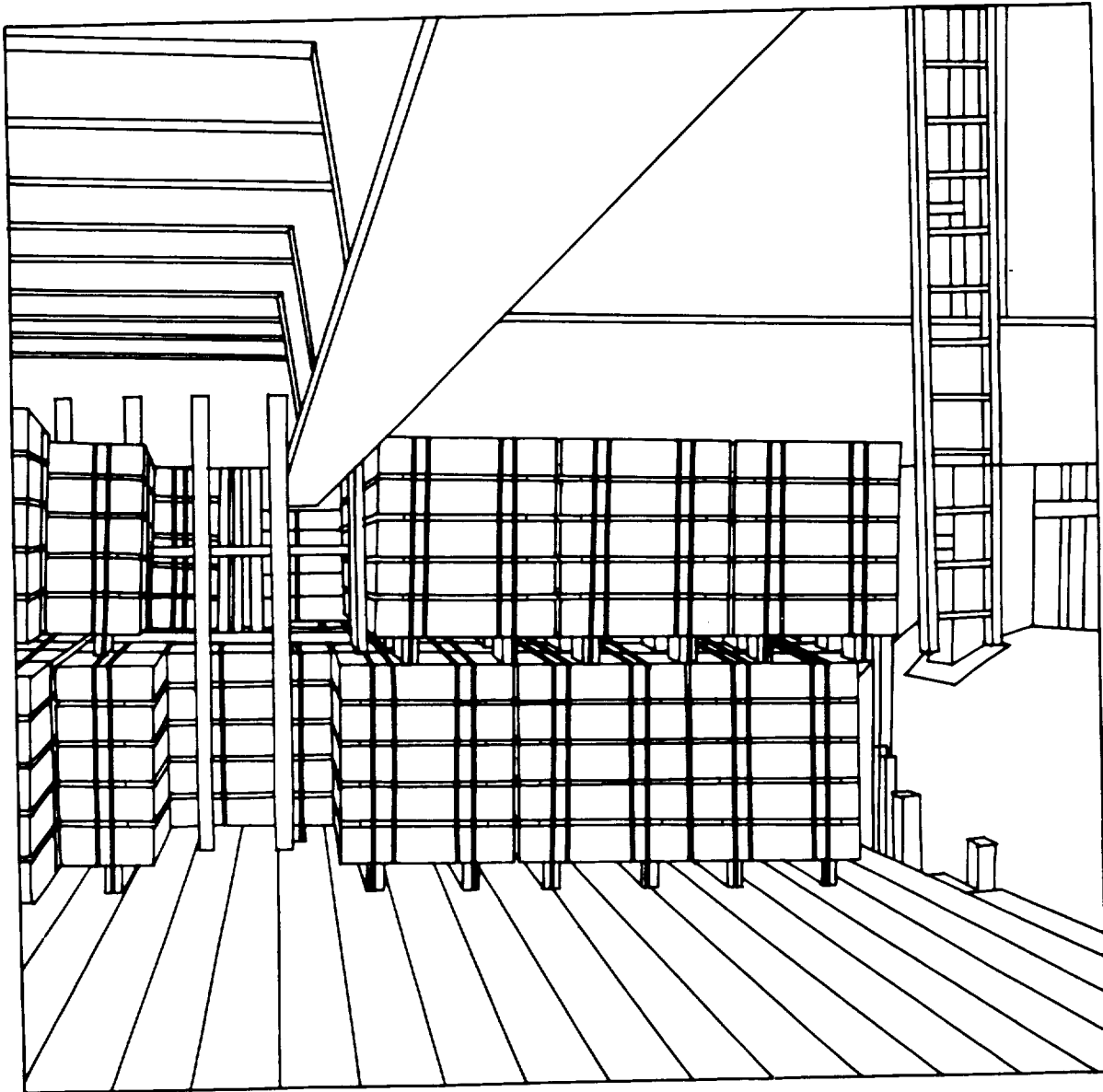


Figure 9-10. Stowing and securing of 105-mm HE cartridges, lower hold No. 4, port side of shaft alley.

d. *Securing of 20-mm Cartridge Palletized Unit Load.* The 20-mm cartridge palletized unit load consists of 20 ammunition boxes, MK 1 MOD 0, which are mounted on metal materials-handling pallet, MIK 12 MOI 0. The unit load weighs 3,800 pounds and is approximately 35 cubic feet in volume. Block stowage or sweatboard-to-sweatboard stowage is possible in any hold of a ship, as well as in deep tanks and on the weather deck.

(1) Figure 9-11 illustrates three-high sweatboard-to-sweatboard stowage of the unit load in lower hold number 1, as viewed forward of the hatch, starboard to port. The unit loads are stowed with the

fore-and-aft axis of each load parallel with the center line of the ship. Strip sheathing provides a suitable bearing surface for loads placed along the side of the hold. Significant lateral displacement of the unit loads from tier-to-tier is caused by hull shear. Consequently, vertical shoring in the form of a table is required for the first tier at the end of the row, since it spans a void that exceeds the minimum allowable width of 3 feet. All voids in the top tiers are fully blocked, including those along the strip sheathing. Partial encasement of the stanchion and ladder is adequate for this type of load.

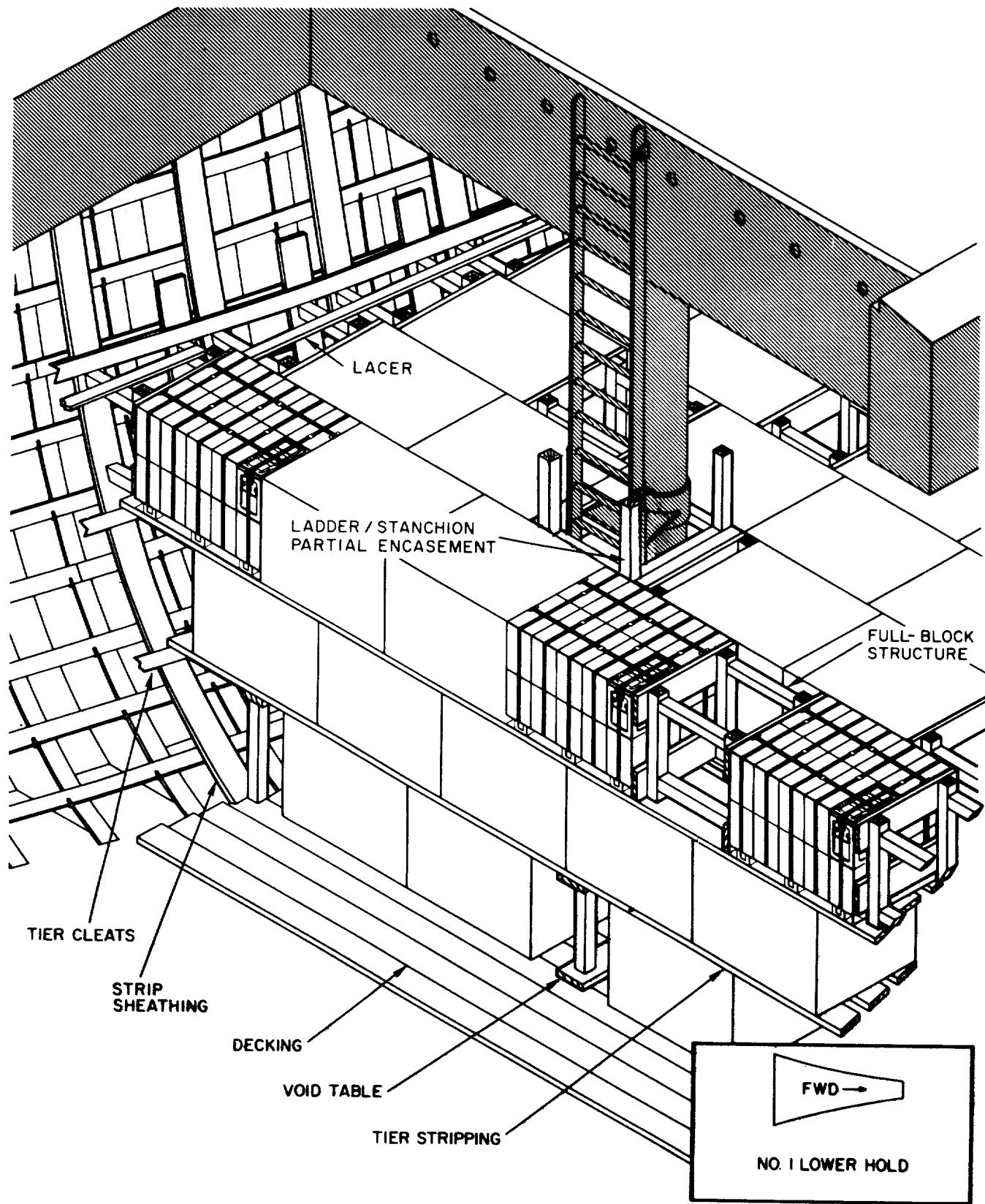


Figure 9-11. Sweatboard-to-sweatboard stowage of 20-nmm cartridges, lower hold No. 1 (sweatboard blocking technique).

(2) Figure 9-12 illustrates palletized unit loads of 20-mm cartridges stowed four high in the number 3 lower hold. The ship's structures at the skin are enclosed effectively with 2-by 6-inch spacers under the strip sheathing. Boarding fastened to the strip sheathing provides a bearing surface for the top and bottom of each load along the side of the hold. This structure resembles a nonheat bulkhead. Stripping on the bottom tier spans TM 55-607/NAVSEA OP 3221 Rev 2 the end

load and the structural ledge, thereby allowing additional stow space for the elevated tiers. Since the tier stripping spans a distance of at least 3 feet, it is supported vertically by pieces of 4-by 4-inch lumber cut to fit between a cleat and each tier strip. Tier decking is shown laid between the third and fourth tiers. Such decking is required for safe forklift truck operation on top of the first three tiers.

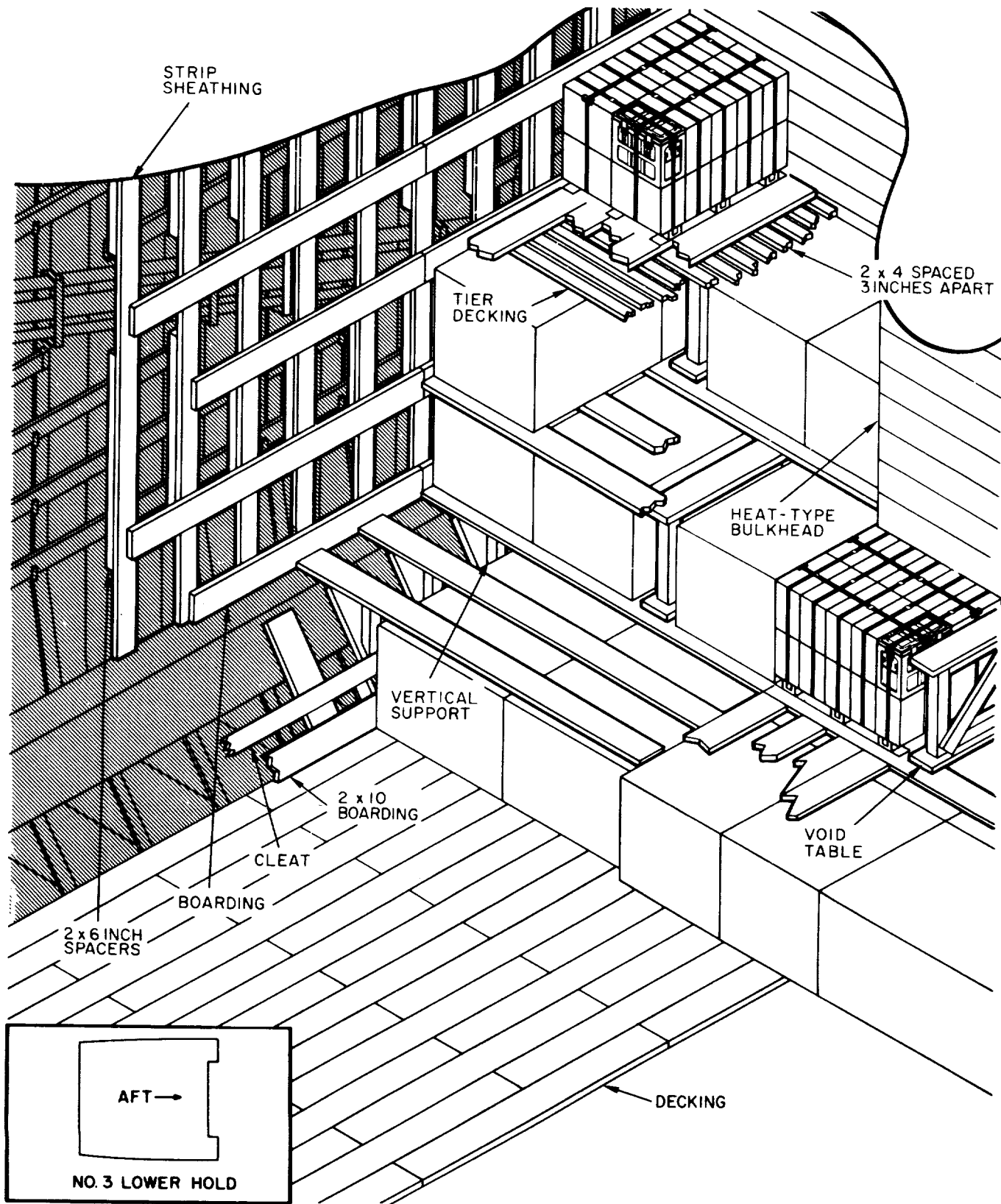


Figure 9-12. Stowing and securing of 20-mm cartridges, lower hold No. 3 (sweatboard blocking technique).



(3) Figure 9-13 illustrates an acceptable method for stowage of 20-mm cartridges in a typical deep tank 4. Since the tank is bisected by the shaft alley, prestowage construction of nonheat bulkheads is required on either side of the alley. Skin framing, in lieu of sweatboard, and decking over the tank bottom also must be completed prior to stowage. The decking consists of two courses of 2by 6inch minimum lumber laid at right angles, which is TM 55-607/NAVSEA OP

3221 Rev 2 strong enough to support forklift truck operations. The skin framing supports the full-block structures at the outboard end of the top tiers as well as the vertical supports beneath the tiers. All loads are positioned parallel with the center line of the ship. Block stowage is an equivalent method for securing 20-mm unit loads at the hull. Basic techniques are illustrated in figures 8-8 through 8-10.

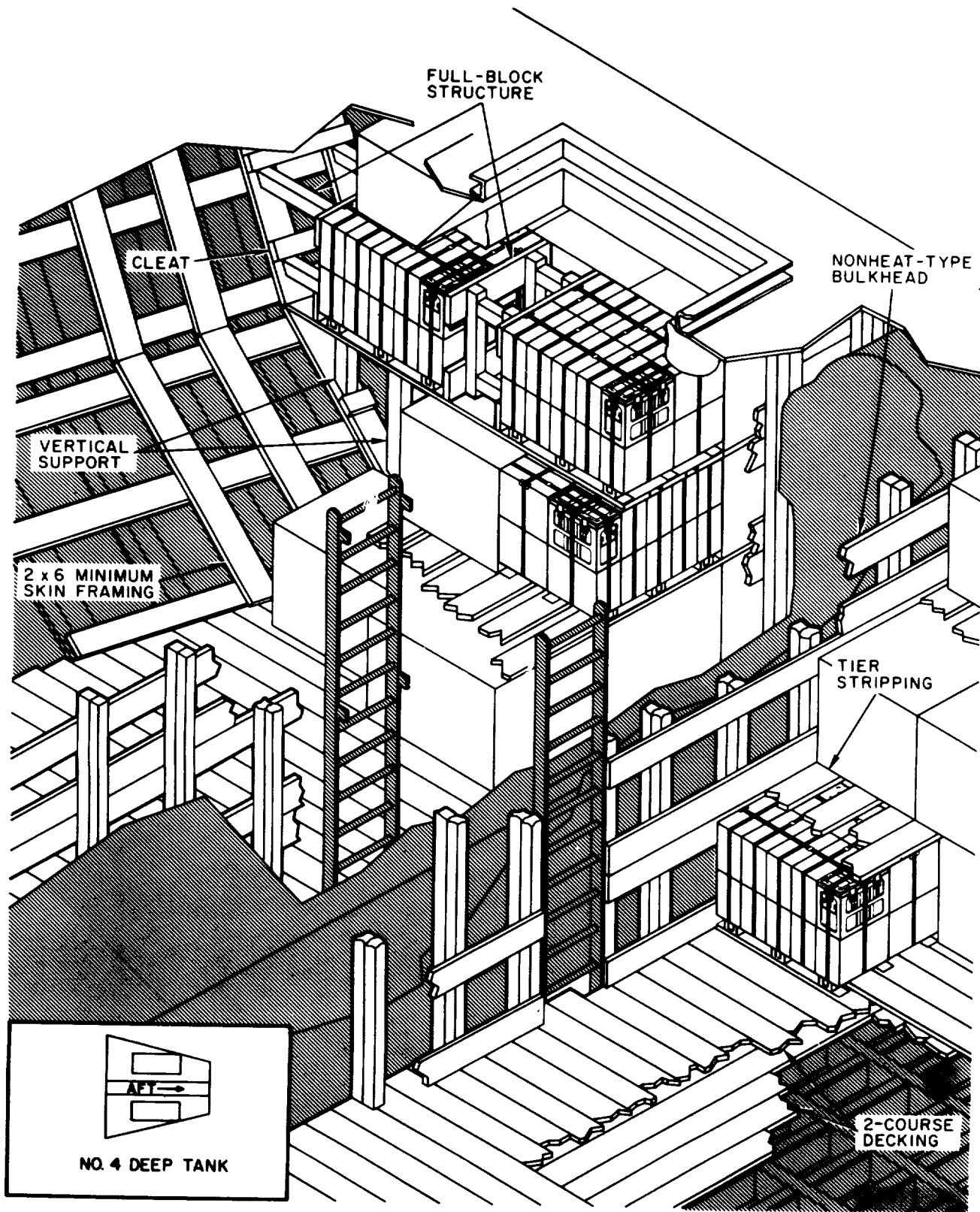


Figure 9-13. Stowing and securing of 20-mmr cartridges, deep tank No. 4 (sweatboard blocking technique).

e. *Securing of 155-mm, 175-mm, and Army 8-Inch Projectile Palletized Unit Loads.* The 155-mm, 175-mm, and Army 8-inch projectile palletized unit loads are shipped frequently and are illustrated in figure 4-4. These unit loads are similar in configuration and consist of individual projectiles mounted on wood pallets unitized with steel straps. Eight 155-mm projectiles are palletized in a load weighing about 800 pounds and measuring 2 1/2 feet long, 1 foot wide, and 2 1/2 feet high. The 175-mm load consists of six projectiles weighing 935 pounds and measuring 2 feet in length, 1 1/2 feet in width, and 3/4 feet in height. A palletized load of 8-inch projectiles weighs 1,230 pounds and is similar in configuration to the 175-mm unit load. These loads are stowed in the same manner as all loads of rectangular configuration; that is, parallel with the ship's center line and in tight contact with each other.

(1) *Tween-deck stowage.* Tween-deck compartments are usually rectangular and permit efficient TM 55-607/NAVSEA OP 3221 Rev 2 stowage

of 155-mm projectiles and similar loads. To form a flush bearing surface for the projectiles, heat or nonheat bulkheads are installed as required, as shown in figure 9-14. Uprights are positioned on 30-inch centers along the perimeter of the compartment and should be of sufficient length to protect the upper tiers of projectiles from contact with the metal bulkhead. Boarding of 2-by 10-inch or 2-by 12-inch stock is secured to the uprights on two levels, the lower bearing directly upon the deck and the upper at a height approximately equal to that of the unit load. A bearing surface is provided for the top and bottom sections of the wood pallet. Figure 9-13 illustrates the stowage of the initial tier of projectiles. Decking is not required for the first tier. Boarding for the second tier of projectiles is installed. The stowage pattern proceeds identically to that used on the first tier, except the tiers are separated with a full floor. Offset units are squared off with filler assemblies as shown in figure 9-16.

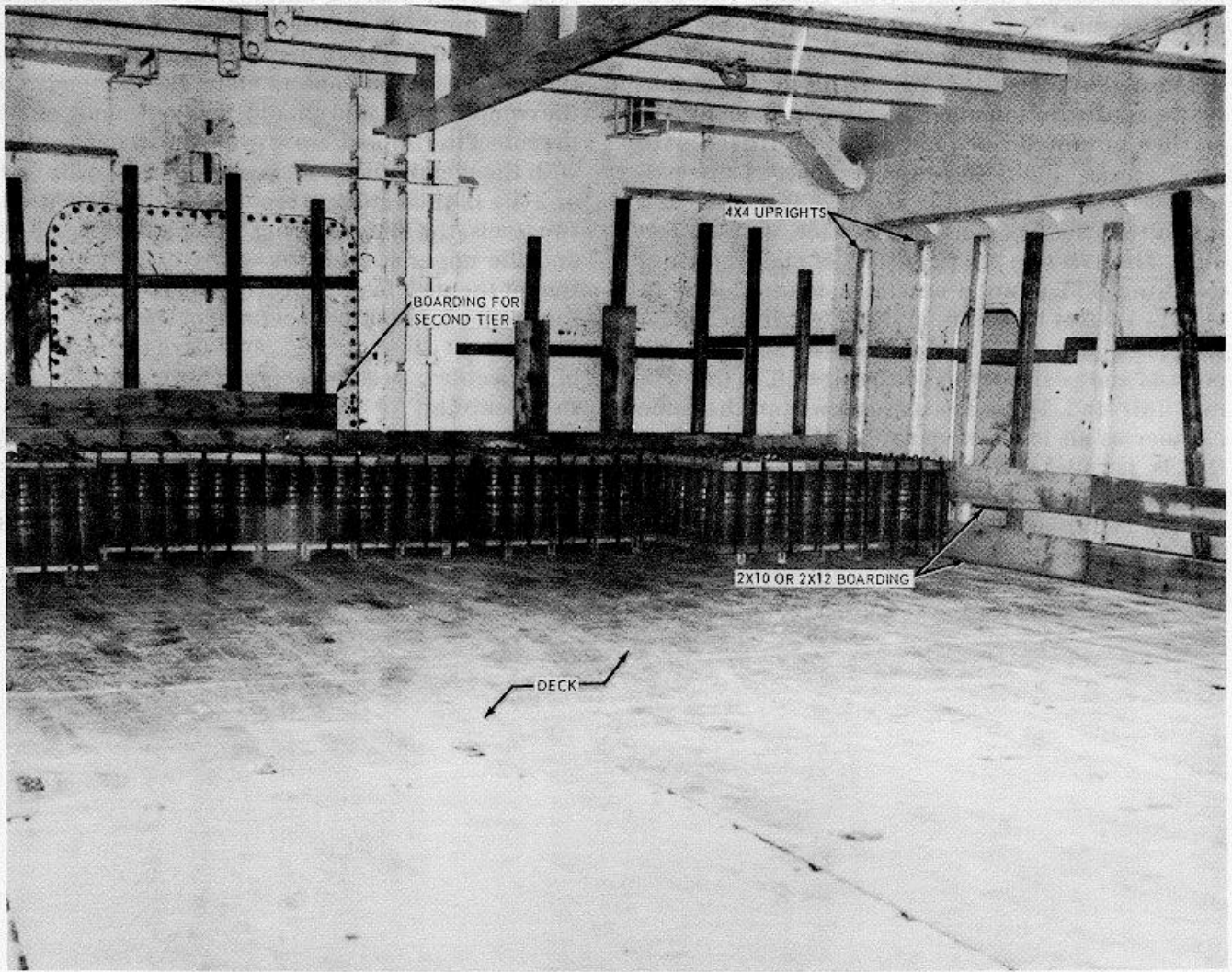
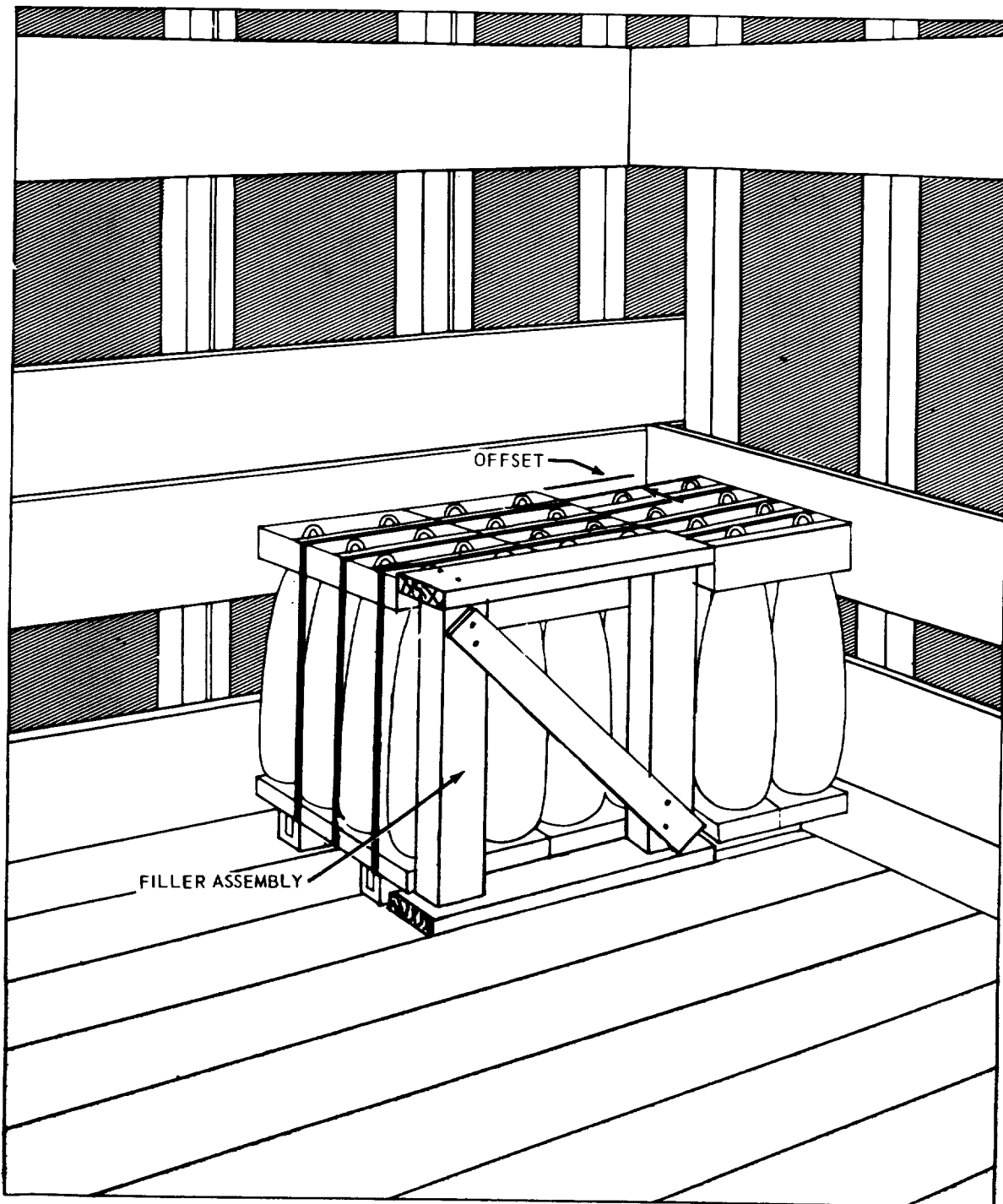


Figure 9-14. Typical prefabricated nonheat bulkhead and securing structures for stowage of 155-mm projectiles, tween-deck compartments.



Figure 9-15. Stowage of initial tier of projectiles, tween-deck compartments (sweatboard blocking technique).



**Figure 9-16. Filler assembly for offset Units.**

(2) Flooring over projectiles. Projectiles are not generally tiered unless a full floor (deck) separates the layers; however, two-high tiering without flooring is used occasionally. Deck-load limitations may limit stowage to two high, or limited overhead clearance will not permit use of forklift trucks upon the stowed projectiles. In either case, installation of a separator floor is not advantageous, and the projectiles would be aligned uniformly and stacked directly with 2- by 3-inch

or 4- by 4-inch spacers in place. Figure 9-17 provides construction details for flooring over 155-mm and similar palletized projectiles. To eliminate the obstruction caused by the lifting rings of the projectiles and provide a foundation for the floor, spacers are placed across each tier between the lifting eyes. Spacers are usually 2- by 3-inch lumber although 4- by 4-inch lumber may be utilized. Use of the 2- by 3-inch spacer is preferred



for the 155-mm projectile, as larger lumber will increase the overall height of the stow and can preclude stowage of a tier of projectiles in a compartment with marginal overhead clearances. Differences in construction of the 175-mm projectile and the Army 8-inch projectile palletized unit loads butt-to-butt. Figure 9-18 illustrates a floor over 155-mm projectiles nearing completion. The 155-mm projectile is a highly compact and strong TM 55-607/NAVSEA OP 3221 Rev 2 unit load that can

be efficiently floored over and overstowed with other explosives cargo. Figure 9-19 illustrates the 155-mm projectile overstowed with 105-mm palletized unit loads within the same tween-deck compartment. A full-block structure separates the commodities and is constructed of 4by 4-inch uprights and 2by 10-inch or 2by 12inch boarding. The projectiles are shown prior to installation of the floor.

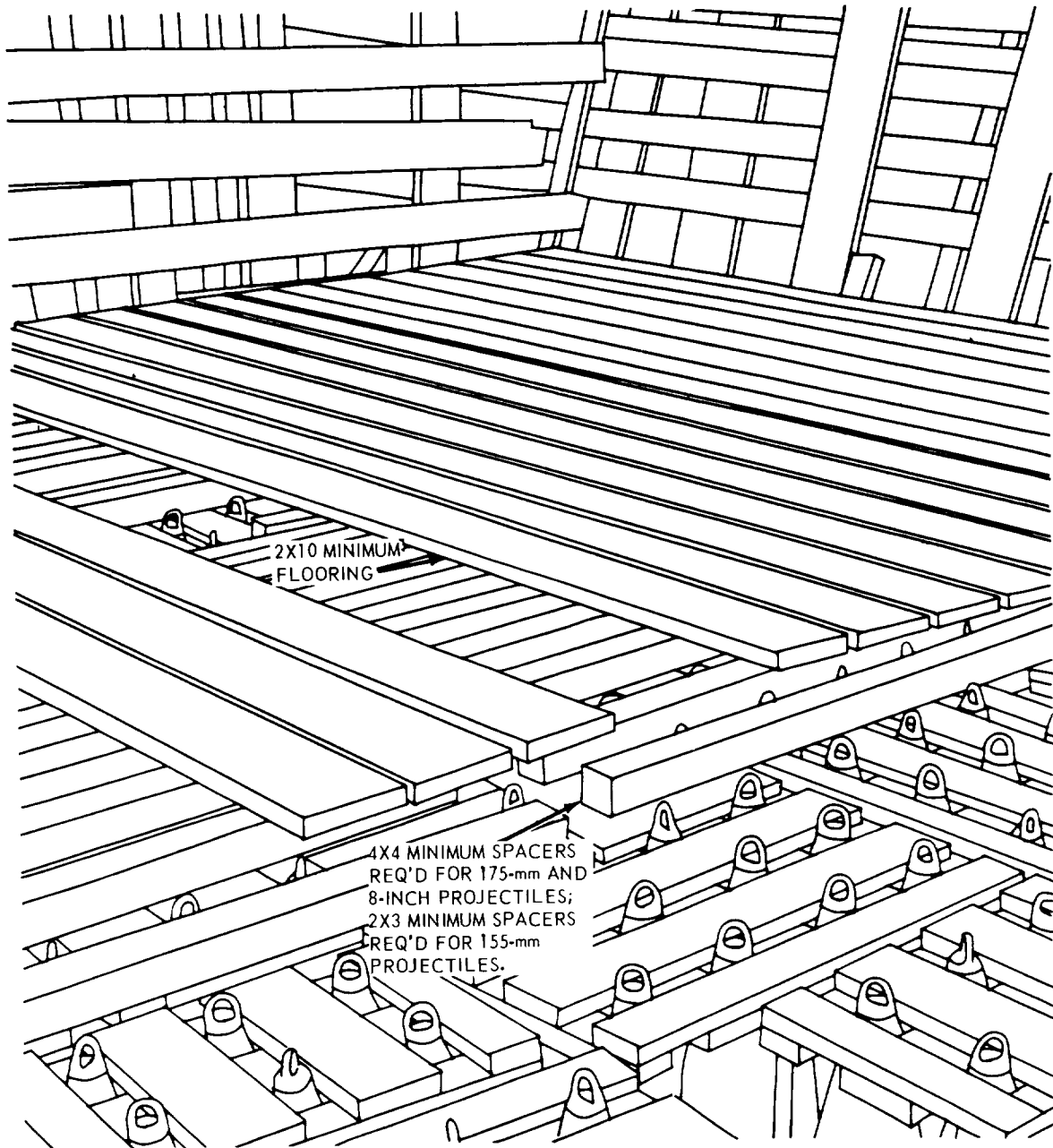


Figure 9-17. Construction details for flooring over projectiles.

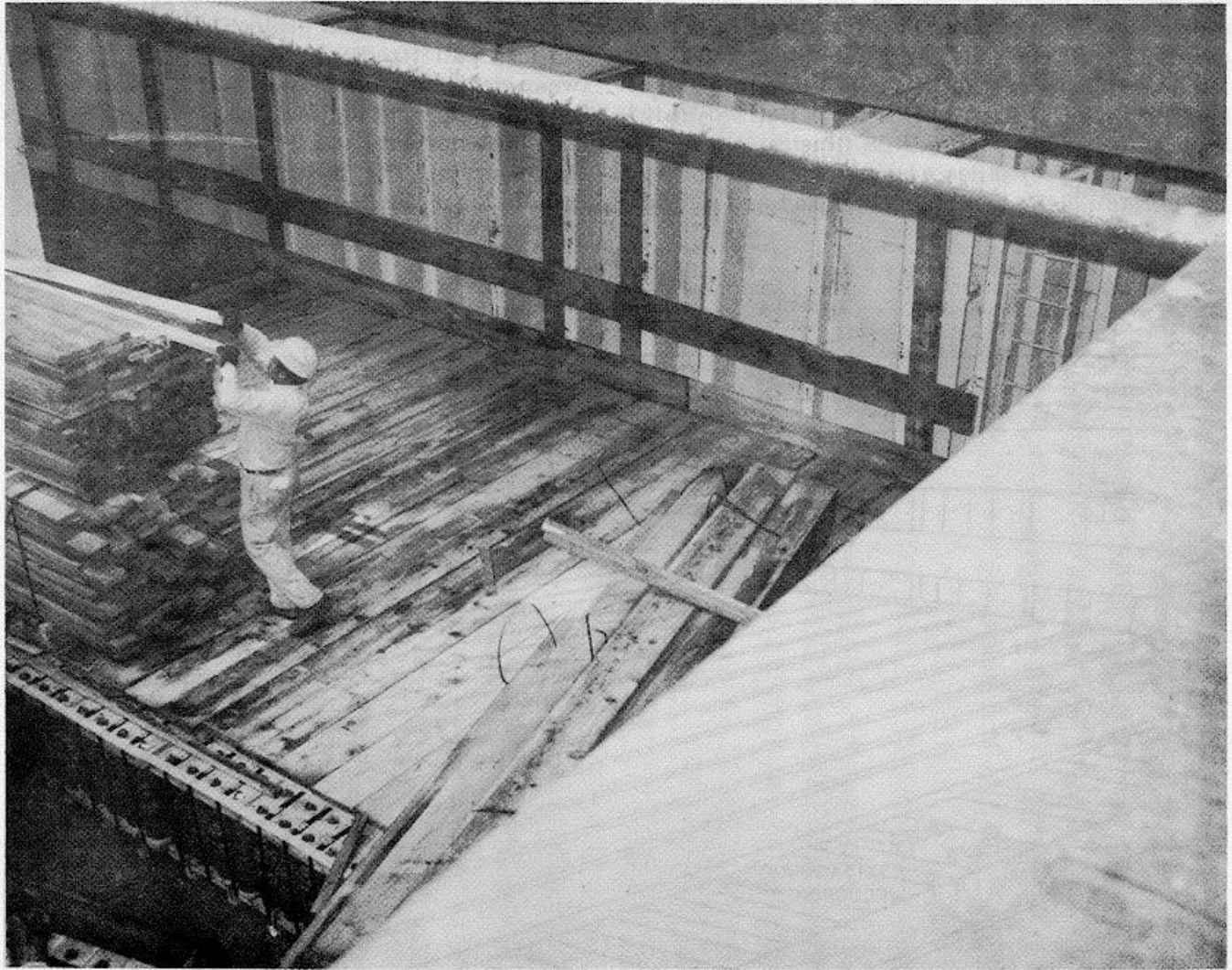


Figure 9-18. Construction of flooring (decking) over 155-mm projectiles.



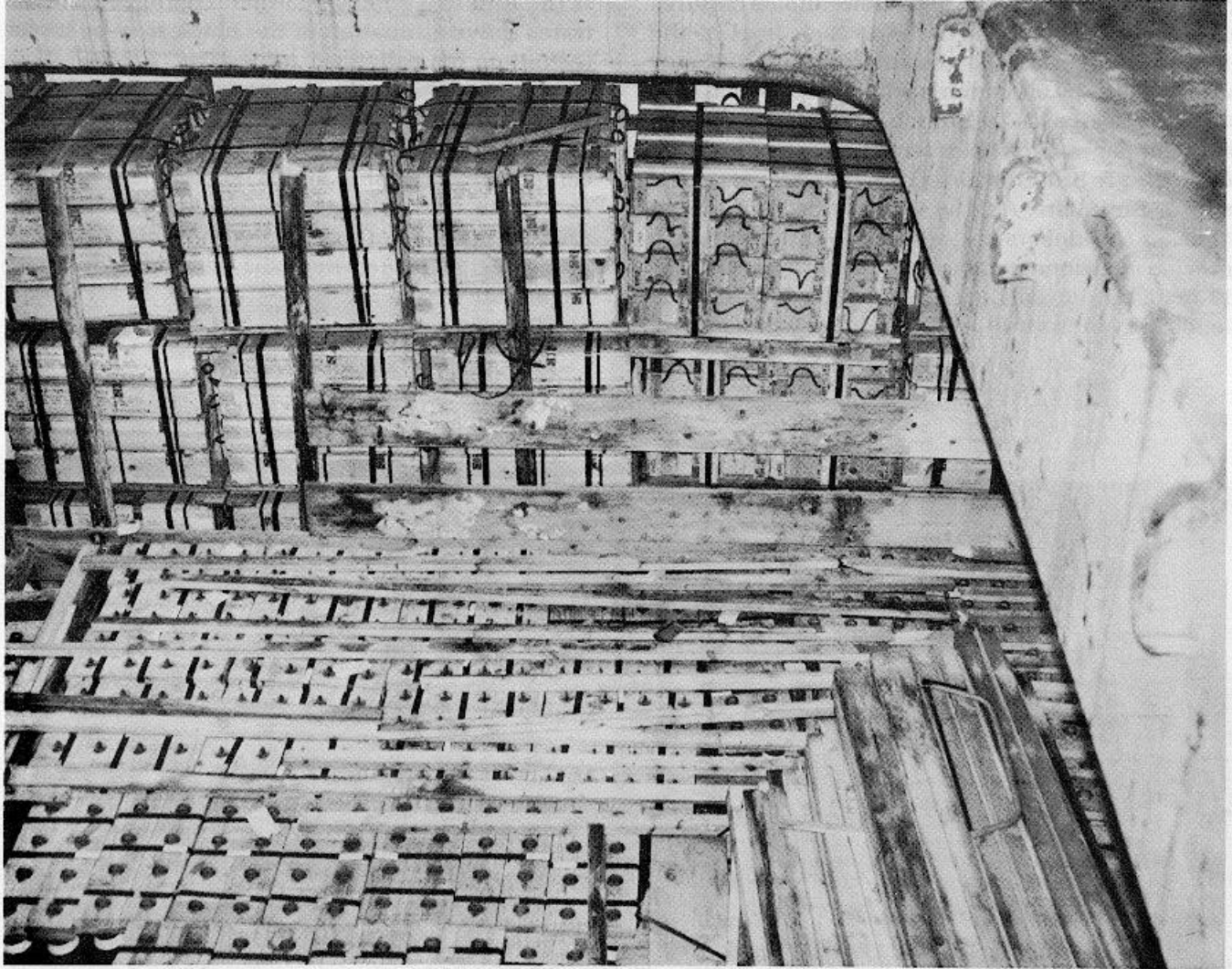


Figure 9-19. Mixed stowage of 155-mm projectiles with other explosives cargo (stowage in progress).

(3) Block stowage of projectiles. Block stowage of the 155-mm projectile in the lower holds requires that securing be constructed at each level of the stow to compensate for obstructions and hull curvature. Four by four-inch uprights on 30-inch centers bear against 2-by 10-inch boarding positioned at the upper and lower extremities of the unit load. Uprights are braced with 4-by 4-inch kickers to the ribs or hull plate. A 2-by 4-inch cleat is installed beneath the kickers and secured to the uprights to provide additional support for the 2-by 8 or 2-by 10-inch minimum flooring support. Flooring extends fully to the hull, and the block

stow of projectiles is repeated on the next tier. Pallets are secured at the hull in a similar manner. Figure 9-20 illustrates the continuation of the block-stow-by-levels technique for palletized projectiles. A block-stow structure is shown in the process of installation before stowage of an additional tier of projectiles. The bearing surface is parallel to the longitudinal center line of the ship and is boarded in a manner similar to that utilized for tween-deck compartments (fig 9-14). After completion of the floor, another tier of projectiles will be stowed in tight alignment.

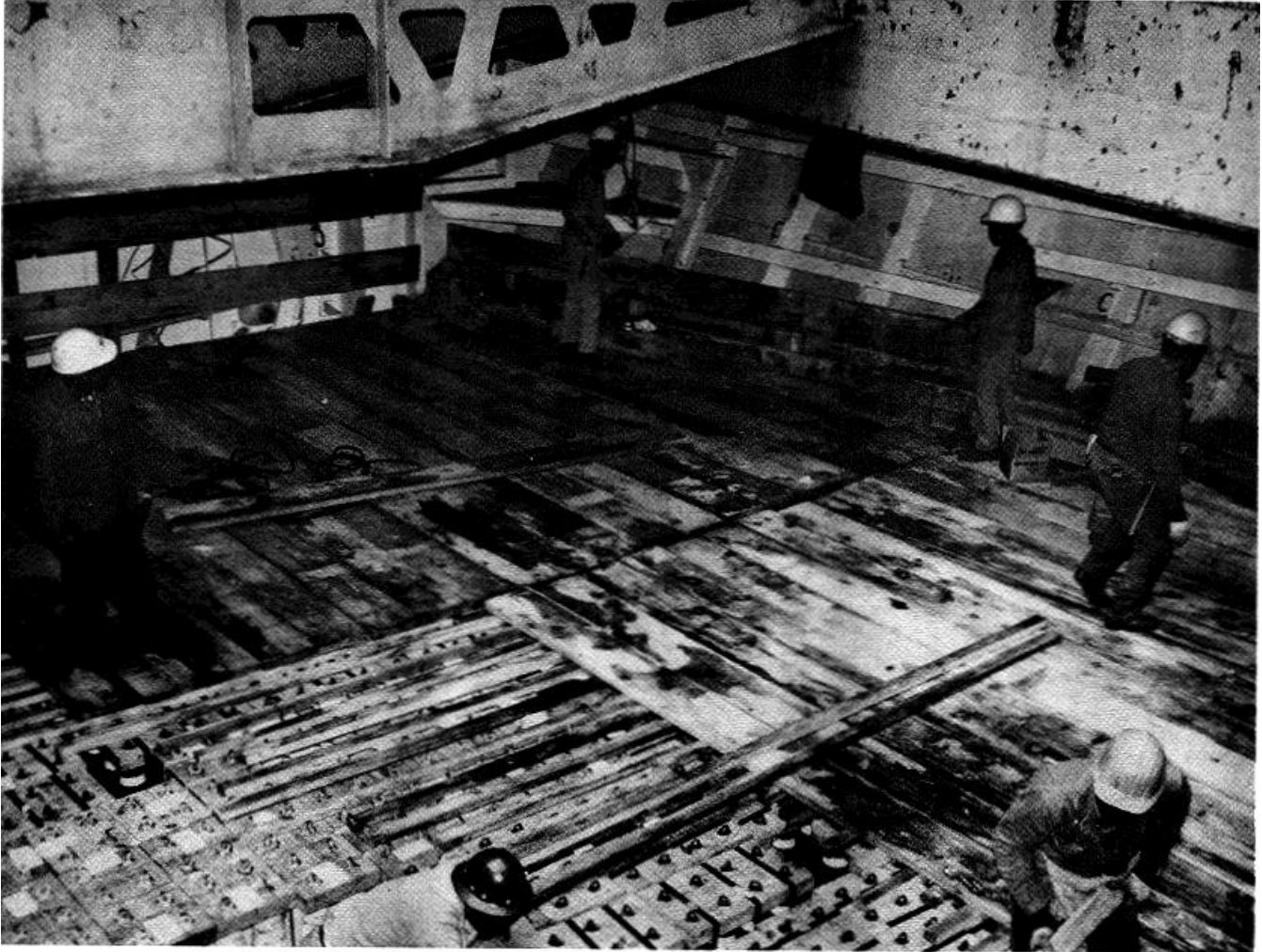


Figure 9-20. Continuation of block stowage of projectiles in upper tiers.

(4) *Sweatboard-to-sweatboard stowage of projectiles.* Figure 9-21 depicts the 155-mm unit load stowed in lower hold number 1, where camber and sheer angles are important factors influencing stowing and dunnaging. Loads are maintained parallel with the ship's center line and are made to bear tightly against one another. Wood decking for the first tier is not required, as the item is unitized on wood skids. An alternate sweatboard-to-sweatboard method for stowage of projectiles is shown in figure 9-22. In this case, the compact unit load of projectiles can be extended to the hull, offering a significant gain in the number of pallets

stowed per row. In general, sweatboard-to-sweatboard stowage increases in efficiency with compartment width and in compartments having convex sheer such as shown in figure 9-22. Camber and sheer angles are quite severe in this type of hold, and loads stowed at the sweatboards require considerable vertical shoring. The boarding separating the first row aft is essentially a full-block construction; this construction is needed to fill a void at the edge of a step in the ship's deck, which extends the width of the hold. This step is the reason that the next rows forward are somewhat lower.

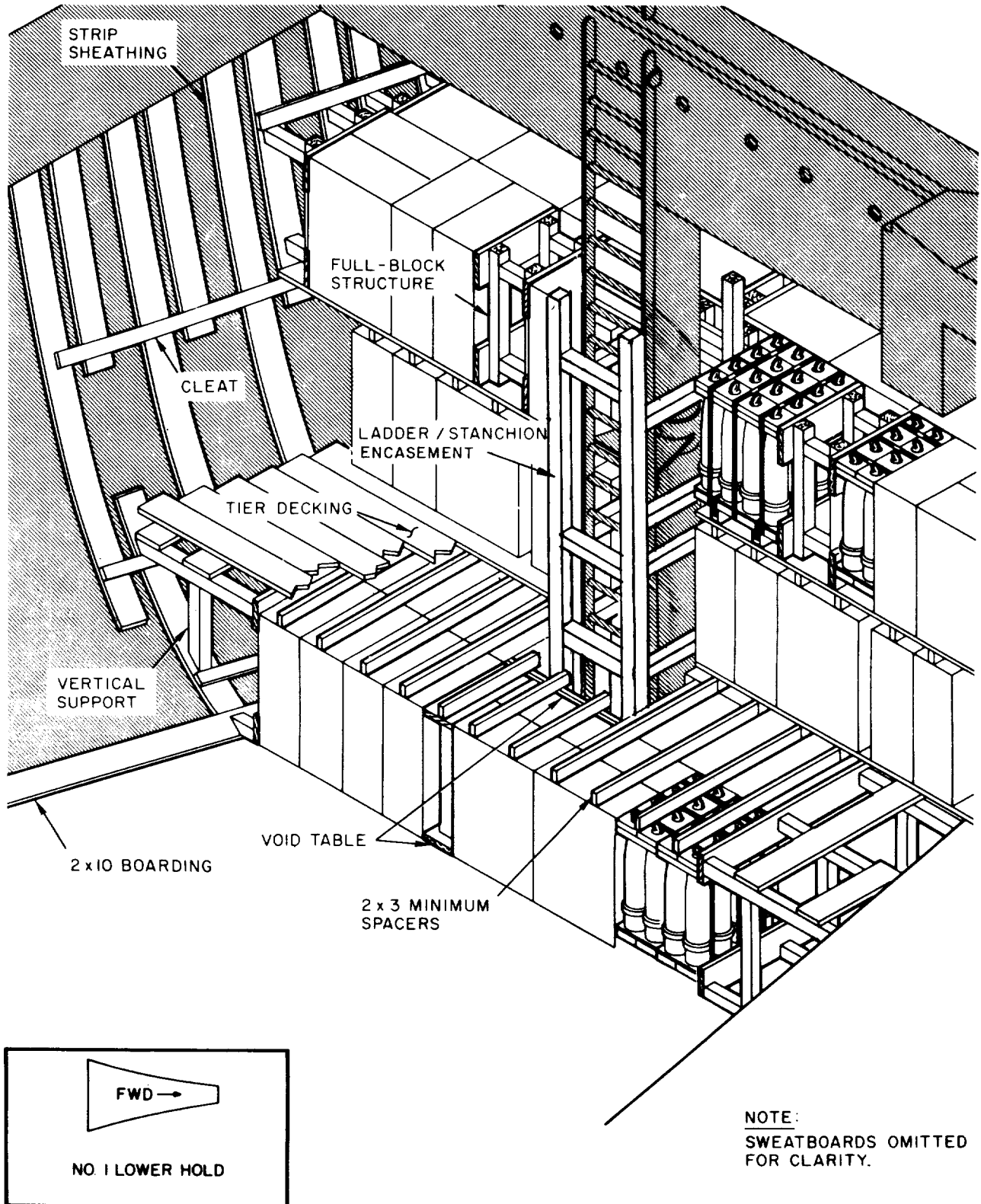


Figure 9-21. Sweatboard-to-sweatboard storage of 155-mm projectiles, lower hold No.1 (sweatboard blocking technique).

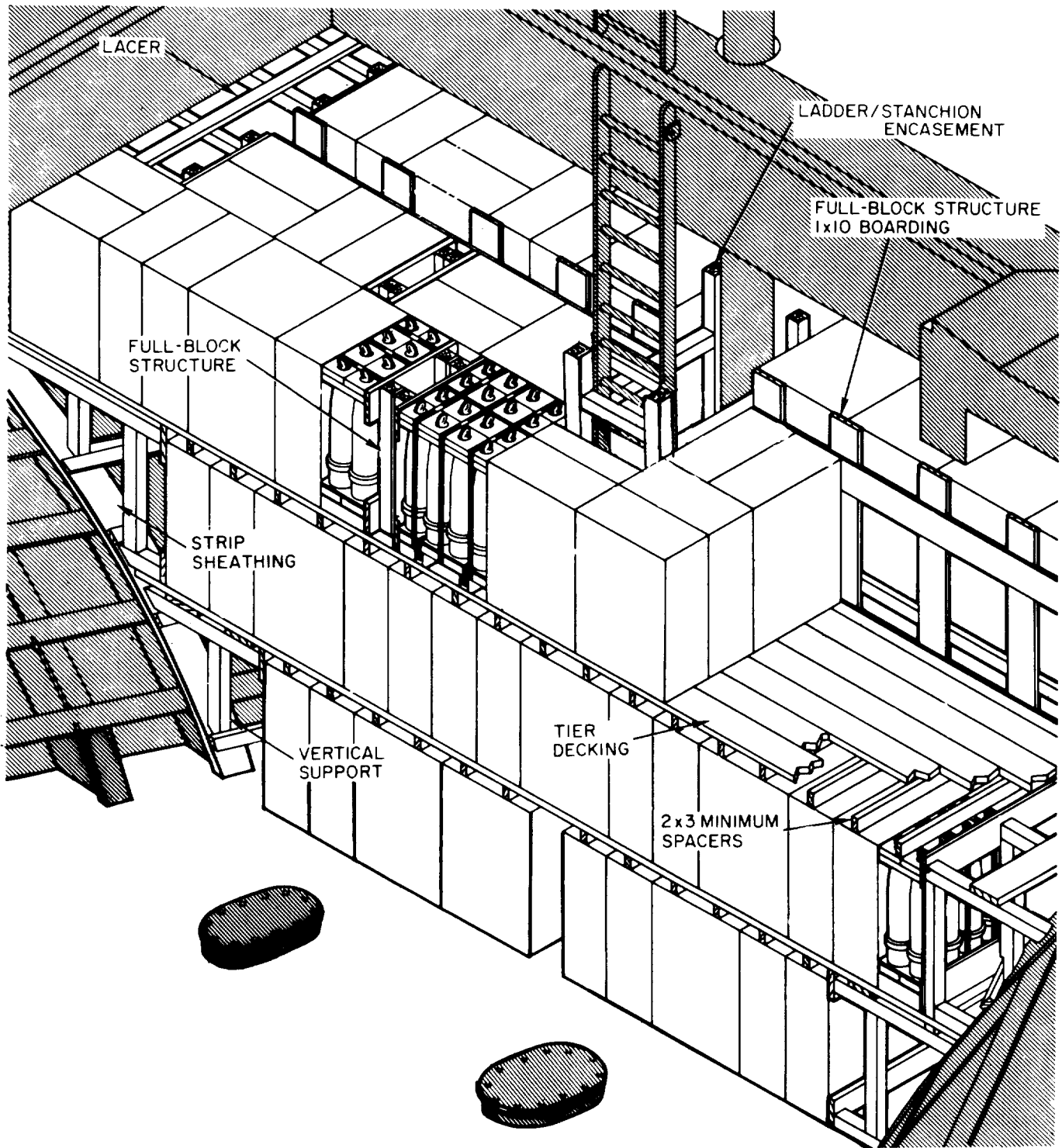


Figure 9-22. Sweatboard-to-sweatboard storage of projectiles in compartment with convex sheer (sweatboard blocking technique).

(5) *Stowage in lower holds.* Stowage in lower hold number 3 is illustrated in figure 9-23. The ledge running along the ship's skin can be used to provide a

firm support for the machine floor. Lumber is positioned on the ledge to raise the flooring supports to the appropriate height of the unit load.

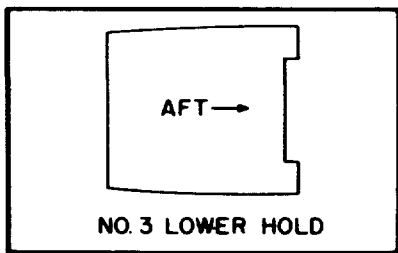
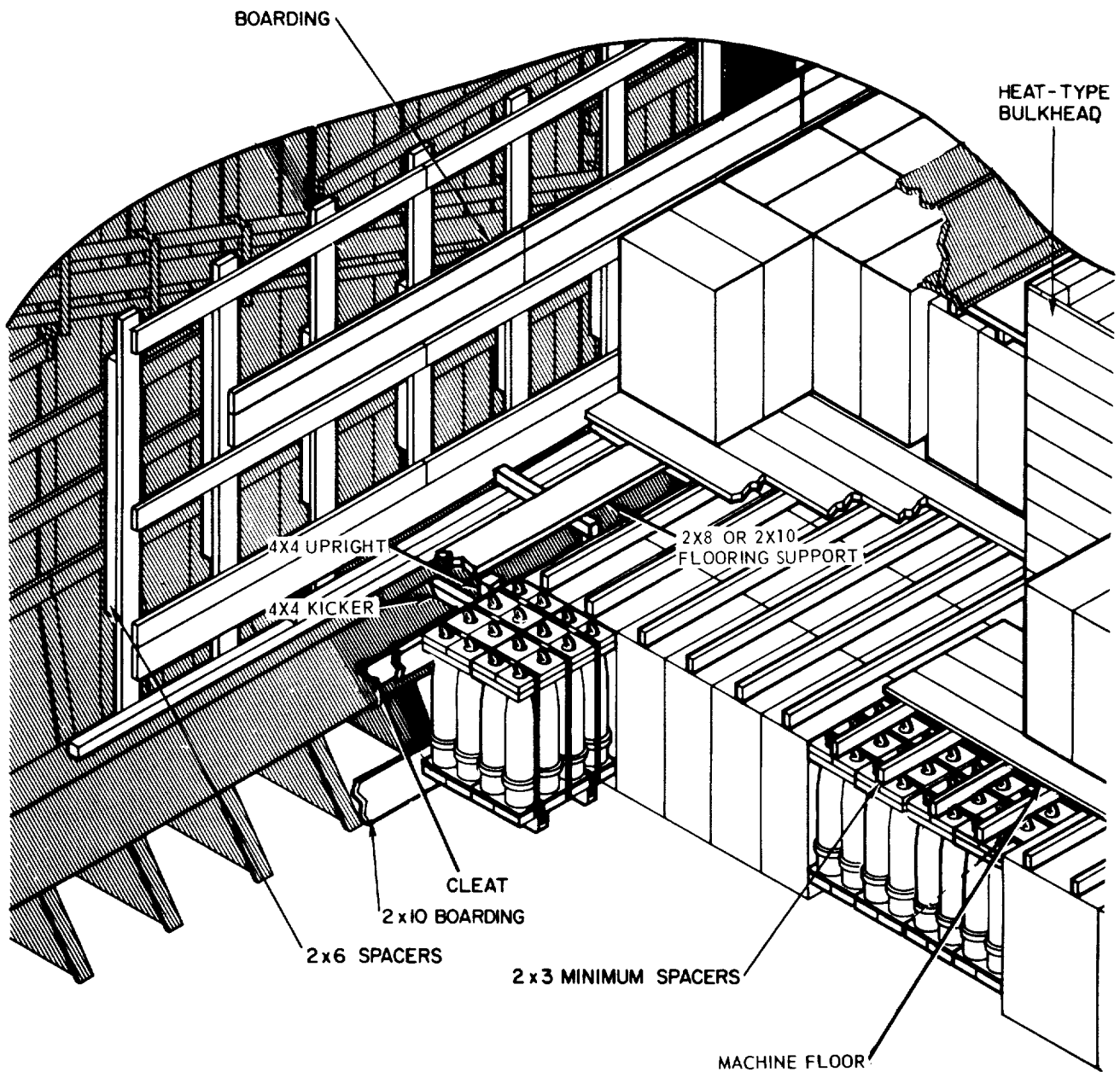


Figure 9-23. Stowing and securing of 155-mm projectiles, lower hold No. 3 (hull blocking technique).



(6) *Deep tank stowage.* Deep tank stowage of palletized projectiles is illustrated in figure 9-24. Flooring requirements for the deep tanks must be evaluated for individual compartments. Obstructions such as tank top caps and coils are usually floored over; however, if the bottom of the deep tank is level and free of such obstructions, the need for a floor is eliminated. The deep tank illustrated is TM 55-607/NAVSEA OP

3221 Rev 2 bisected by the shaft alley. A nonheat securing structure is installed to separate the cargo from the shaft alley, as described previously in paragraph 6-4b(5). Boarding of 2-by 6 or 2-by 10-inch stock is secured to the 4-by 4-inch uprights at deck level and at the same level as the top of the projectile unit load. Block stowage proceeds in the usual manner.

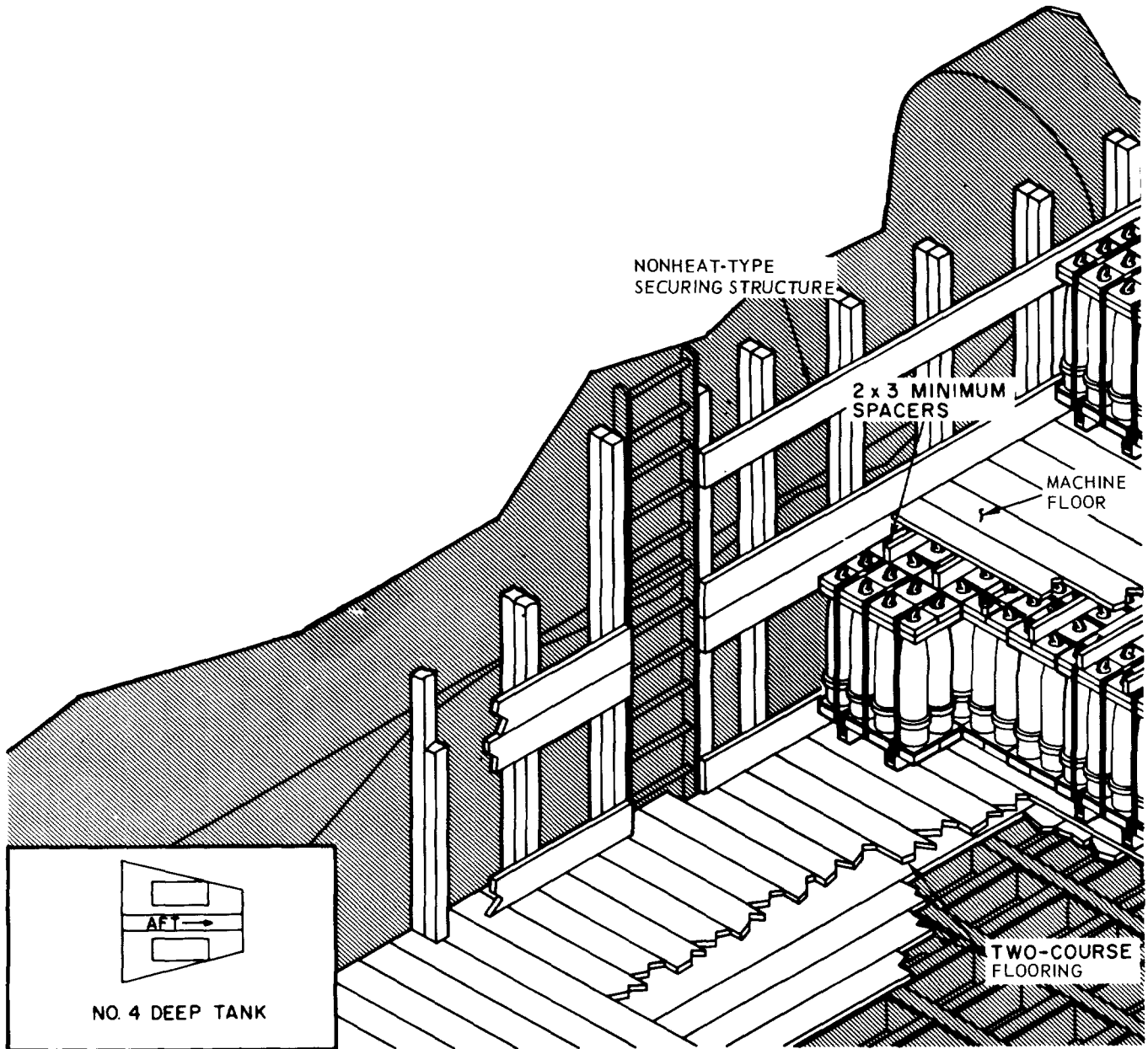


Figure 9-24. Stowing and securing of 155-mm projectiles, shaft alley, deep tank No. 4 (hull blocking technique).

(7) *Stowage of propellant charges.* Propellant charges normally accompany shipments of 155-mm projectiles and are stowed as shown in figure 9-25. Commonly known as "prop" charges, these items are efficiently block stowed with a minimum of securing in tween-deck compartments. The load can be oriented

either fore and aft or athwartships. Random voids occurring within the stow are shored with full-block structures or void tables. Securing procedures for compartments with significant hull curvature are similar to those employed for the stowage of rectangular unit loads, as described above.



Figure 9-25. Stowing and securing of M4A2 propellant charges in tween-deck compartment.



### 9-3. Securing of Round, Single-Item Loads

a. *3,000-Pound General-Purpose (GP) Bomb.* The 3,000-pound bomb is a typical cylindrical single-item load that is representative of the majority of commodities in the classification. In the securing of round items, such as bombs, it is of particular importance to eliminate all voids, in the stow, that could permit cyclic rolling of the load in response to ship motions. A secure stow can be achieved by positioning the bombs in tight contact with each other to unitize the load. Further restraint is attained by installing chocking after each bomb is in place. Nonpalletized bombs are loaded in a fore-and-aft orientation to eliminate the possibility of penetration of the hull by the pointed bomb noses. This is especially significant for 3,000-pound bombs; the pointed nose can exert extreme pressure upon impact with any surface due to its small area in relation to the high item weight. Although stowed most efficiently in rectangular tween-deck compartments, the 3,000-pound bomb loads readily in holds with appreciable hull curvature, when proper securing is installed.

(1) Figure 9-26 illustrates stowage of 3,000-pound bombs on the tween deck, in the number 3 hold. Hull curvature is not a factor in this compartment. Since metal-to-metal contact would otherwise occur, 2-inch flooring must be laid prior to loading. Boarding, usually 2- by 6- or 2- by 10-inch lumber, is installed at equal intervals of 2 to 3 feet along the sides of the compartment to prevent the bombs from contacting with

the sweatboards and ribs and to distribute the load more effectively. Additional 2- by 10- or 2- by 12-inch boarding is secured horizontally to the upright members at the point where contact of the bomb would occur; that is, 12 inches on centers, as measured from the flooring. Stowage of bombs begins at the aft corner of the compartment. The first bomb is positioned fore and aft in full longitudinal contact with the boarding, the base bearing tightly against the heat bulkhead. Athwartship movement is prevented by the installation of 4- by 4-inch chocks beveled to wedge shape on each end and cut to the necessary length to secure to the floor between bombs, one forward and one aft. The next bomb is positioned tightly against the first and is chocked similarly. After completion of the row, 2- by 10- or 2- by 12-inch separators, 2 feet high, are positioned upright between bomb noses. The separators are capped with a 2- by 10- or 2- by 12-inch member, which serves as a flooring support over the sloping bomb noses. In the installation of the 2-inch floor, the first course is laid athwartships directly over the bombs. To separate and provide necessary protection between rows of bombs, a 2- by 10- or 2- by 12-inch nose board is secured to the upright structure. Following rows are stowed with the preceding rows in solid contact with the nose board. Voids occurring in the stow are secured with full-block structures maintaining the fore-and-aft orientation of the bombs.

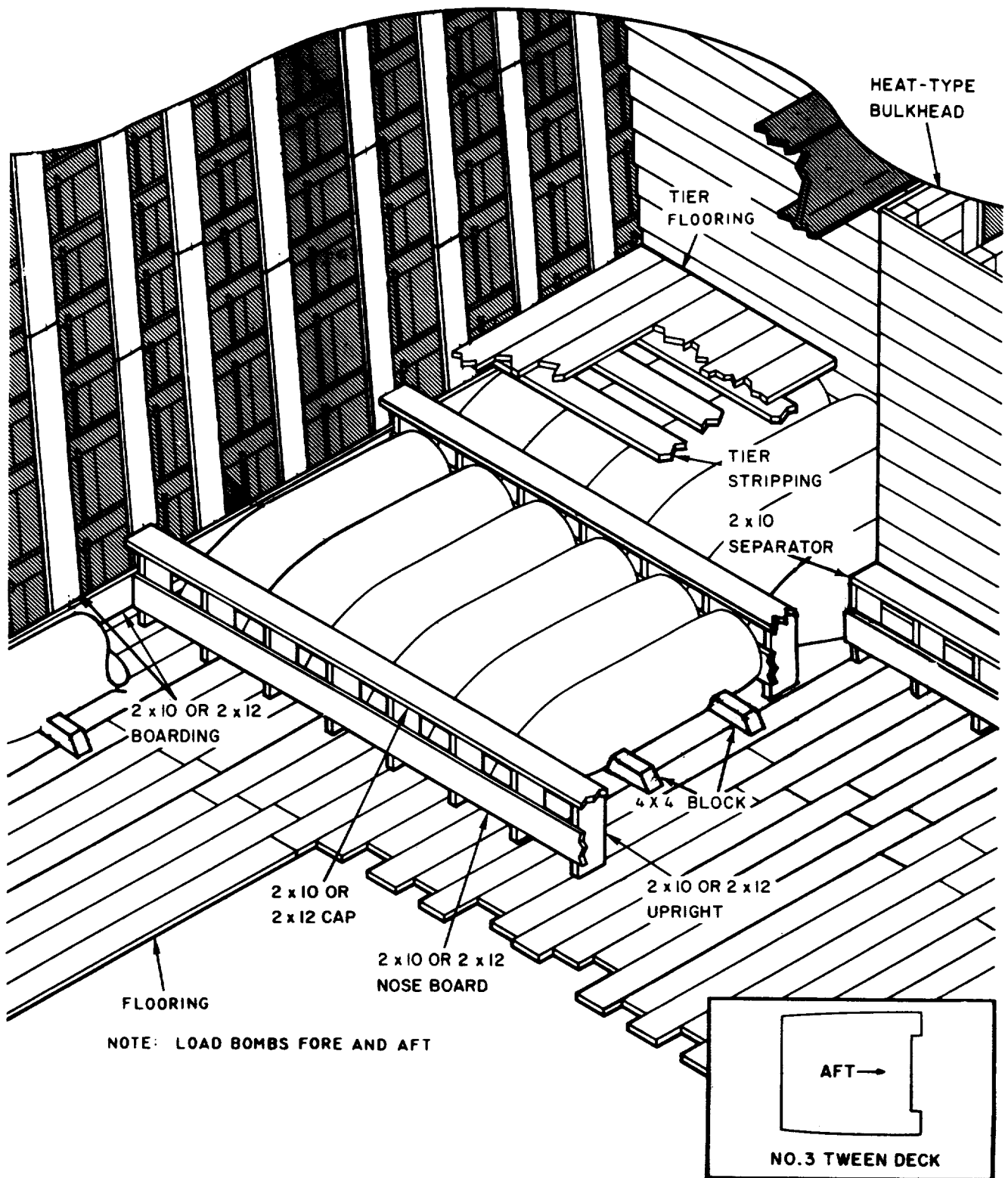


Figure 9-26. Stowing and securing of 3,000-pound bomb, tween deck No. 3 (hull blocking technique).

(2) Dunnaging of 3,000-pound bombs in lower holds where camber and sheer are significant is accomplished through block stowage by tiers. Figure 9-27 illustrates the details of such stowage in lower hold number 1. The requirement for a block-stow structure at the hull constitutes the only major difference in securing technique for 3,000-pound bombs in the lower holds. Uprights of 4-by 4-inch stock are securely braced to the skin or ribs of the vessel by means of 4- by 4-inch

kickers. Vertical supports, commonly known as "stiff legs," can be added to provide additional support for the machine floor. Kickers are cut to fit the curvature of the hull or ribs, as required. Securing methods in the central areas of the compartment are similar to those used on the tween decks. Tight, nose-to-butt stowage of bombs in a fore-and-aft orientation must be maintained. Vertical restraint can be provided by tomming or by overstowing with compatible palletized cargo.

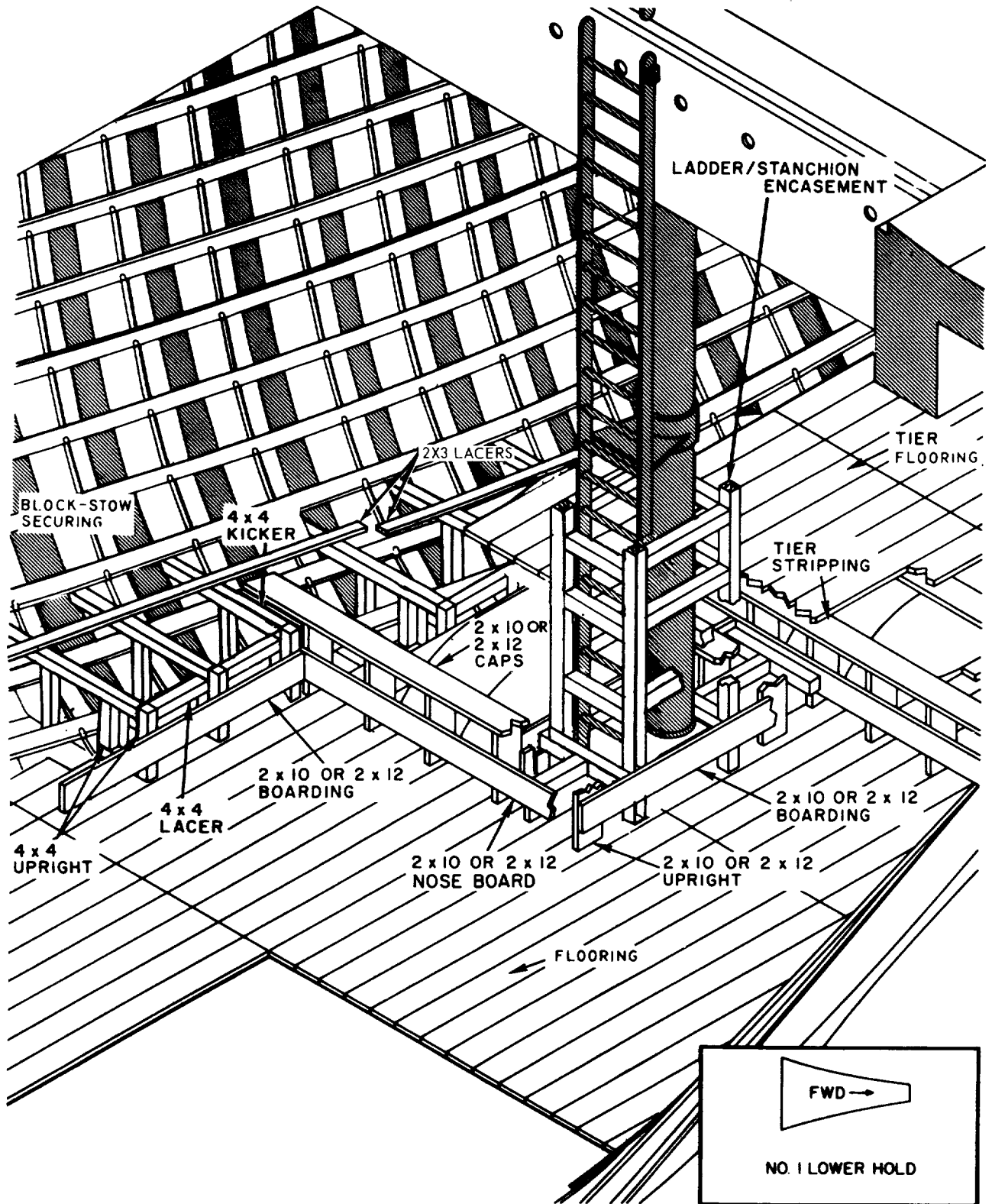


Figure 9-27. Stowing and securing of 3,000-pound bomb, lower hold No. 1 (hull blocking technique).

b. *15,000-Pound Slurry/ Bomb, BLU-82/B, Skidded Load.* Although handled infrequently by loading activities, special securing procedures for the 15,000-pound slurry bomb warrant discussion. The BLU-82/B skidded unit load measures approximately 12 feet in length, 5 feet in height, and 5 feet wide. Item weight precludes handling with conventional forklift trucks and most shipboard cranes, and stowage is limited to the square of the hatch. The BLU-82/B 15,000-pound slurry bomb is shown in its shipping configuration in figure 9-28.

(1) The relatively small deck contact area of the slurry bomb skid requires that flooring be laid prior to loading to distribute the load over a larger deck area. Two perpendicular courses of 2-inch lumber are laid, followed by a single layer of 3/4-inch plywood panels.

Two staggered layers of 1-inch decking can be used in lieu of the lower course of 2-inch lumber. Figure 9-29 illustrates construction details for preload flooring and boarding. A single slurry bomb is shown in a fore-and-aft stowage orientation, the pointed bomb nose bearing against bulkhead boarding installed previously. Double thickness of 2- by 10- or 12-inch lumber is secured to 4- by 4-inch uprights on centers not to exceed 30 inches. The upper boarding is secured to the uprights centered to and bearing against the bomb nose. The lower layer of boarding bears against the flooring. Double 4- by 4-inch sleepers are secured along the lower boarding to provide a bearing surface for the nose ends of the skids. When initial boarding has been completed, preparation is made for stowage of a second slurry bomb.

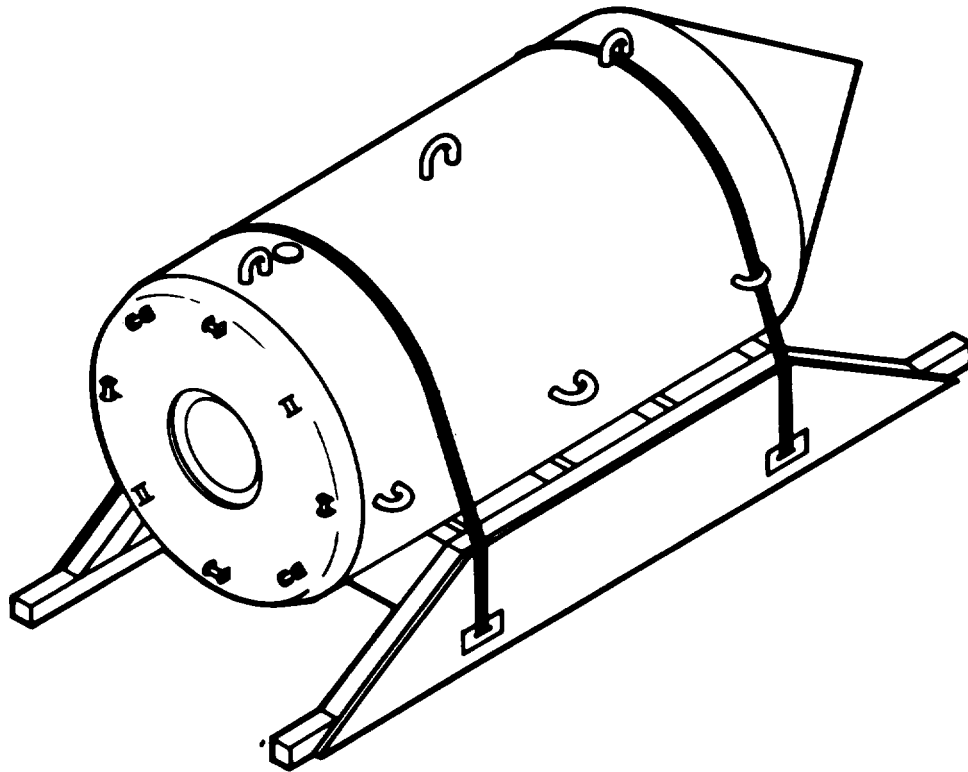
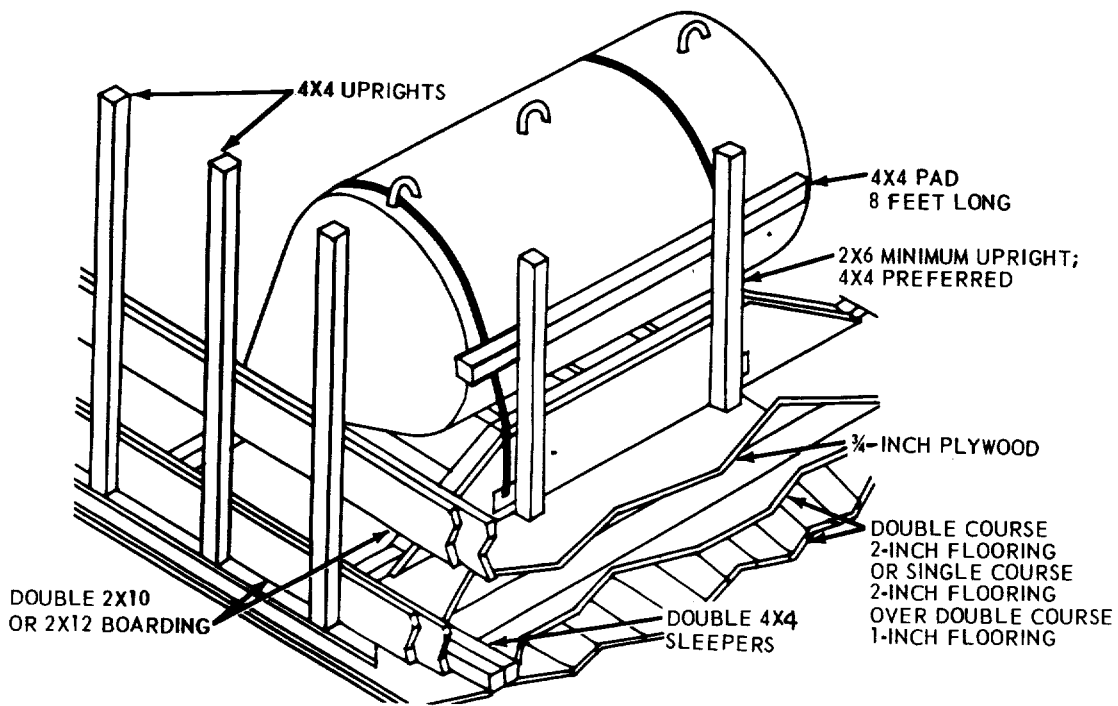


Figure 9-28. BLU-82/B15,000-pound slurry bomb, skidded unit load.

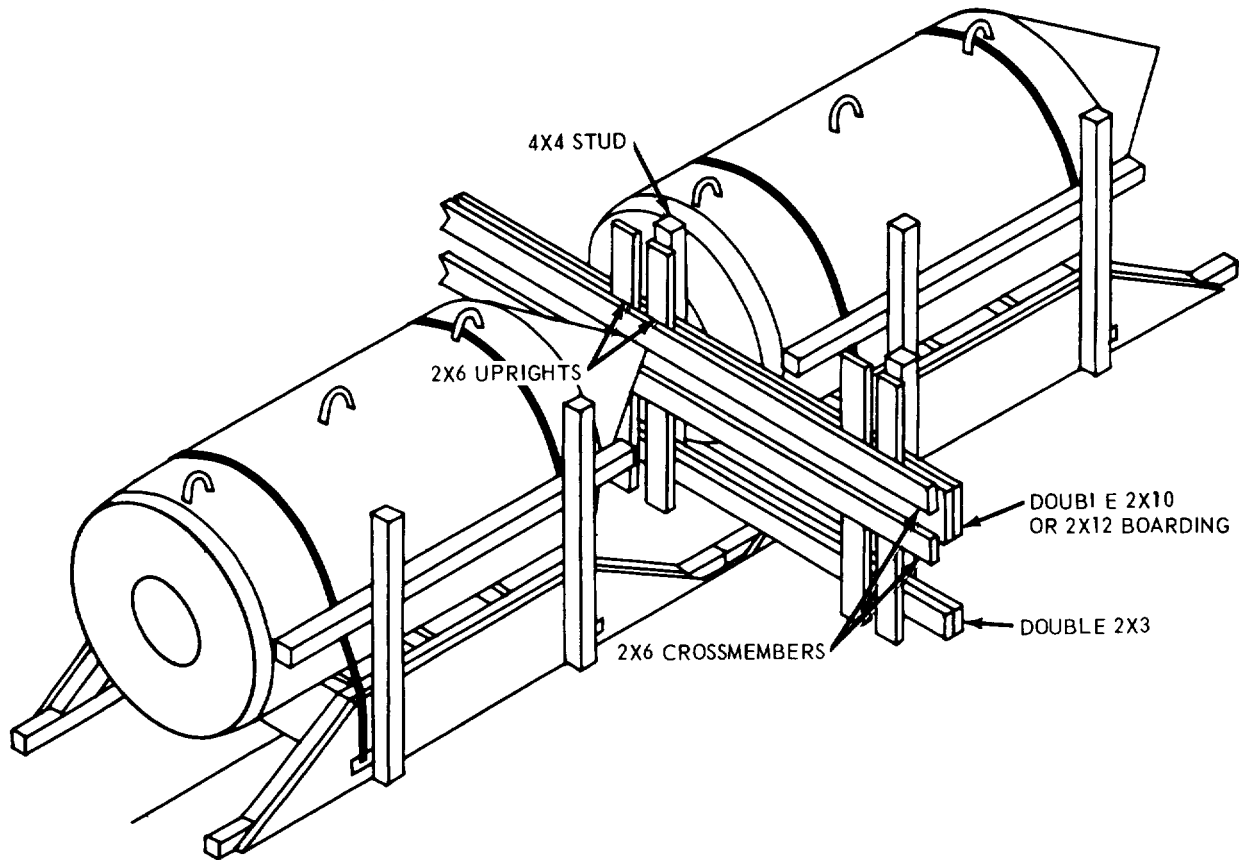


**Figure 9-29. Preload boarding and flooring for 15,000-pound slurry bomb.**

(2) A separator pad is installed between bombs to prevent chafing between the sides of the skids and to fill the void of approximately 8 inches, which would otherwise occur. The pad is constructed of an 8-foot length of 4- by 4-inch lumber and rests upon the three lifting eyes on the side of the bomb. Two 63-inch uprights are spaced as shown in figure 9-29 and nailed securely to the pad. A second 8-foot length of 4- by 4-inch lumber is secured similarly on the opposite side of the uprights. The sides of the skids of the adjacent unit load are made to bear tightly against the uprights.

(3) Unit loads in the next row are loaded nose-to-butt with the first row and with the ends of the skids in solid contact. Studs of 4- by 4-inch stock are

positioned on center against the bases of the first row of bombs. Double 2- by 10- or 2- by 12-inch boarding is secured to the uprights centered on and in contact with the bomb nose. Two 2- by 3- or 2- by 4-inch boards are fastened about 12 inches above the decking to serve as further support for the structures to follow. A 2- by 6-inch upright is placed against either side of the bomb nose and secured to the boarding. Finally, 2- by 6-inch crossmembers are affixed against the top and bottom of the bomb nose, effectively boxing the nose end and preventing any movement likely to weaken the integrity of the securing structure. Figure 9-30 shows a second bomb in its final stowage position and illustrates construction details for nose boarding in nose-to-base stowage.



**Figure 9-30. Construction details for nose boarding in nose-to-base stowage.**

(4) The stow is shown in final stages of completion in figure 9-31. To tom the load (prevent upward movement), 1/2-inch wire strap is secured to the ship's structure and is run through the center lifting eyes of each bomb ill the row. The load is unitized by diagonally threading wire strap through the end lifting eyes as shown in the figure. Proper tension is achieved by means of turnbuckles. Full-block structures are

required to secure any void areas in the compartment. Two 4- by 4- inch crossmembers are placed directly on the bomb, and three 2- by 10-inch boards are installed to provide a bearing for the main 4- by 4-inch uprights. The structure is stabilized by means of 4- by 4-inch horizontal kickers, again bearing on 2- by 10-inch boarding. Cleats of 2- by 3-inch stock are added to provide support for the upper kickers; lower kickers rest upon the deck.

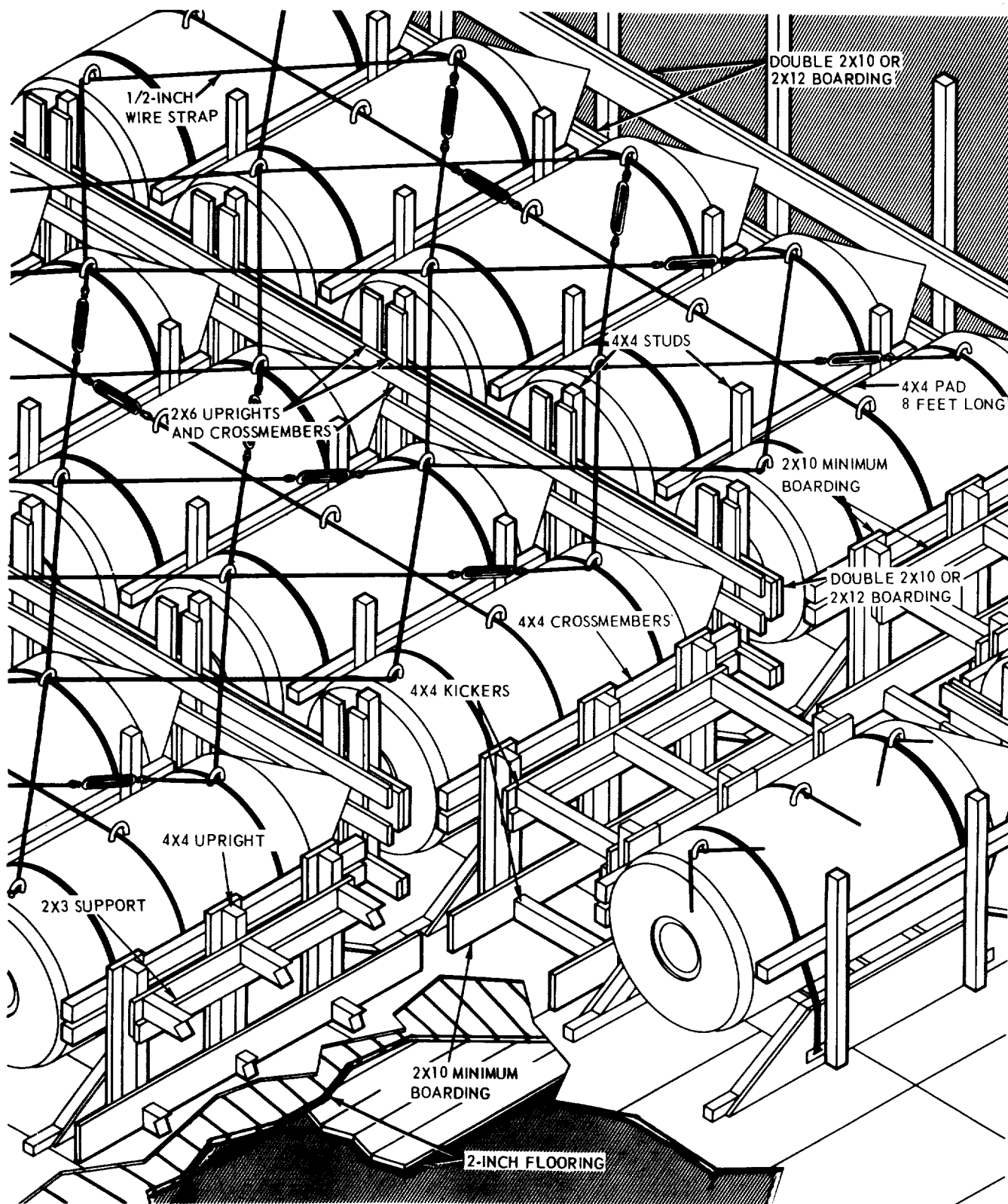


Figure 9-31. Stowing and securing of 15,000-pound slurry bomb, nose-to-base, fore-and-aft.



(5) Base-to-base, athwartship stowage of the 15,000-pound slurry bomb is permissible provided a full-block structure is constructed along the base of the unit loads, as illustrated in figure 9-32. The unit loads are stowed so that the base ends of the skids bear against a length of 4- by 4-inch stock fastened to the decking. A full-block structure is constructed along the bases of the unit loads. This structure consists of a series of jacks, each made to fit tightly between the unit loads at the centers of the bomb bases. The jacks, which are constructed of 4- by 4-inch uprights 63 inches high and 4- by 4- inch kickers with lengths cut-to-fit snugly, are interconnected with four 2- by 3-inch lacers. The kickers

are spaced so that their ends bear above and below the circular recess in the base of the bomb. Finally, one end of 1/2-inch wire strap is secured to the ship's structure behind the hatch coaming in the next level below and is routed through the nearest access hole in the coaming and through the center lifting eyes of the bombs in each row. The other end of the strap is run through the nearest access hold in the hatch coaming on the opposite side and the strap is secured to the ship's structure. Thus, each row of unit loads is tommed. Also, the loads are interstrapped from row to row in the manner shown in the illustration.

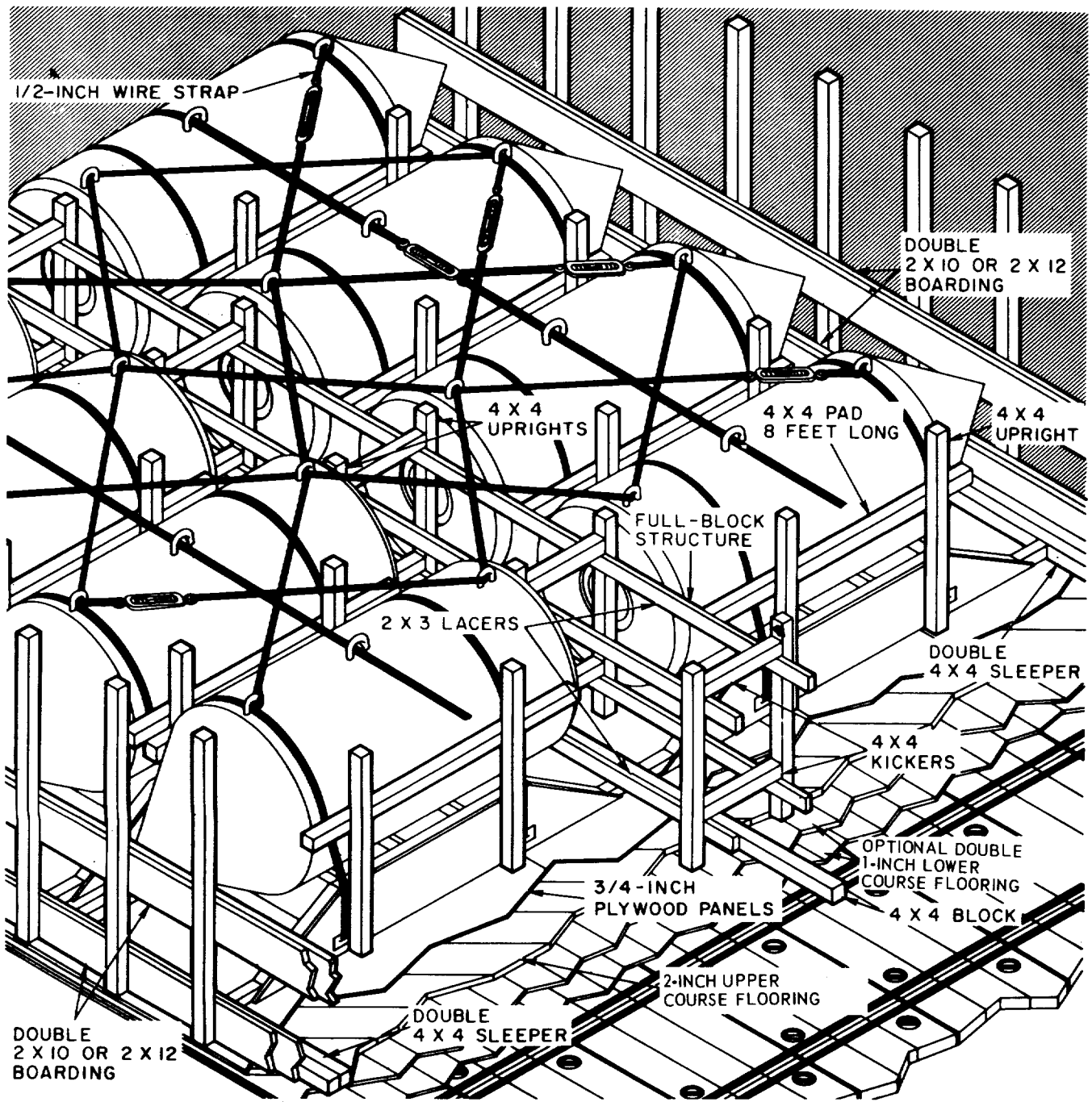


Figure 9-32. Stowing and securing of 15,000-pound slurry bomb, base-to-base, athwartship.

(6) When stowed nose-to-base athwartships, as shown in figure 9-33, the nose ends of the unit loads along the edge of the hatch are dunnaged in the same manner as those stowed base-to-base and illustrated in figure 9-32. The dunnage between loads stowed side by side also is identical to that shown in figure 9-32. The units in the next row are positioned so that the nose ends of the skids abut the base ends of the skids in the first row. As a result, the noses of the bombs in the second row will be aligned with the center of the bases in the first row. As shown, 4- by 4-inch studs, 63 inches high, are placed on center against the bases in the first row. Two 2- by 10- or 12-inch nose boards bearing on center against each nose of the bombs in the second row are fastened to the studs. Along the lower portion of the studs, two 2- by 3-inch boards are fastened

approximately 10 or 12 inches above the decking. Next, 2- by 6-inch uprights are placed against each side of the bomb noses and are fastened to the nose board, and 2- by 6-inch crossmembers bearing against the top and bottom of each bomb nose are fastened to the uprights. This structure resists upward and sidewise movement of the nose ends of the unit loads. The base ends of the loads in the second row are dunnaged by using jacks and lacers constructed and placed in the same manner as that illustrated in figure 9-32. The base ends of the skids, however bear against two 4- by 4-inch sleepers fastened to the decking along the jacks. This construction constitutes a full-block structure, which itself must be blocked and/or braced to resist movement fore and aft -as well as athwartships.

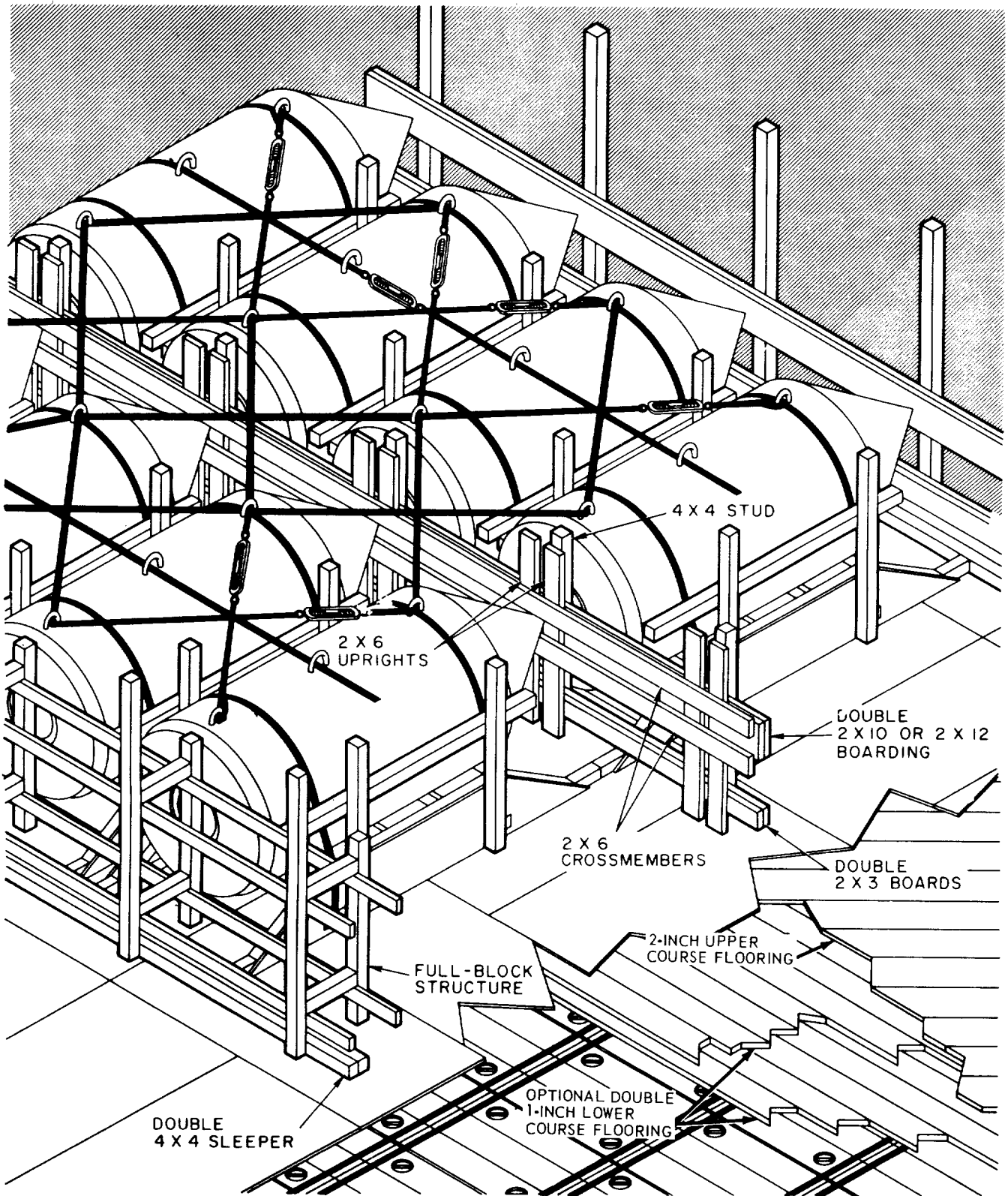


Figure 9-33. Stowing and securing of 15, 000-pound slurry bomb, nose-to-base, athwartship.

**9-4. Securing of Overhanging Unit Loads**

a. *500-Pound Low-Drag (GP) Bomb, MK82.* The 500-pound bomb is loaded frequently aboard merchant-type ships and is the most typical example of stowage and (dunnaging techniques for overhanging unit loads. Four types of palletized unit loads for this item, two of Navy design and two of Air Force origin, may be encountered at explosives-loading activities. The general configuration of each type of unit load is similar, and the stowage practices are essentially the same. Each unit load weighs approximately 3,200 pounds and occupies about 38 cubic feet. Six bombs (each fitted

with a nose plug) are strapped securely to a pallet. One of the Navy loads uses metal bomb pallet, MK9 MOD 0; the other three loads use wood pallets. With the exception of strip decking required for the Navy metal-pallet load, each type can be stowed and secured in the same manner. Figure 9-34 and 9-35 show typical 500-pound-bomb palletized unit loads. All types of the 500-pound-bomb unit loads are designed for transport by standard forklift trucks and are easily transferred from railcar to hoisting spot. The Navy metal-pallet load is a two-way entry load; the others are all four-way entry loads.

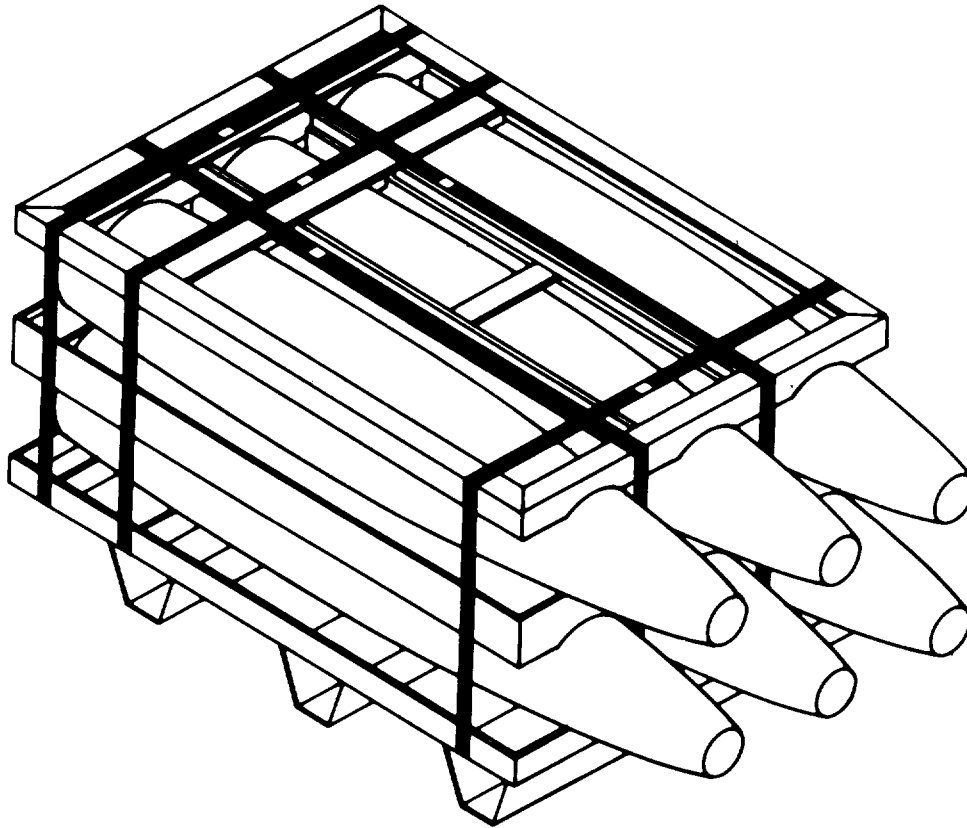
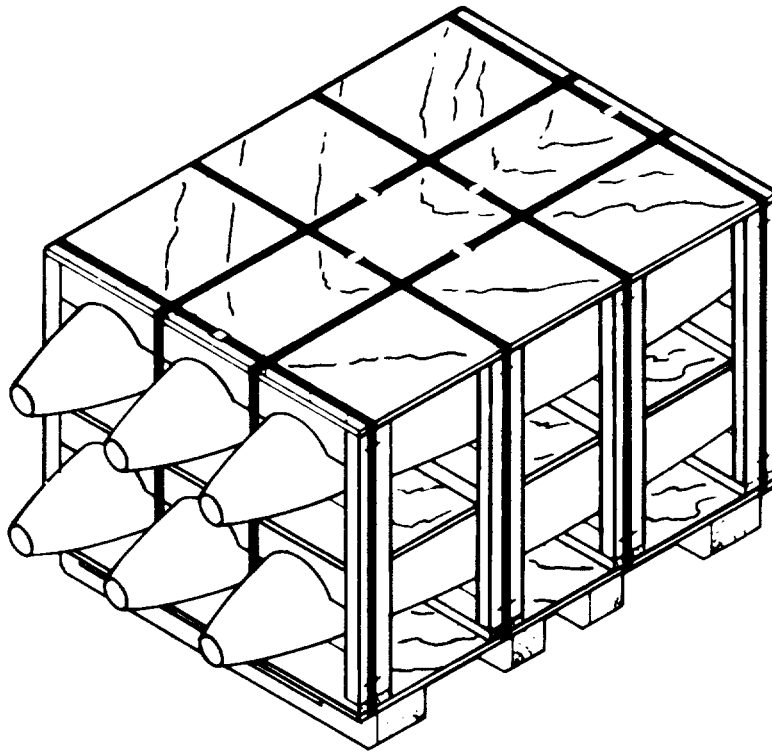


Figure 9-34. Typical 500-pound bomb, Navy palletized unit load (metal pallet).



**Figure 9-35. Typical 500-pound-bomb palletized unit load (wood pallet).**

(1) *Application to similar items.* Similarities in configuration between the 250-, 500-, and 1,000-pound-bomb palletized unit loads permit the application of identical techniques to the stowage and dunnaging of these units. The unit load of 250-pound bombs, shown in figure 9-36, consists of 12 bombs strapped to a metal pallet; the 1,000-pound-bomb unit load, shown in figure 9-37, includes three bombs and a metal pallet; the 2,000-pound-bomb unit load, shown in figure 9-38,

consists of two bombs strapped to a metal pallet, which, unlike the others, has stacking pins. Stowage methods illustrated for the 500-pound-bomb palletized unit load can be applied to the 250-pound bomb, the 1,000-pound bomb, and 2,000-pound bomb unit loads. Stowage patterns unique to the 2,000-pound loads are discussed separately in paragraph 9-4c, as illustrated in figures 9-64 and 9-70.

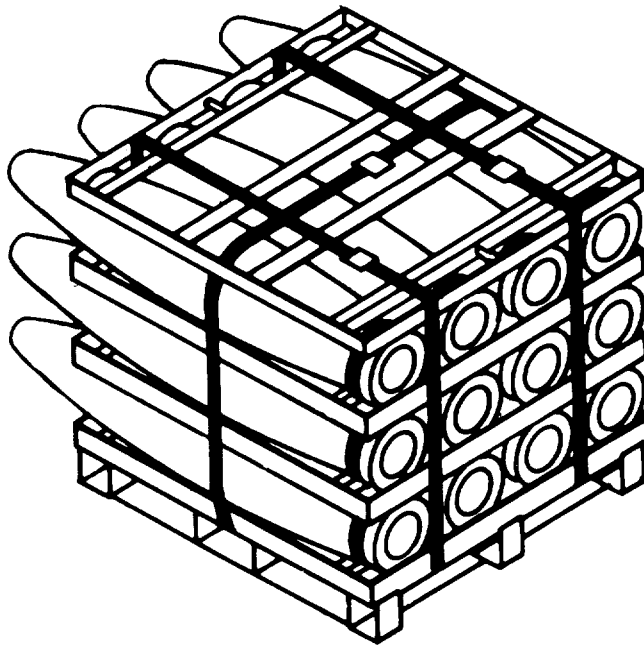


Figure 9-36. 250-pound-bomb palletized unit load.

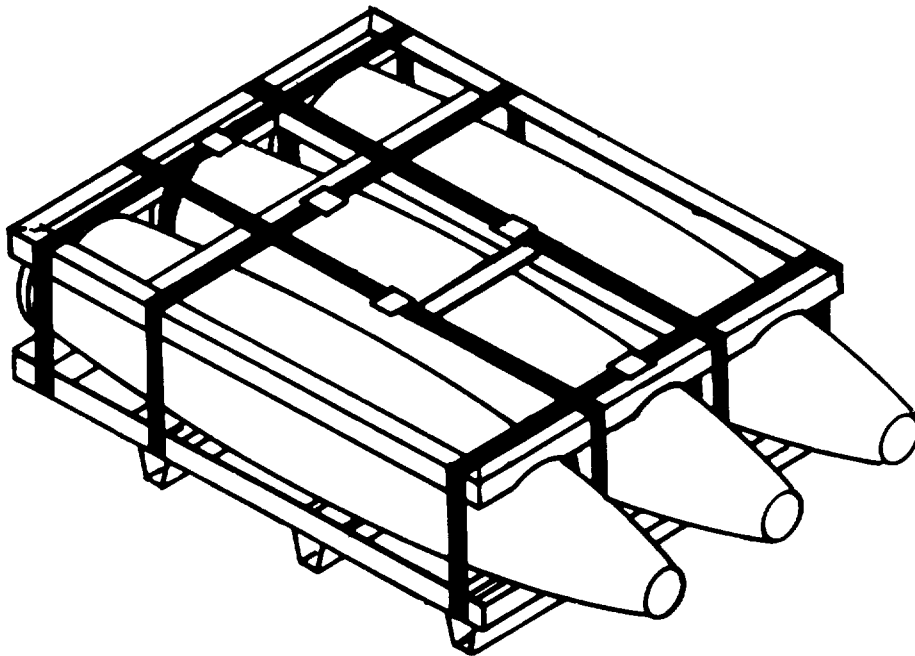


Figure 9-37. 1,000-pound-bomb palletized unit load.

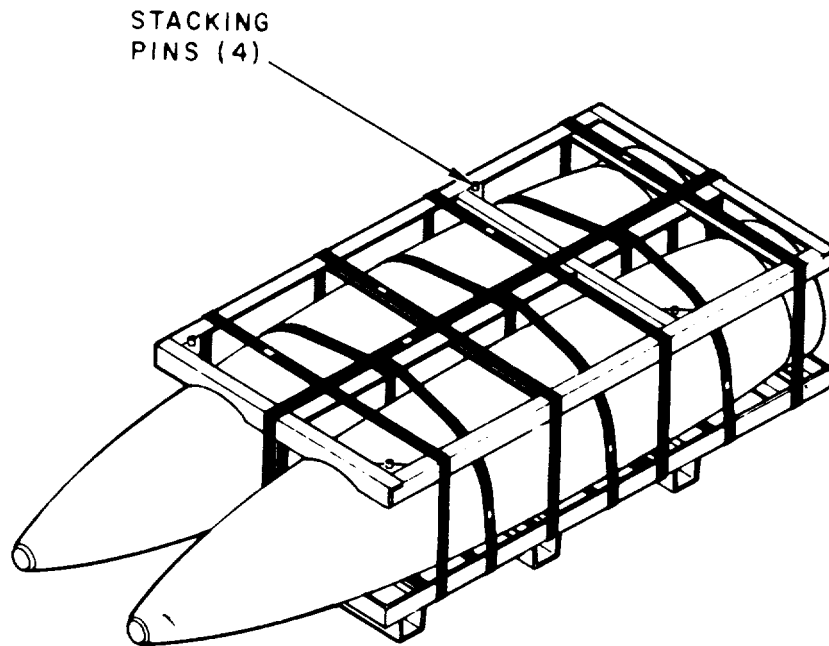
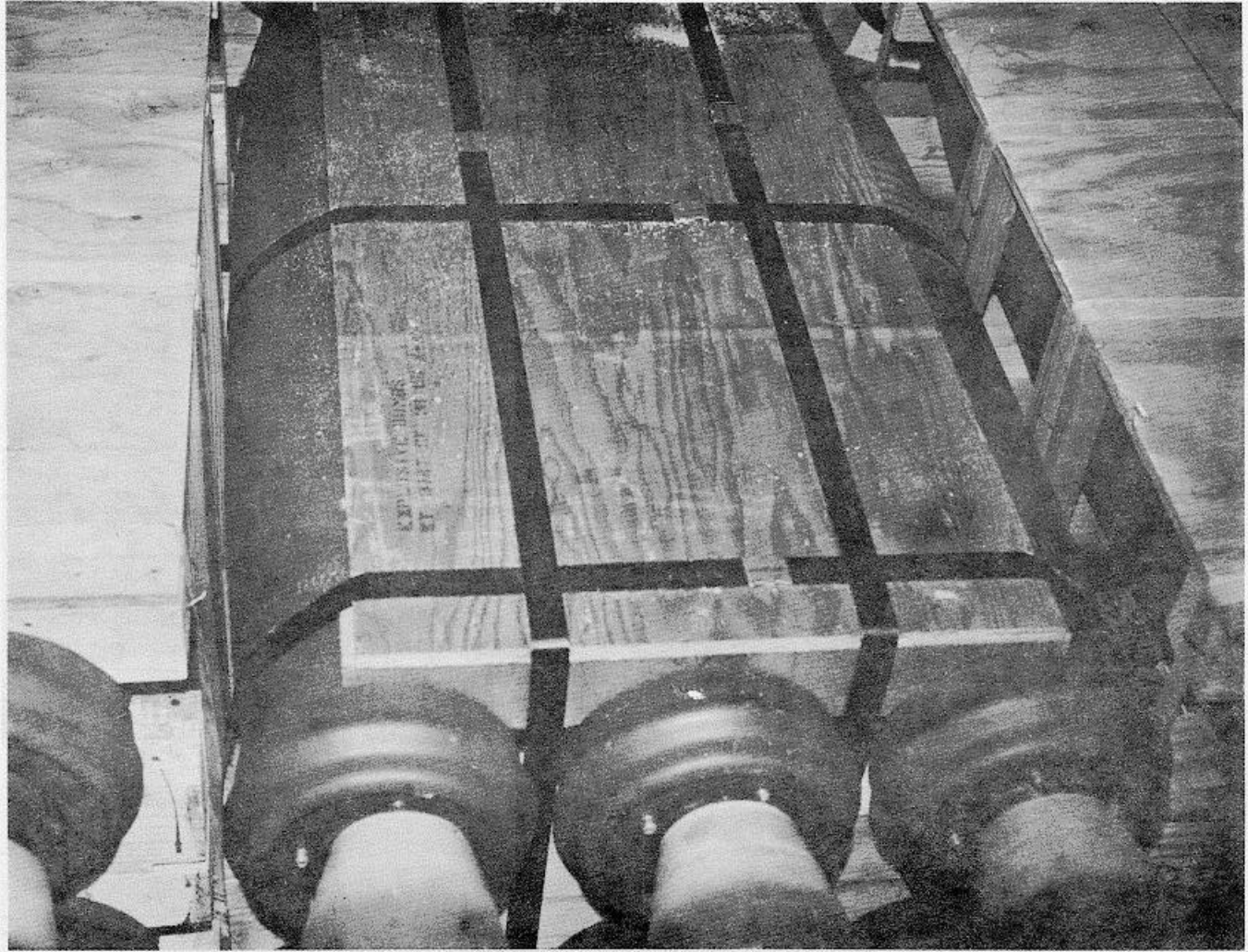


Figure 9-38. 2,000-pound-bomb palletized unit load.

(2) *General stowage requirements.* The 500-pound bomb unit load can be stowed with the longitudinal axis oriented either fore and aft or athwartships, whichever is more conducive to efficient compartment utilization. Bomb loads are normally stowed fore and aft when block stowage techniques are used. They are oriented athwartships when sweatboard-to-sweatboard loading principles are applied. However, the base end of the unit load at the end of a tier or row should always face the hull, where applicable, to provide a suitable surface for dunnaging purposes. Unit loads of bombs equipped with the obsolescent pointed nose plugs should be separated by means of nose boards. The majority of 500-pound bombs currently being received for ocean shipment are equipped with flat plastic nose cones and plastic butt plates. These modifications are a significant improvement over the pointed nose plugs described previously. In addition to providing a more suitable pallet configuration for stowage, the flat plastic nose cone reduces the probability of damage from accidental contact between unit loads. Nose-to-nose or butt-to-butt stowage of

bombs equipped with flat plastic nose cones is acceptable without a requirement for nose boarding, provided nose-to-nose on center contact is maintained or the bombs are reasonably aligned butt-to-butt. However, if proper contact or alignment cannot be maintained and a void area exists at the nose or butt of the bomb, or, if bomb noses are offset, nose boards should be used. Nose-to-butt stowage of 500-pound-bomb unit loads without nose boarding is permissible only when all nose cones of the bomb unit load can be aligned on center with the butt plates of the bombs in the adjacent unit load, as shown in figure 9-39. This requirement is introduced to minimize the possibility of damage to the plastic nose cone by the set screws on the butt end of the adjoining bomb. Deviation from precise center-to-center alignment will necessitate the use of board barriers between loads. Appropriate care should be taken during stowage to ensure that bombs are not brought into contact forcibly, particularly during loading operations. Missing or damaged protective nose cones should be replaced prior to loading the pallet.

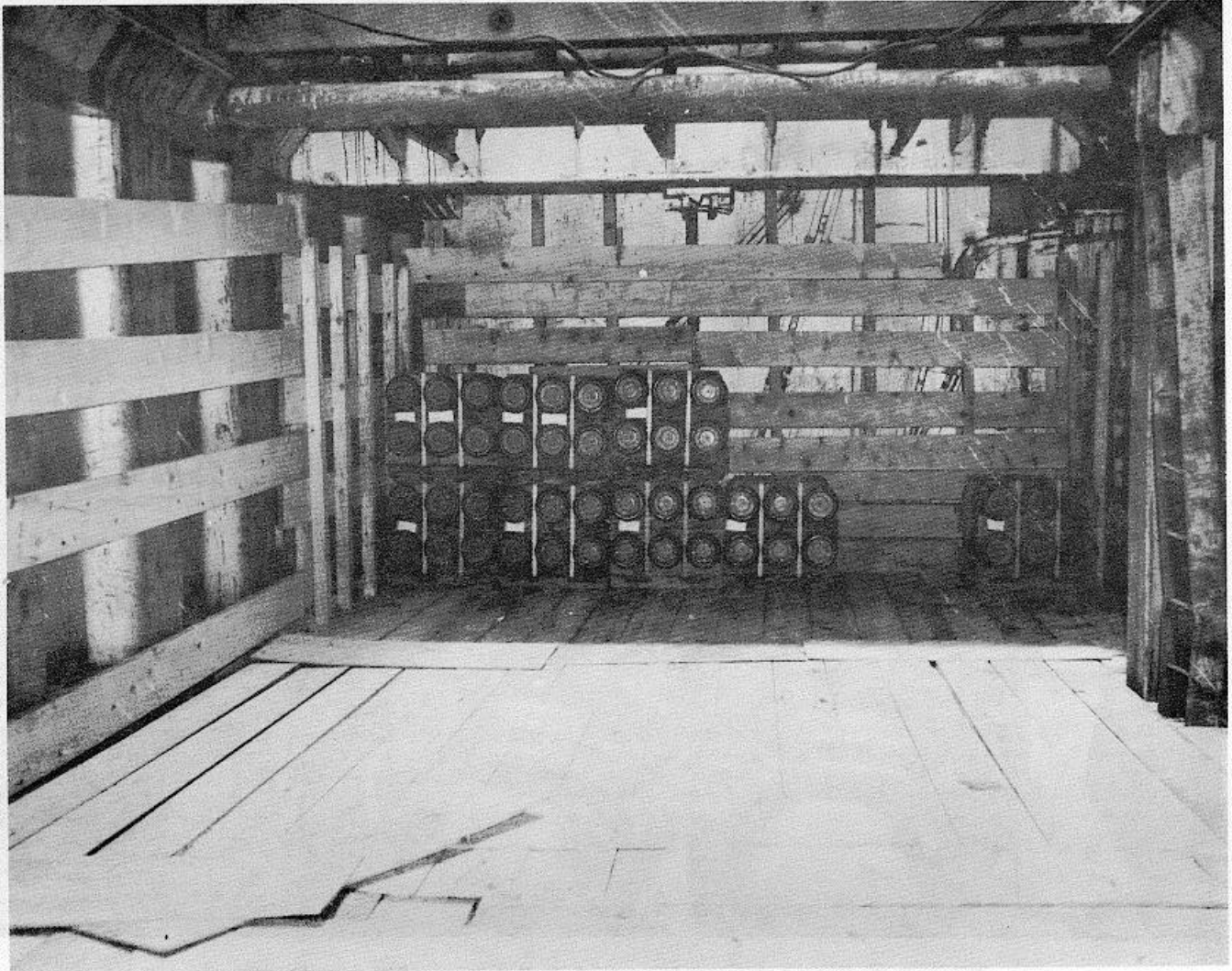




**Figure 9-39. Correct alignment for nose-to-butt stowage of 500-pound bombs.**

(3) *Tween-deck stowage.* Stowage of the 500-pound-bomb unit load in tween-deck compartments or in rectangular areas of certain lower holds is achieved with efficient utilization of space and securing materials. Figure 9-40 illustrates the stowage of 500-pound bombs in a portion of a compartment having essentially perpendicular bulk-heads. Fore-and-aft nonheat bulkheads serve a dual purpose; they provide a level bearing surface over bulkhead protuberances, and prevent the bomb nose area from contacting with metal surfaces. The boarding is constructed of 2-inch minimum stock securely fastened to 4- by 4-inch uprights and centered on the nose cones of each row of individual bombs. Bombs are shown loaded fore and aft, with the bomb noses of the first row of unit loads at both ends of the compartment solidly bearing against

the end boarding. In this case, the loading progresses nose-to-butt from both ends of the compartment. Any voids will be butt-to-butt, confined to the central area. Stowage can also begin with the butt end of the bomb-unit loads in contact with the end boarding. Loading would proceed alternately nose-to-nose and butt-to-butt, working toward the center of the compartment. Unit loads will again be oriented butt-to-butt at the void to facilitate shoring with full-block structures. Two 4- by 4-inch uprights are positioned against each butt end of the unit loads facing the void. These uprights are braced to each other and to those of the load, across the void, with 4- by 4-inch kickers installed near the top and bottom of each upright in forming the full-block structure. Similar structures are used to shore cross-tier voids, as illustrated previously in figure 8-21.



**Figure 9-40. Stowage of 500-pound-bomb unit loads in rectangular compartments.**

(4) *Blockage stowage of palletized bombs.*

(a) Securing the 500-pound-bomb unit load in compartments with significant hull curvature requires construction of block-stow structures to restrain the stow effectively. Figure 9-41 illustrates simple three-high block stowage of 500-pound bombs in a lower hold of a typical C3 hull. Block stowage is particularly advantageous in narrow, contoured compartments, such as in forward and aft lower holds. Emplacement of the unit loads in block fashion prior to installation of dunnaging considerably reduces requirements for precise measuring and construction in confined areas. Extending the stow fully to the sweatboards in such areas is not recommended, since the potential number of additional unit loads stowed per row does not warrant the additional dunnaging and stowage time required. However, sweatboard-to-sweatboard stowage can be

applied more efficiently in wider compartments, such as the upper tween, in which space utilization can be improved. The stability of the illustrated stow is evident in the aligned, tightly contacting tiers confined parallel to the ship's center line. Construction details for general block-type securing closely follow the principles described in paragraph 8-2. Two 4- by 4-inch uprights are required to secure the end unit loads of each three-high tier, since the tiers are not held in position by overstowed cargo. Figure 9-42 shows additional details of prefabricated shoring in which the parallel securing structures are constructed as a unit, raised into place, and braced to the hull or structural ribs before loading. The 2- by 10-inch boarding facilitates prefabrication and is fastened to the uprights at the premeasured level of each tier, thereby providing additional bearing surface for

the unit loads. Additional 2- by 3-inch lacing will be added to complete the structures. Figure 9-43 illustrates nonprefabricated securing structures installed at the hull. In this case, prefabricated construction was not used;

instead, the bomb loads were emplaced before dunnaging. Hence, face boards are not illustrated on the structure

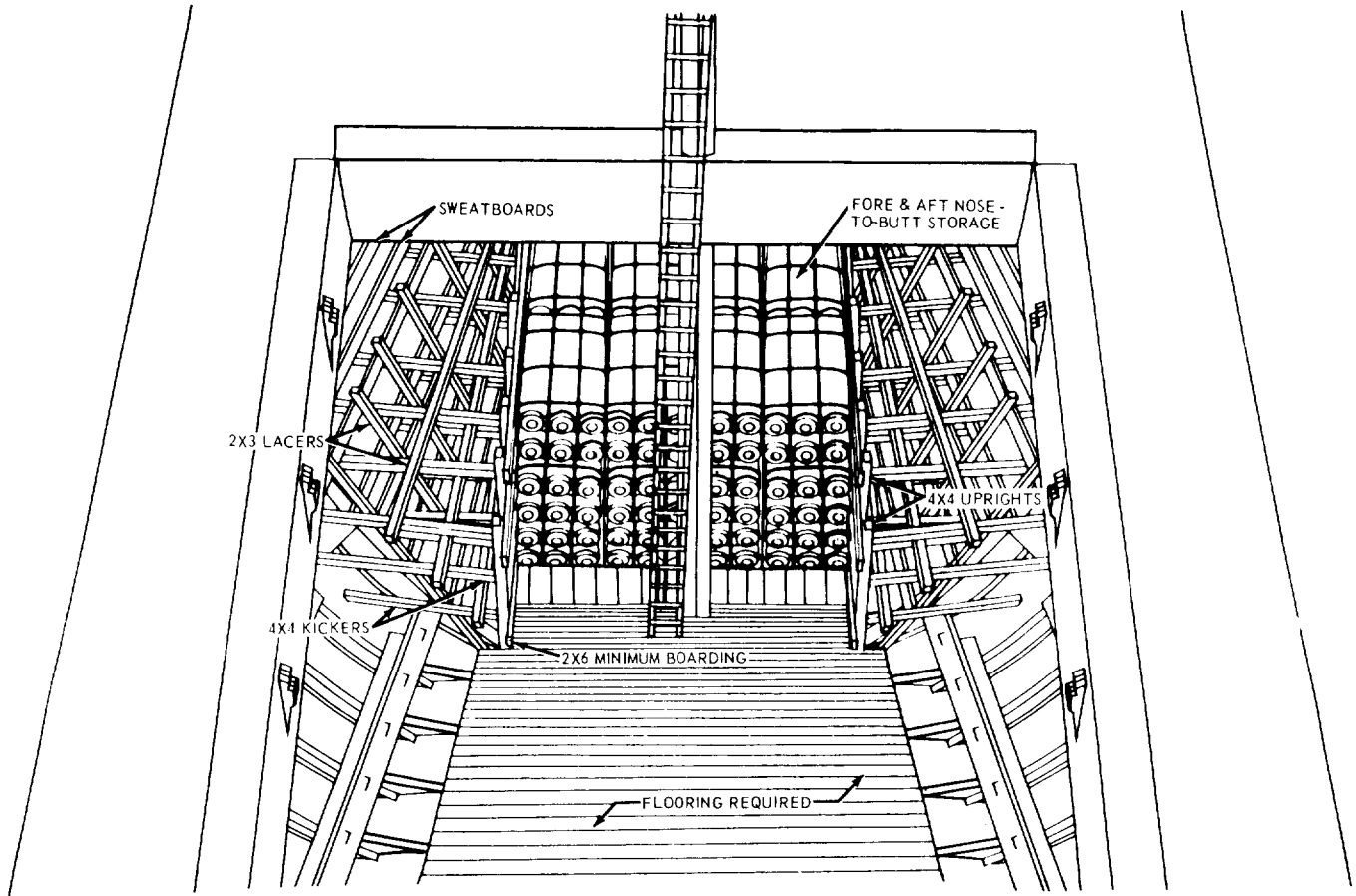


Figure 9-41. Simple block stowage of 500-pound-bomb Unit loads, lower hold No. 5 (hull blocking technique).

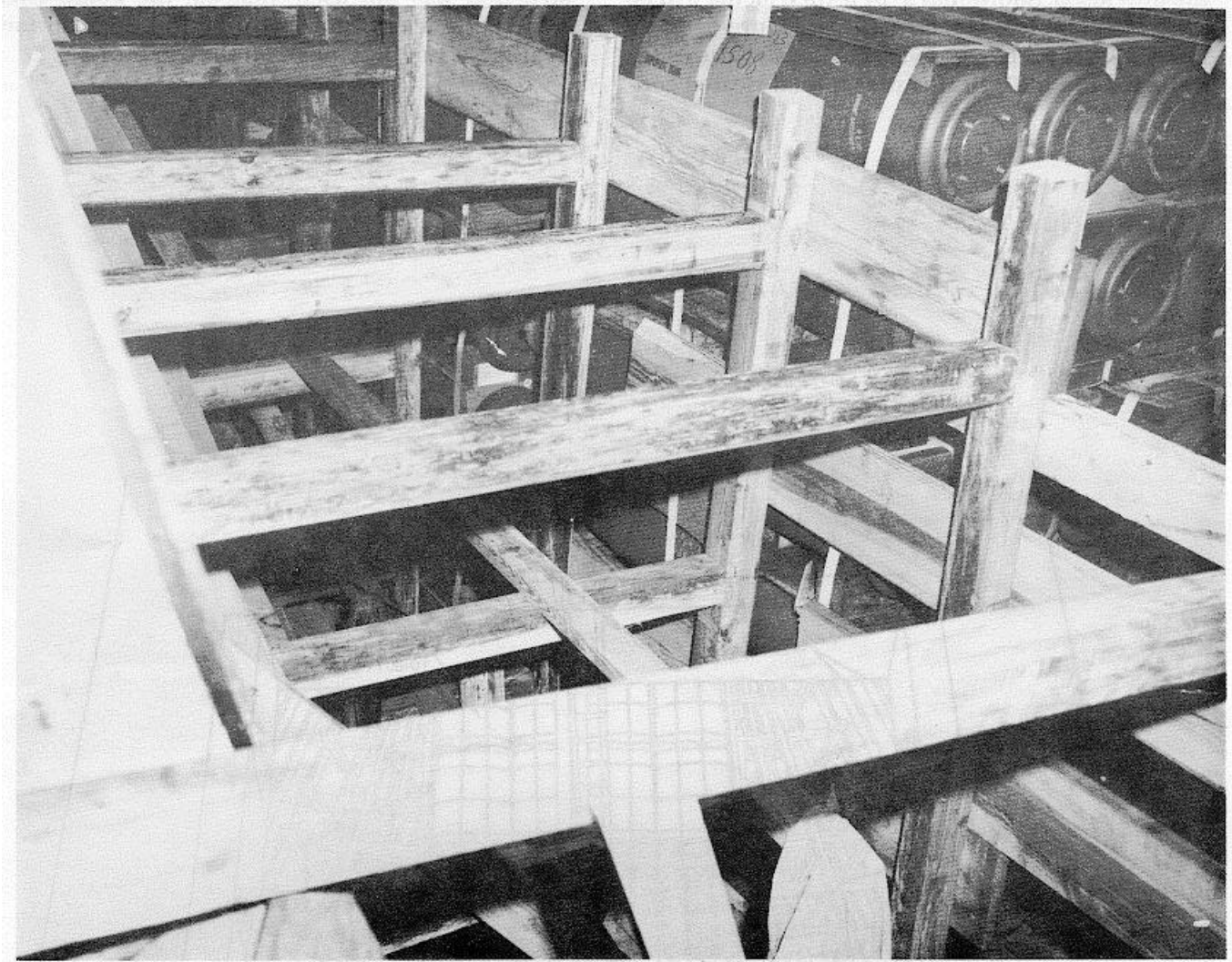
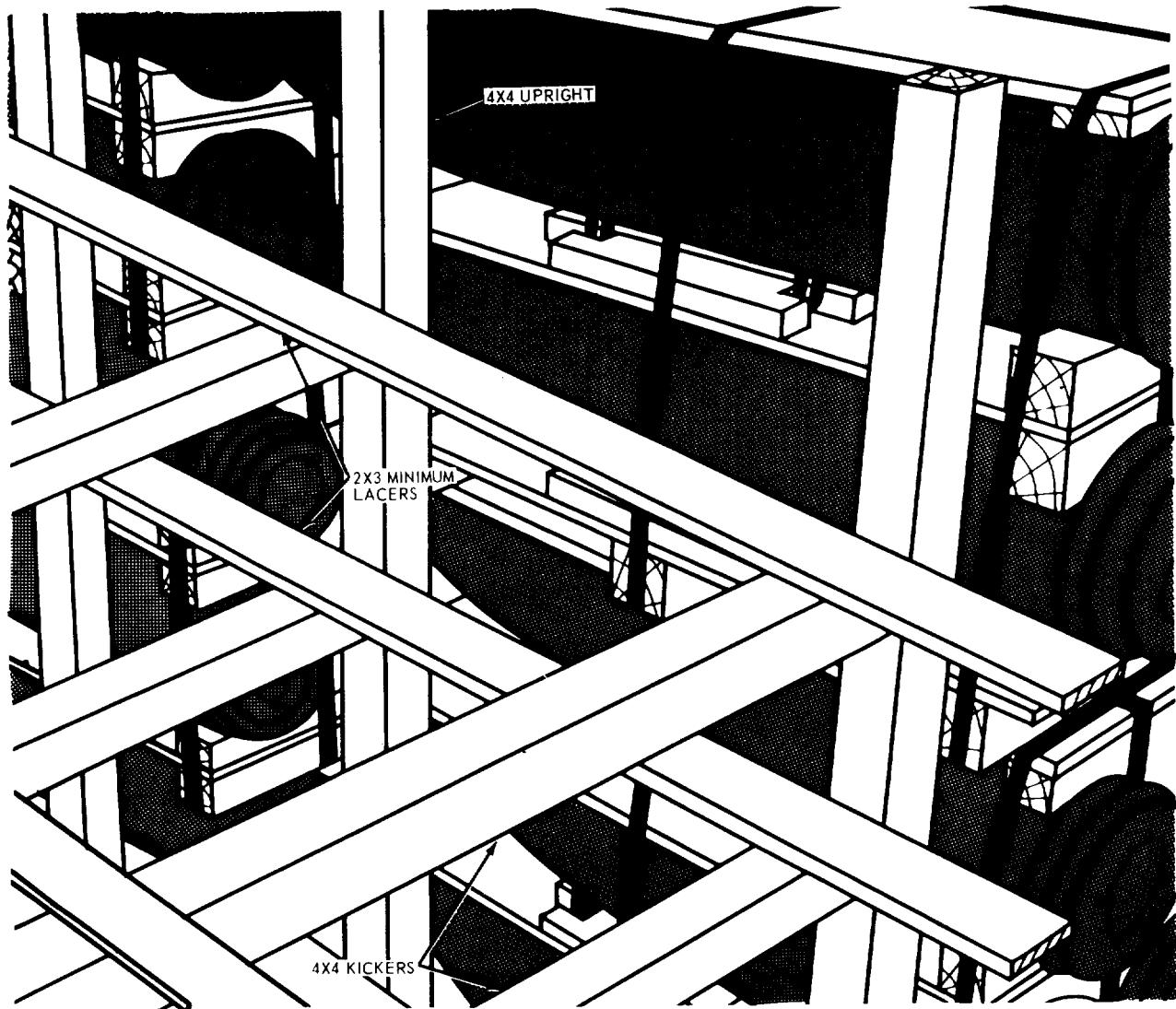


Figure 9-42. Partially completed prefabricated securing for 500-pound-bomb unit loads (hull blocking technique).



**Figure 9-43. Nonprefabricated securing installed after loading.**

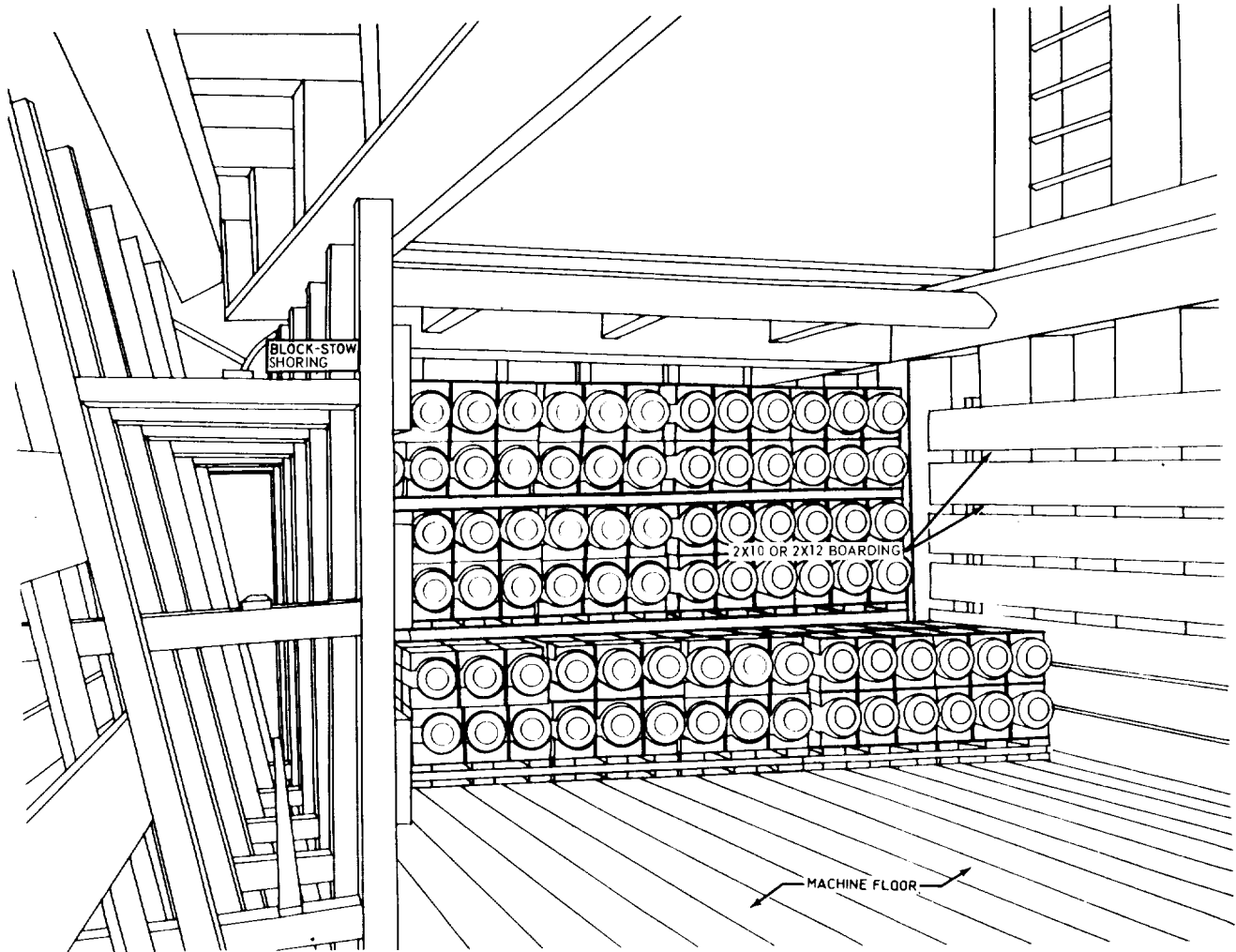
(b) Figures 9-44 and 9-45 illustrate in further detail the use of preconstructed shoring to square off effectively a compartment with significant hull curvature. The shoring at the hull and the end bulkhead shown in figure 9-44 were constructed and erected prior to loading. Block-stow shoring is braced to the hull or structural ribs. In Figure 9-43. Nonprefabricated

securing installed after loading. effect, the contoured compartment is reconfigured similarly to a rectangular tween-deck compartment. The effect of the dunnaging is evident in figure 9-45. Stowage and securing can now proceed rapidly using the procedures as outlined in paragraph 9-4a(3). The hold is worked toward the center, and voids are shored as the stow is completed.





Figure 9-44. Typical preconstructed shoring for block stowage of 500-pound bombs in lower holds.



**Figure 9-45. Slowing and securing of 500-pound bombs, lower hold No. 3, port cell (hull blocking technique).**

(c) Figure 9-46 illustrates stowage of 500-pound-bomb unit loads in an outer cell of a lower hold of a C457 cargo ship. Lower holds in this area are usually of such configuration as to permit the stowage of additional unit loads in a row as loading progresses toward wider areas of the compartment. The pallets are not confined by parallel securing structures, as in full block stowage (fig 9-41); instead, each row is braced individually to utilize the available space more efficiently. In working toward the wider part of the compartment, the number of pallets per row is increased

as soon as compartment width permits. For end loads that do not contact the preceding row, fore-and-aft restraint is provided with 2- by 10-inch nose boarding secured to 4- by 4-inch uprights braced at angles to the hull plate or ribs, as illustrated in figure 9-47. Space utilization is increased additionally by construction of a full floor over the first two levels of bombs. The block-stow-by-levels technique, discussed in paragraph 8-2, provides, in effect, a second deck upon which the stowage pattern can be resumed identically. Flooring will extend fully to the hull as shown.

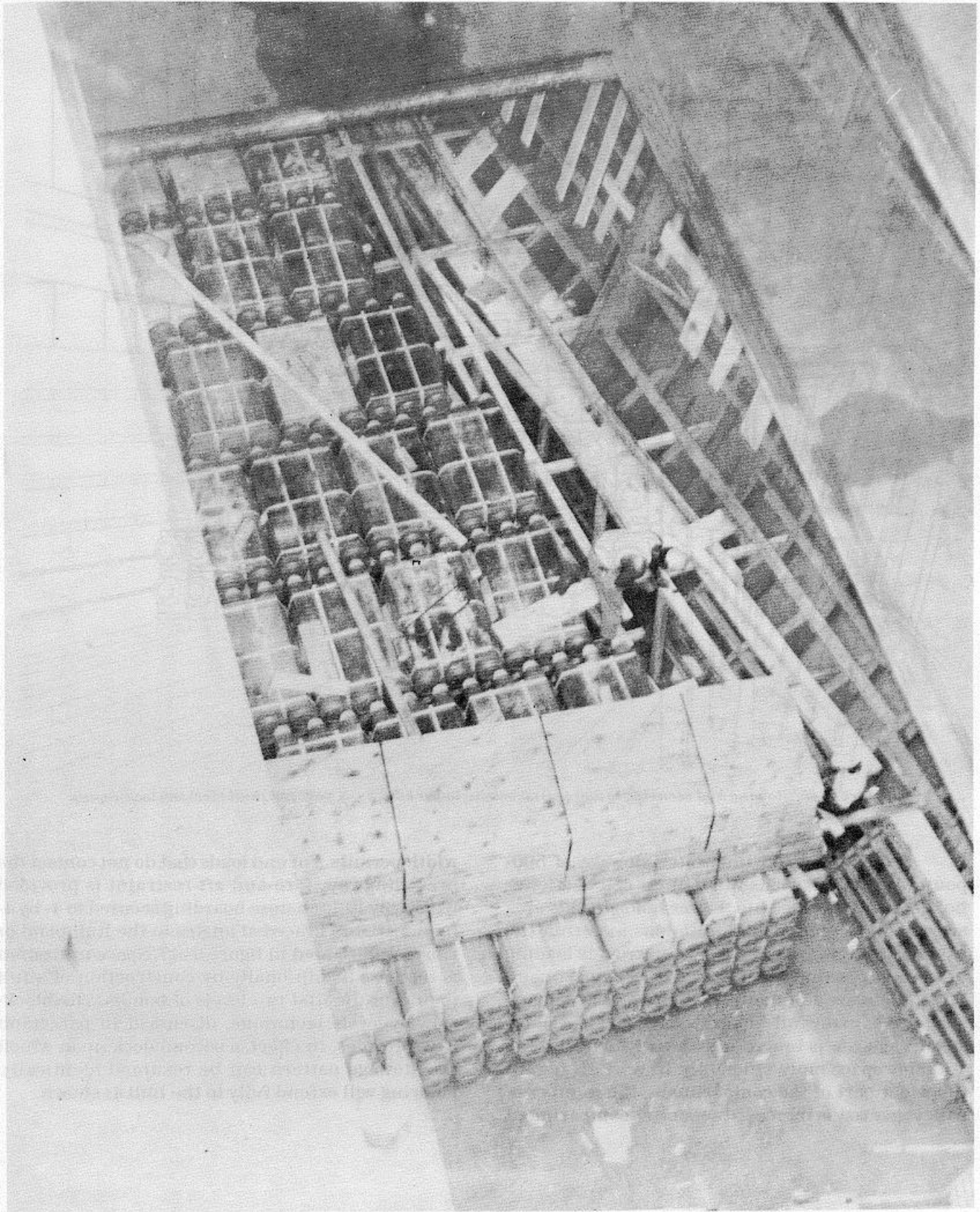


Figure 9-46. Block stowage by levels, 500-pound-bomb unit loads, lower hold No.3, starboard cell (hull blocking technique).



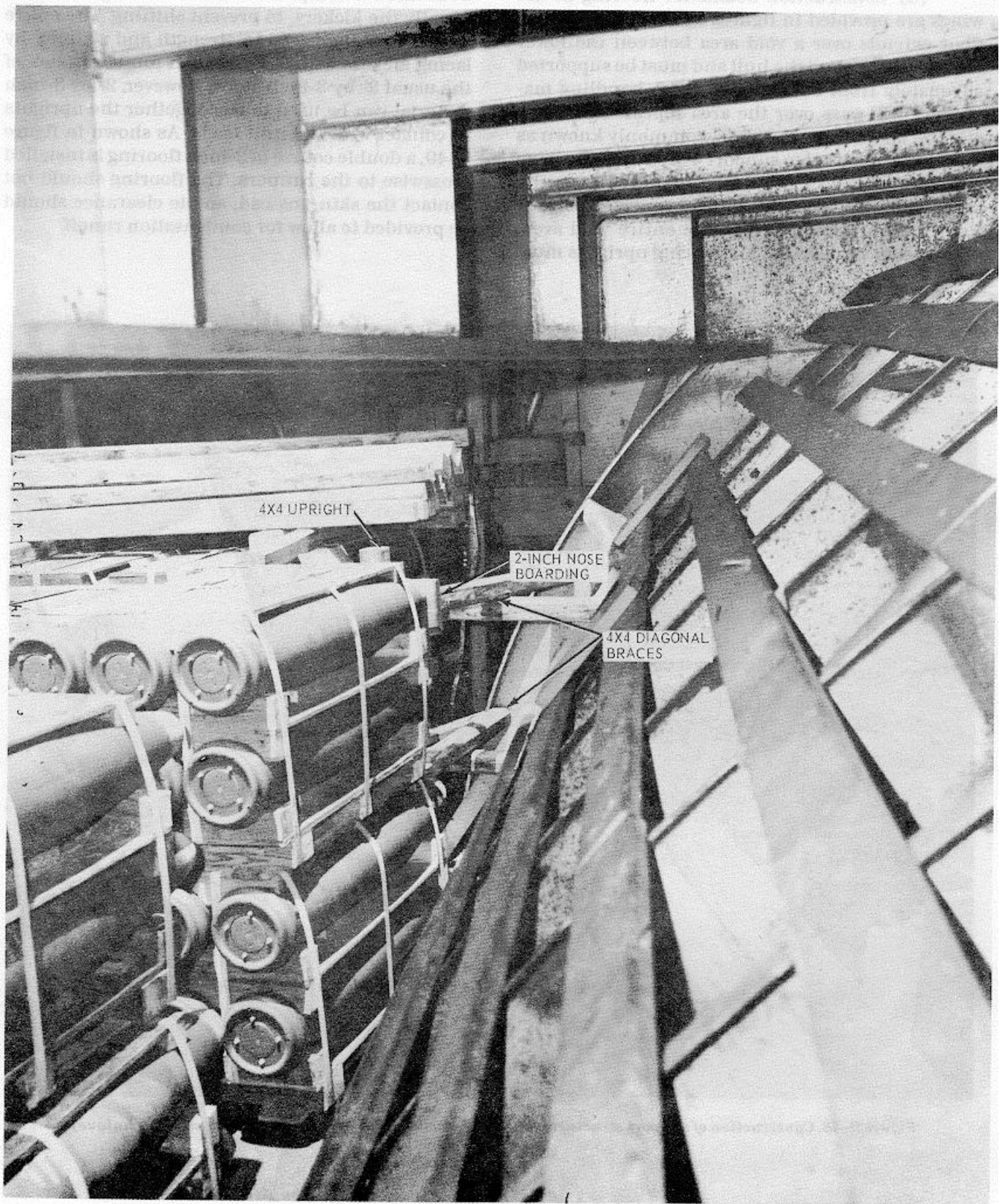


Figure 9-47. Fore-and-aft restraint of end unit loads (hull blocking technique).

(d) Construction details for flooring in the wings are provided in figures 9-48 and 9-49. The floor extends over a void area between the lower level of stowage and the hull and must be supported adequately from below, since cargo-handling machinery will pass over the area repeatedly during stowage operations. Uprights, commonly known as "stiff legs," are used to support 4- by 4-inch flooring runners. Runners should be installed near the cargo and also near the hull to provide a strong flooring foundation across the entire void area, eliminating weak spots. All

flooring uprights must be secured to components of the bracing structure, usually the kickers, to prevent shifting. The entire structure is increased in strength and stability by lacing kickers with 2- by 10-inch lumber in lieu of the usual 2- by 3-inch stock; however, 2- by 3-inch material can be used to lace together the uprights in contact with the unit loads. As shown in figure 9-49, a double course of 2-inch flooring is installed crosswise to the runners. The flooring should not contact the skin; instead, ample clearance should be provided to allow for condensation runoff.

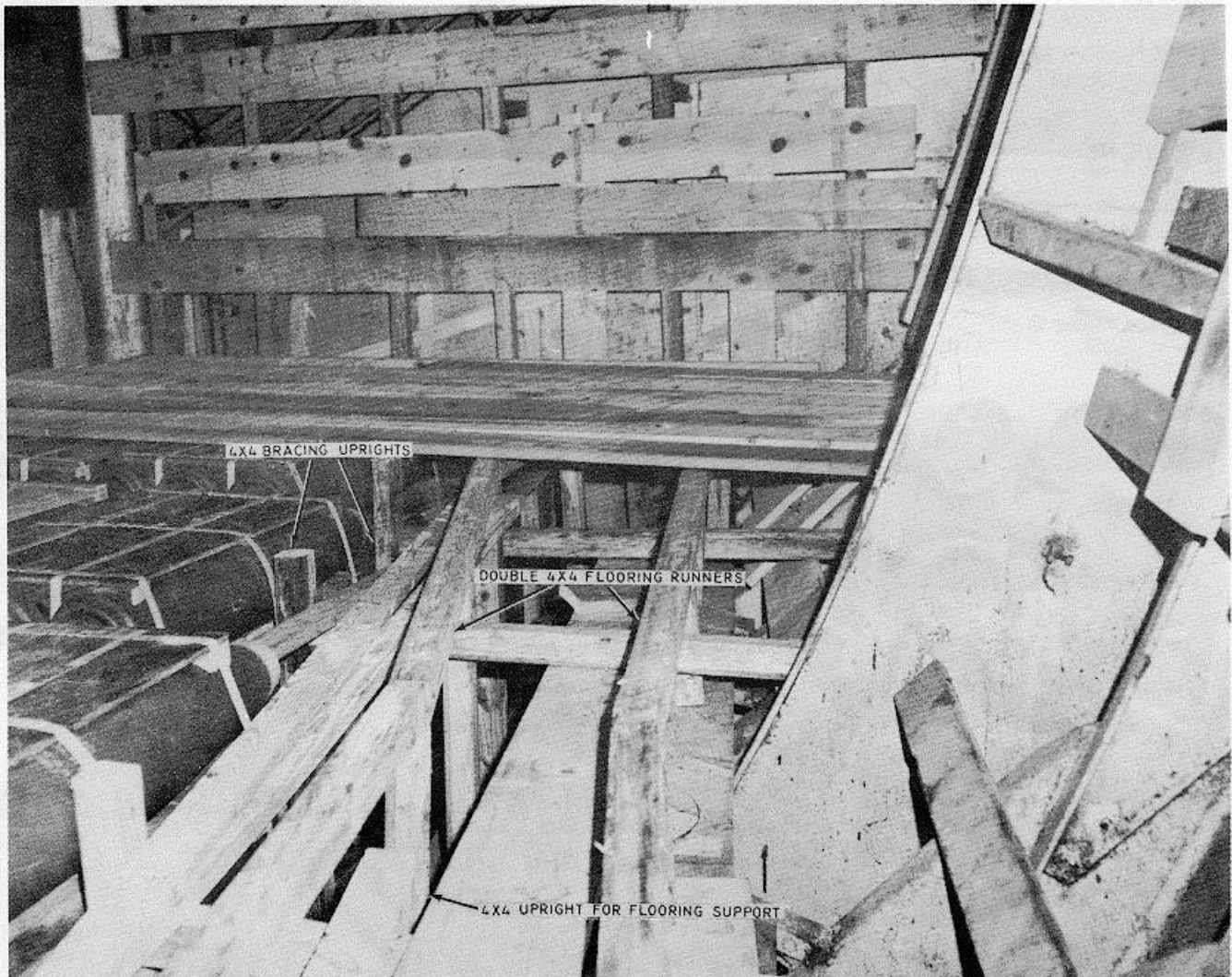


Figure 9-48. Construction of support structures for flooring over voids in the wings (hull blocking technique).



**Figure 9-49. Completion of flooring prior to stowage of additional tiers of bombs (hull blocking technique).**

(e) Block stowage of 500-pound bombs in holds bisected by the shaft alley is illustrated in figure 9-50. The unit loads are stacked two high, floored over,

and shored at the hull, whereupon the stowage pattern is repeated. Details of the securing structure erected at the shaft alley are illustrated in figure 7-8.



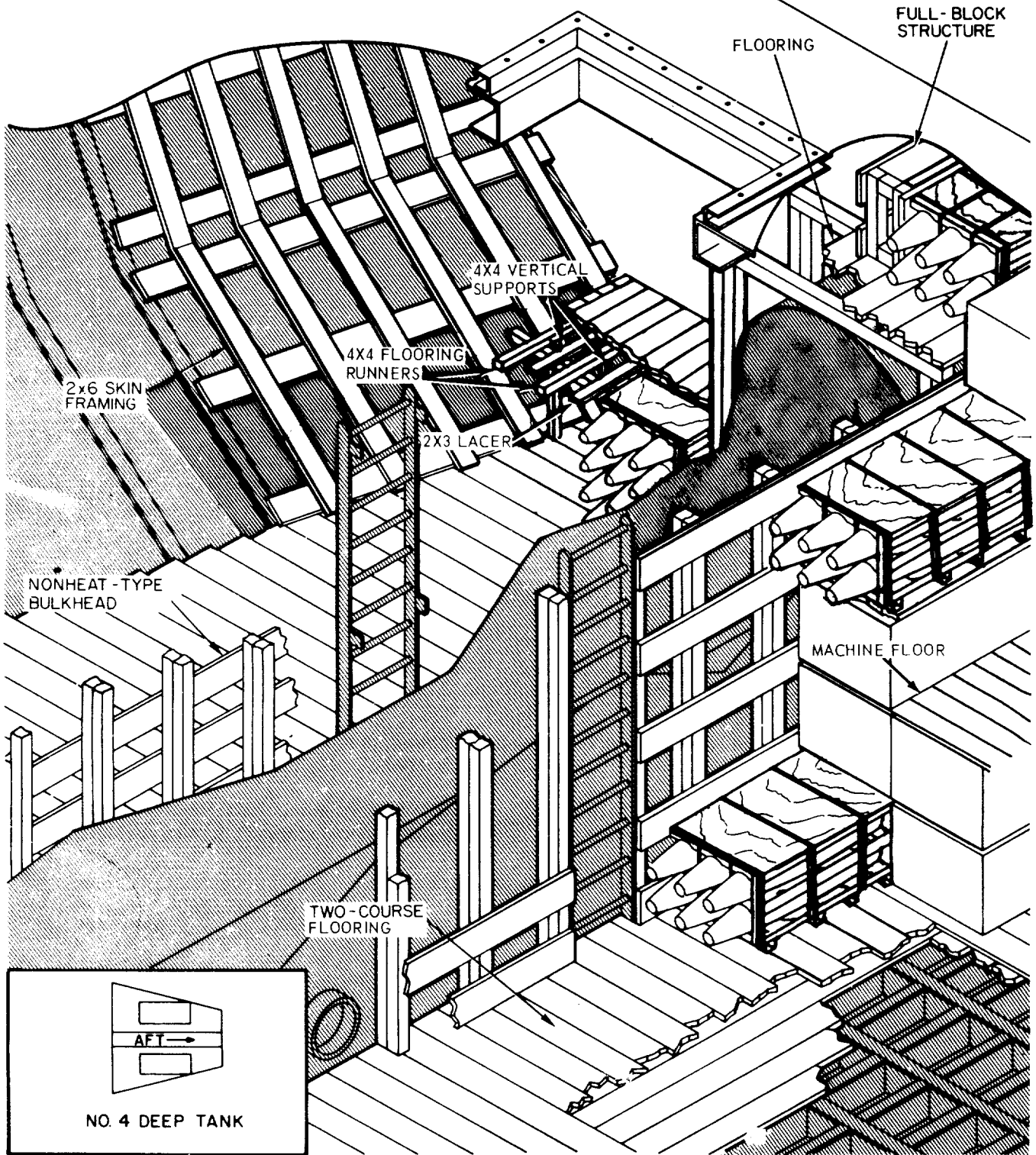


Figure 9-50. Stowing and securing of 500-pound bombs in lower holds bisected by shaft alley (sweatboard blocking technique)

(5) *Sweatboard-to-sweatboard stowage of palletized bombs.*

(a) Figure 9-51 illustrates the application of basic sweatboard-to-sweatboard stowage techniques in the dunnaging of Navy metal-pallet loads. The use of strip decking is illustrated to prevent metal-to-metal contact with the deck. Note that loads equipped with pointed nose plugs are separated with nose boards. Nose boards are not required, however,

for loads having flat nose plugs, except when nose-to-nose or nose-to-butt alignment on centers cannot be achieved. Full-block construction is used to fill all voids in the top tier, including those at the strip sheathing. Voids in the lower tiers that are less than one-third the length of the load stowed above are not blocked or shored vertically, and, for the same reason, full blocking and vertical shoring are not required at the sweatboards in this hold.

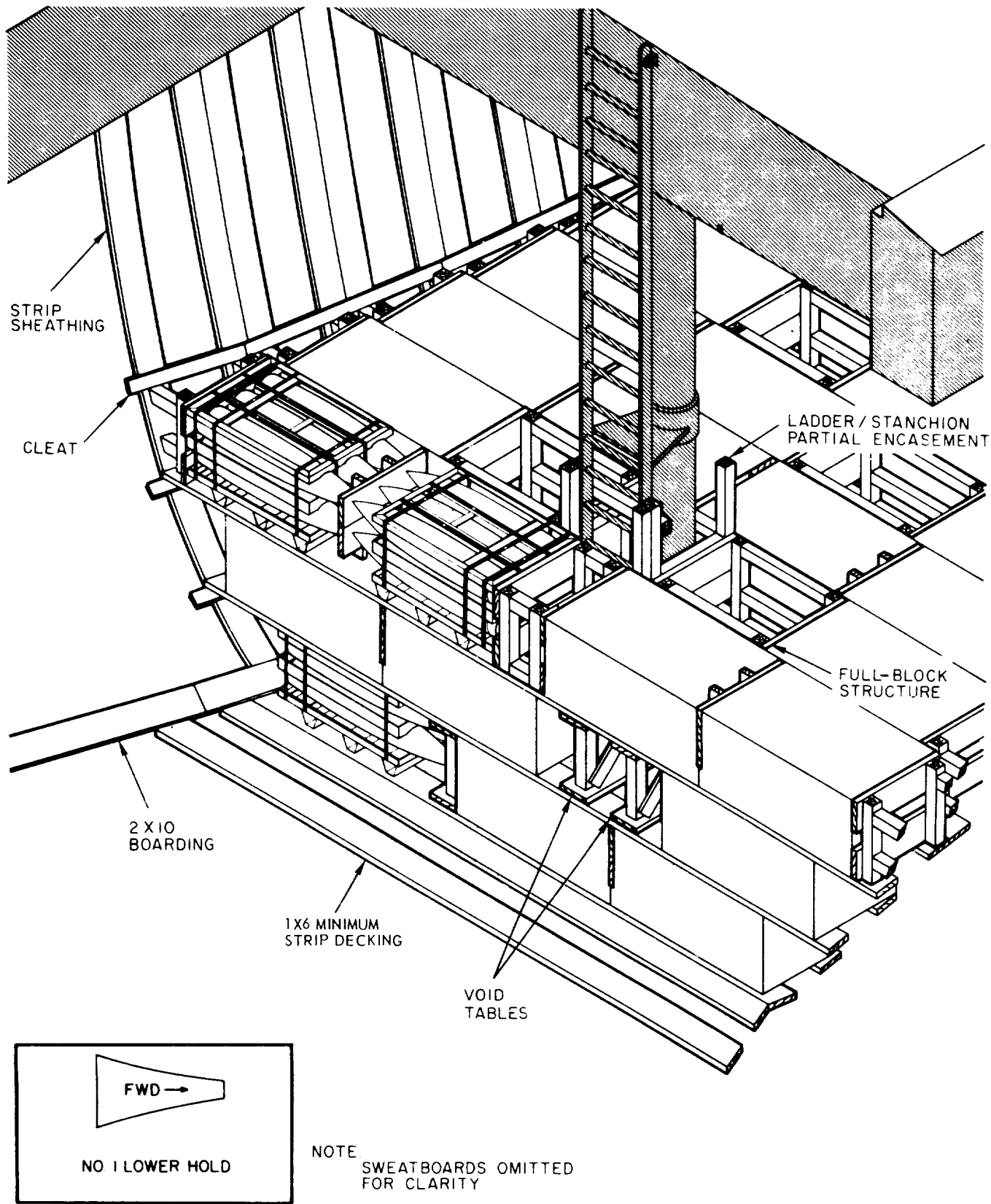


Figure 9-51. Sweatboard-to-sweatboard storage of 500-pound bombs, forward lower holds (sweatboard blocking technique).

(b) An efficient application of sweatboard-to-sweatboard stowage is illustrated in figure 9-52. In this compartment, the pronounced outward sheer and greater width of the stowage area will permit stowage of additional pallets per row. Athwartship orientation of the bomb unit loads is selected to more efficiently utilize the available compartment width. Generally, aft lower holds are more conducive to sweatboard-to-sweatboard stowage than are forward lower holds. In the compartment illustrated,

the loads are stowed on tier decking, which is installed to permit safe forklift operation on top of loads previously stowed. Notice that the load adjacent to the port side of the ladder/stanchion open encasement is stowed with the bases of the bombs inboard. If the load were stowed with the noses inboard, as in the case with the load on the starboard side of the encasement, a bearing surface for the noses would have to be provided in the form of 2- by 10-inch boarding fastened to the encasement.

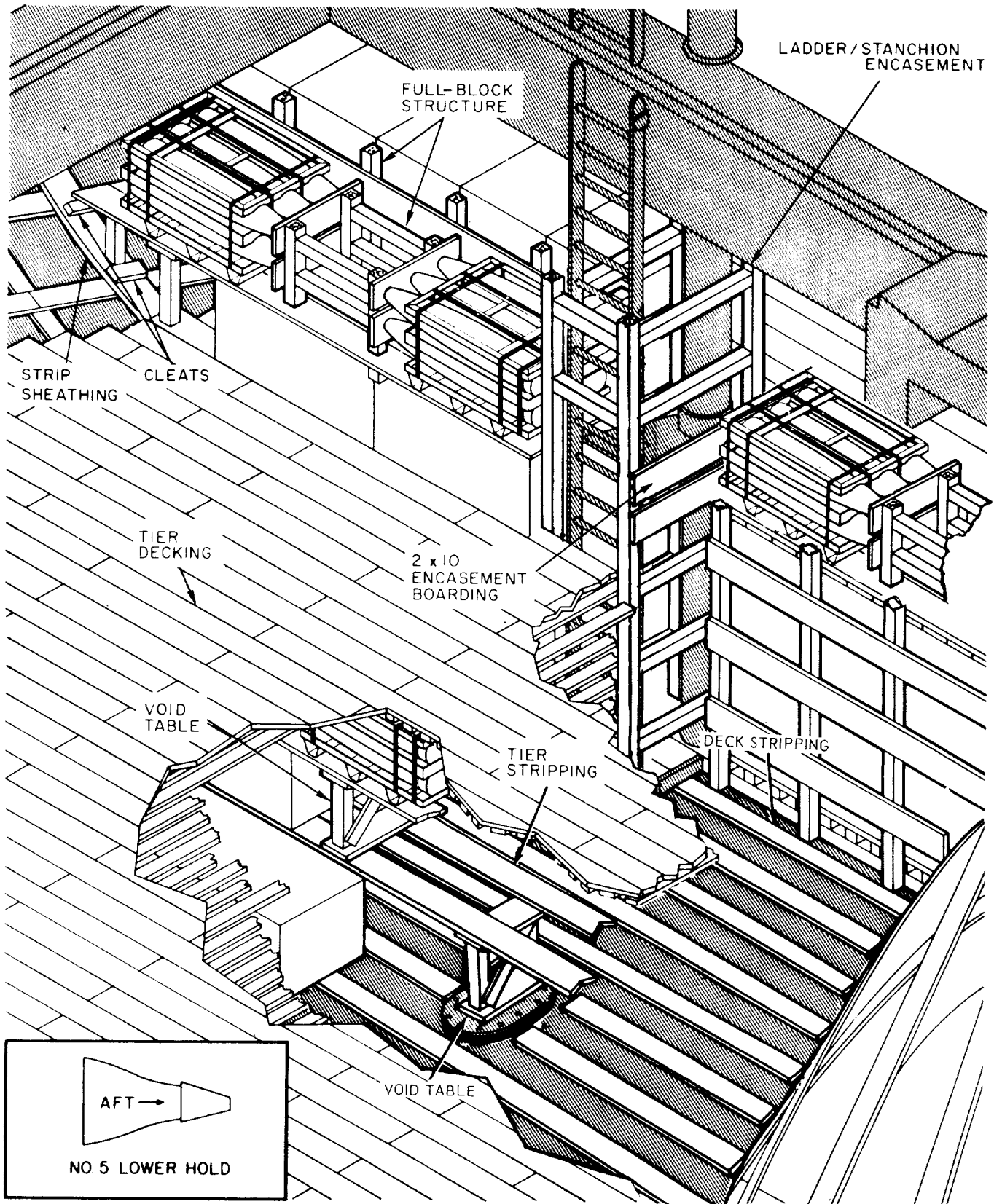
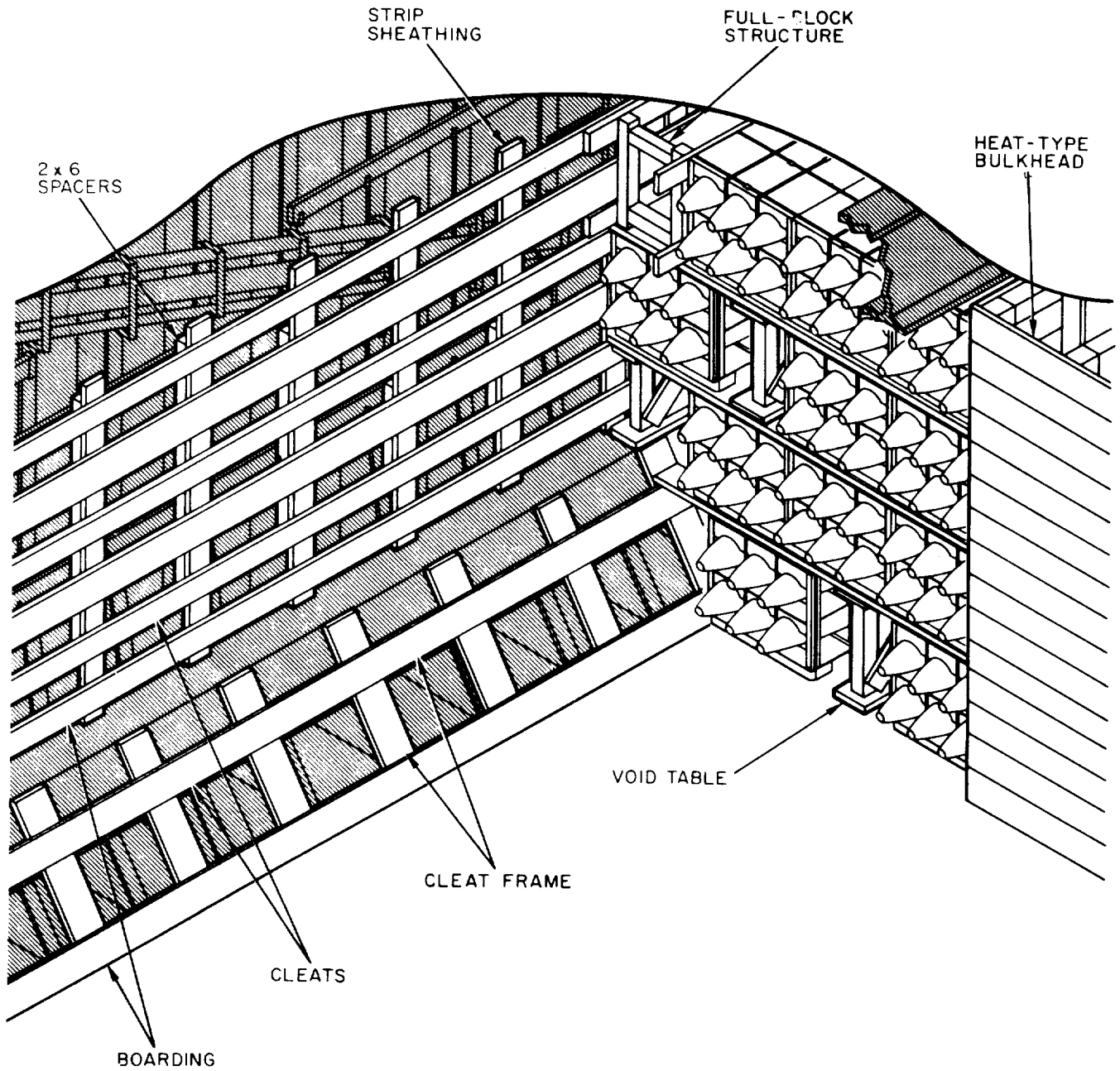


Figure 9-52. Sweatboard-to-sweatboard stowage of 500-pound bombs, aft lower holds (sweatboard blocking technique).



(c) Figure 9-53 shows 500-pound-bomb loads, in this case four-way unit loads, stowed in the aft end of hold number 3 tween decks. The loads are positioned fore and aft here to make full use of the inset area at the heat bulkhead. The loads are blocked fully in the top tier, and void tables are used as required. A cleat frame is installed along the chine as shown. (Two-way loads are stowed longitudinally athwartships in this particular area.) Notice that at the strip sheathing in the top tier, the full-block structure extends even with the overhanging of the unit loads. This arrangement provides bearing surfaces for the adjacent load stowed subsequently, as shown in figure 9-54. When the inset stowage has been completed, a dunnage structure is placed across the front of these loads and then loads are stowed athwartships in the conventional manner. This structure, seen in figure 9-54, serves to protect the bombs, strapping, and pallets of the athwartship loads from damage (luring stowing operations and provides a straight, solid surface against which the loads should be made to bear. Two acceptable stowage orientations for the 500-poundbomb unit load are illustrated. Nose-to-nose stowage requires contact between the flat nose plates of adjoining loads. Nose boards illustrated are required only if nose-to-base contact on centers cannot be achieved. Stowage with bomb noses intermeshed is not permissible. Short random lengths of 4 by 4-inch dunnage are placed wherever nose-to-nose abutment occurs, to provide support for tier stripping.



NOTE:  
**ONLY FOUR-WAY PALLET CAN  
BE STOWED IN THIS WAY.**

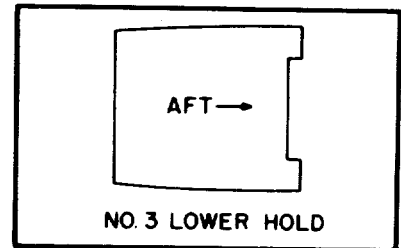


Figure 9-53. Stowing and securing of 500-pound bombs, lower hold No. 3, at heat bulkhead (swealboard blocking technique).

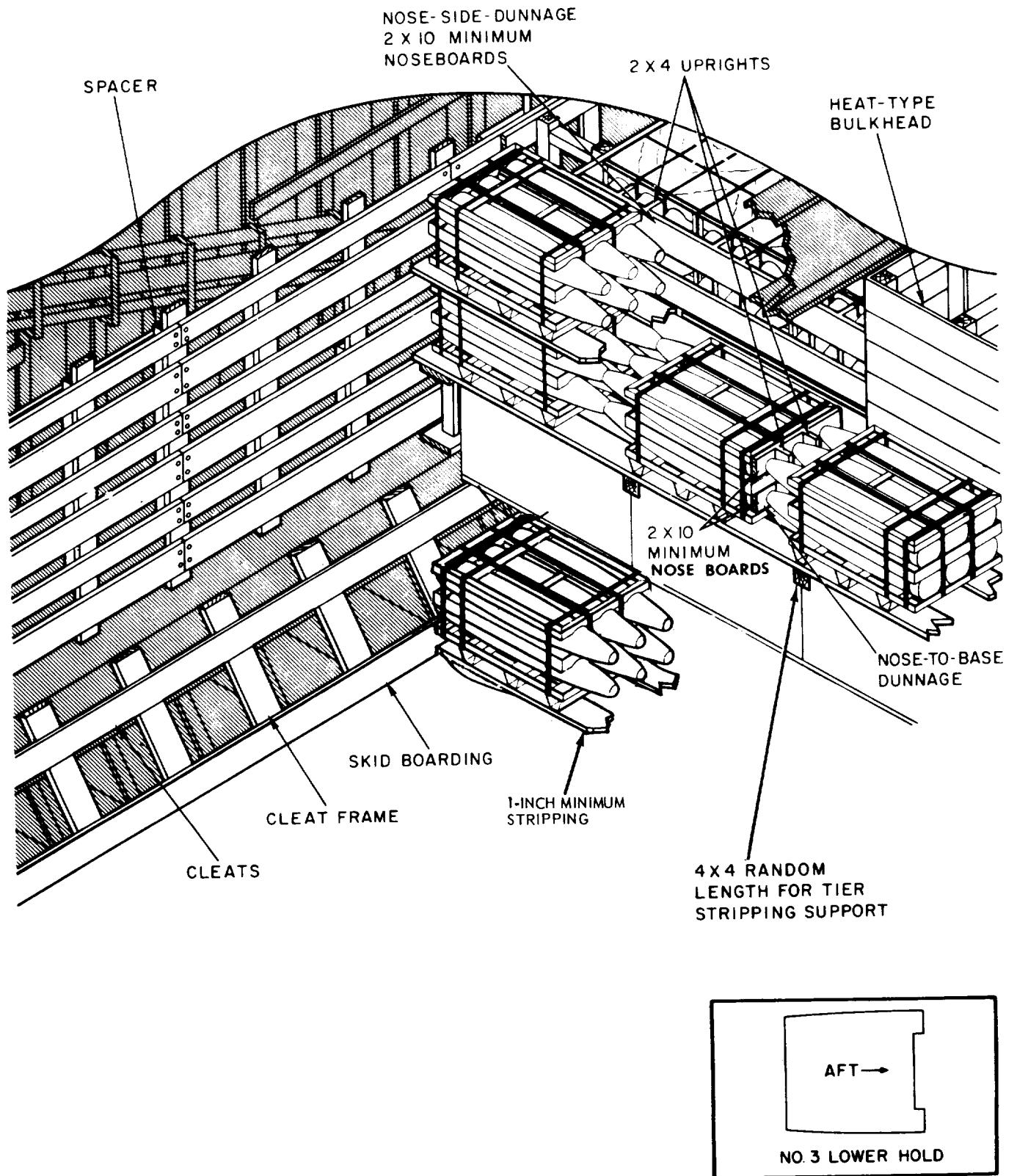


Figure 9-54. Stowing and securing of 500-pound bombs, lower hold No. 3, forward of heat bulkhead (sweatboard blocking technique).

(6) *Height differential dunnaging.* An area where unit loads of 500-pound bombs are often stowed is in the square of the hatch. Figure 9-55 shows the stowing and dunnaging of the unit loads tween decks in the square of the hatch. In this case the hatch edges are beveled, and 2by 4-inch strips are placed around the perimeter of the hatch on top of the bevel (fig 7-6). The decking laid across the strips and the hatch boards provides a level stow area in the square of the hatch, but it is evident that the decking in the square of the hatch is somewhat higher than that in the remainder of the hold. Therefore, a height differential exists between loads stowed in the square of the hatch and those stowed in the surrounding area. Two-way bomb loads, which are shown in the illustration, and several other types of loads have exposed unsupported strapping on the sides; therefore, if adjacent loads or tiers are uneven in height, the top edges of the lower loads will damage the strapping of the upper load during stowing or shipment unless preventive measures are taken. The dunnage required to protect strapping on the sides of adjacent two-way bomb loads that are uneven in height is constructed of 2by 10-inch minimum lumber spaced on 24-inch centers and nailed to the tier stripping.

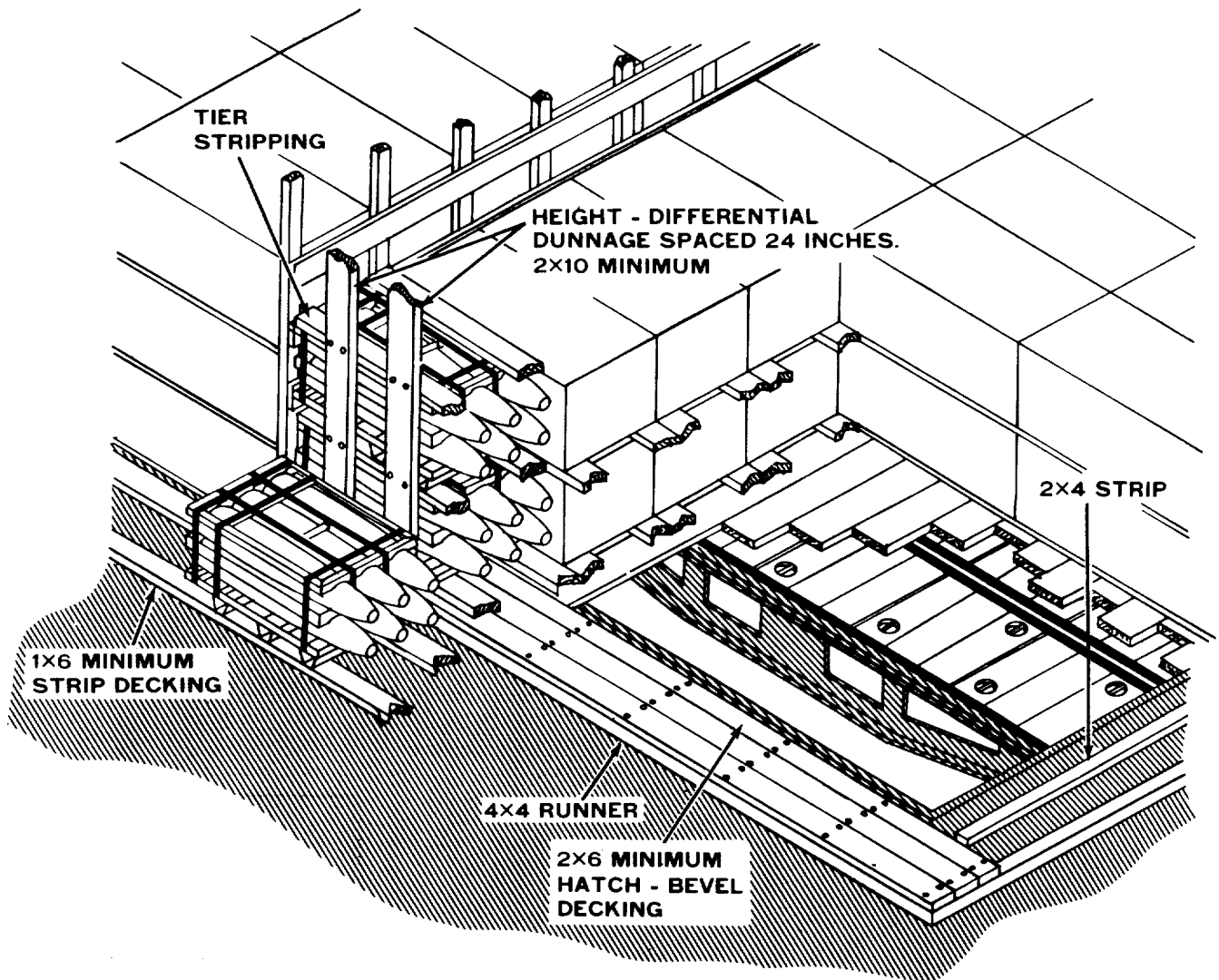


Figure 9-55. Height differential dunnaging for 500-pound-bomb unit loads in square of the hatch.

b. 750-Pound General-Purpose Bomb, Palletized Unit Load, Mn17A2. The M117A2 750-pound bomb is loaded aboard merchant-type ships as a palletized unit load. Two bombs are secured on each pallet by metal straps. Each palletized unit weighs approximately 1,541 pounds and measures 22.2 cubic feet in volume. These units may be stowed in any compartment, including tween decks and lower holds.

(1) General stowage requirements. Since the pallet skids are constructed of wood, decking is not required unless obstructions in the ship's deck make it necessary to provide a level surface for stowage. Unit loads of 750-pound bombs are positioned parallel with the ship's center line, regardless of the stowage technique employed. Whenever practical, the loads are stowed nose-to-base. Nose boards are not necessary, provided the nose of one load is aligned with some portion of the base of another, since the center portion of each base is protected by a metal cover. However, when rows are offset, particularly as a result of camber and sheet angles, nose boards must be used.

(2) Tween-deck stowage. General principles of tween-deck stowage of 750-pound-bomb unit loads are illustrated by figure 9-56. The same techniques are applicable in any hold or compartment where hold curvature is not significant. Stowage proceeds from both ends of the compartment and progresses toward the center. By orientation of the unit loads in the preferred nose-to-butt position, final voids will occur between butts of the final two rows and will occur in the central area of the compartment. Nose boards are not required between unit loads if proper end alignment is maintained, as shown. However, nose boards must be utilized in cases where a bomb would otherwise face a void, or when bombs are stowed nose-to-side.

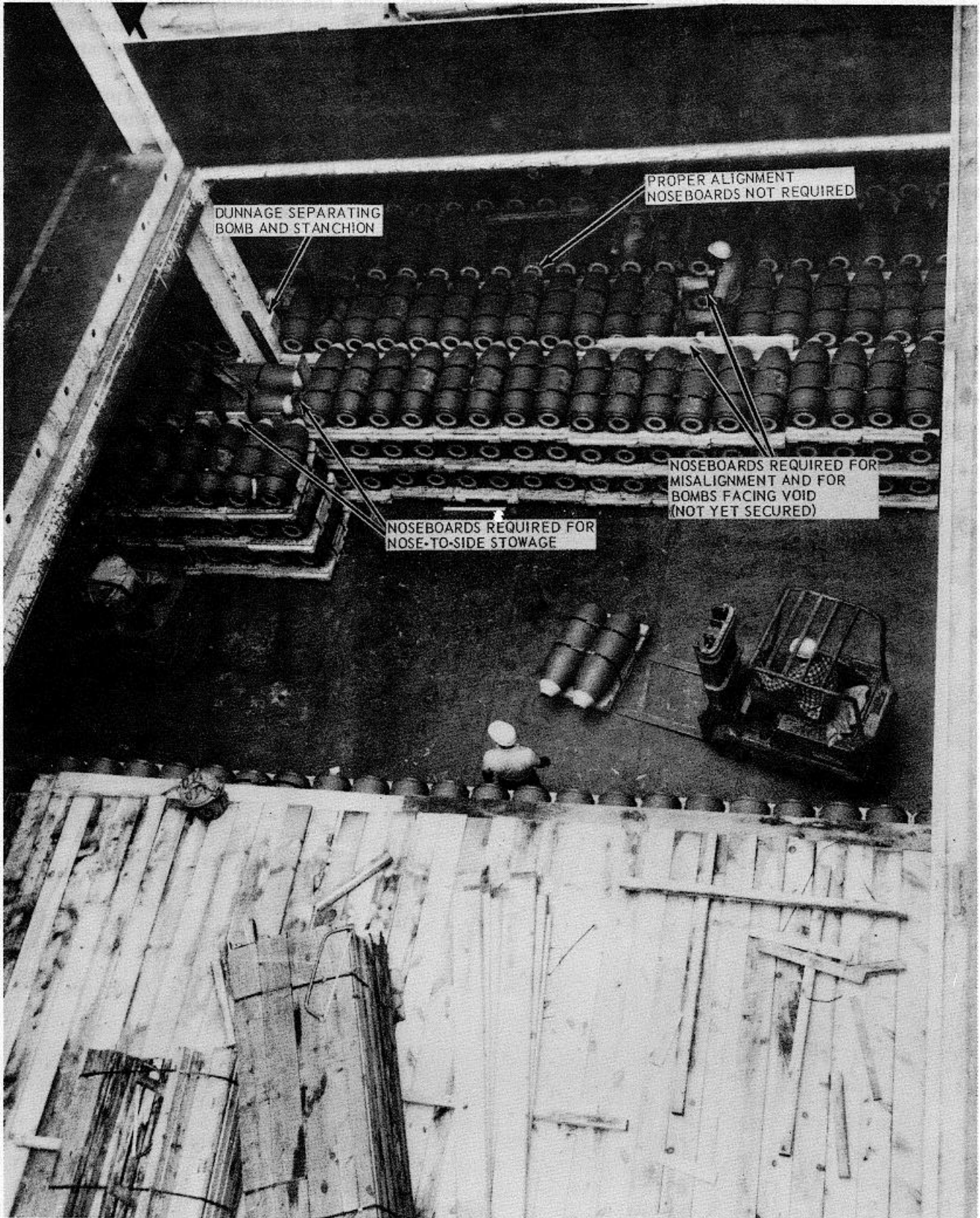


Figure 9-56. Tween-deck stowage of 750-pound-bomb unit loads.

(3) *Block stowage.*

(a) Securing 750-pound bombs in deep tanks, in lower holds, or in any compartment with appreciable hull curvature can be accomplished through construction of block-stow securing structures, as illustrated in figure 9-57. The palletized bombs are first stowed parallel to the ship's center line in tight, vertical alignment. Two 4by 4-inch TM 55-607/NAVSEA OP 3221 Rev 2 uprights bear against each row and are braced to the hull by means of 4by 4-inch kickers bevel-cut to fit the curvature. Each tier of bombs must be braced to the hull with two kickers, as shown. The securing structure is laced with 2by 3-inch minimum lumber; vertical lacers must be extended to the overhead to prevent any vertical movement of the dunnage.

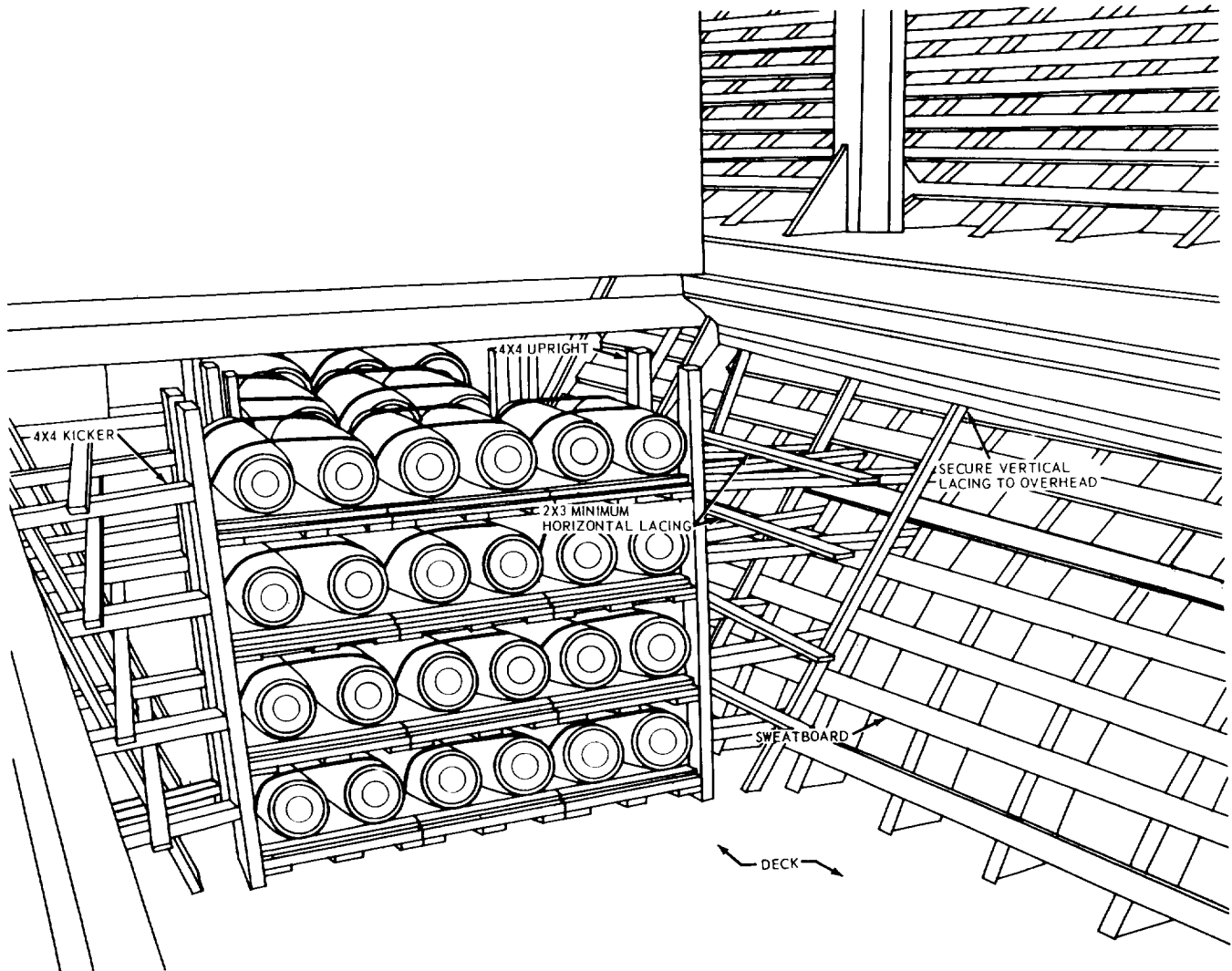


Figure 9-57. Block stowage of 750-pound bombs (hull blocking technique).

(b) Completion of block stowage in a similar lower hold is illustrated in figure 9-58. The void between butt ends of bombs is secured with 4by 4inch horizontal pieces positioned along each tier in contact with the base end of each bomb. These members are braced to those of the opposite row by means of 4by 4-inch kickers, installed at the center of each unit load. The structure is laced with 2by 3-inch material secured to the kickers. Voids occurring within a row of bombs are secured in a similar manner. A 4by 4-inch upright is positioned at each corner of the void, contacting the unit load near but not over the strapping. The full-block structure is formed by bracing the uprights to each other and to those of the adjacent unit load with 4by 4-inch kickers. Lacing is secured between kickers for stability, and several voids occurring in proximity can be shored and the full-block structures laced together for added strength, as shown.



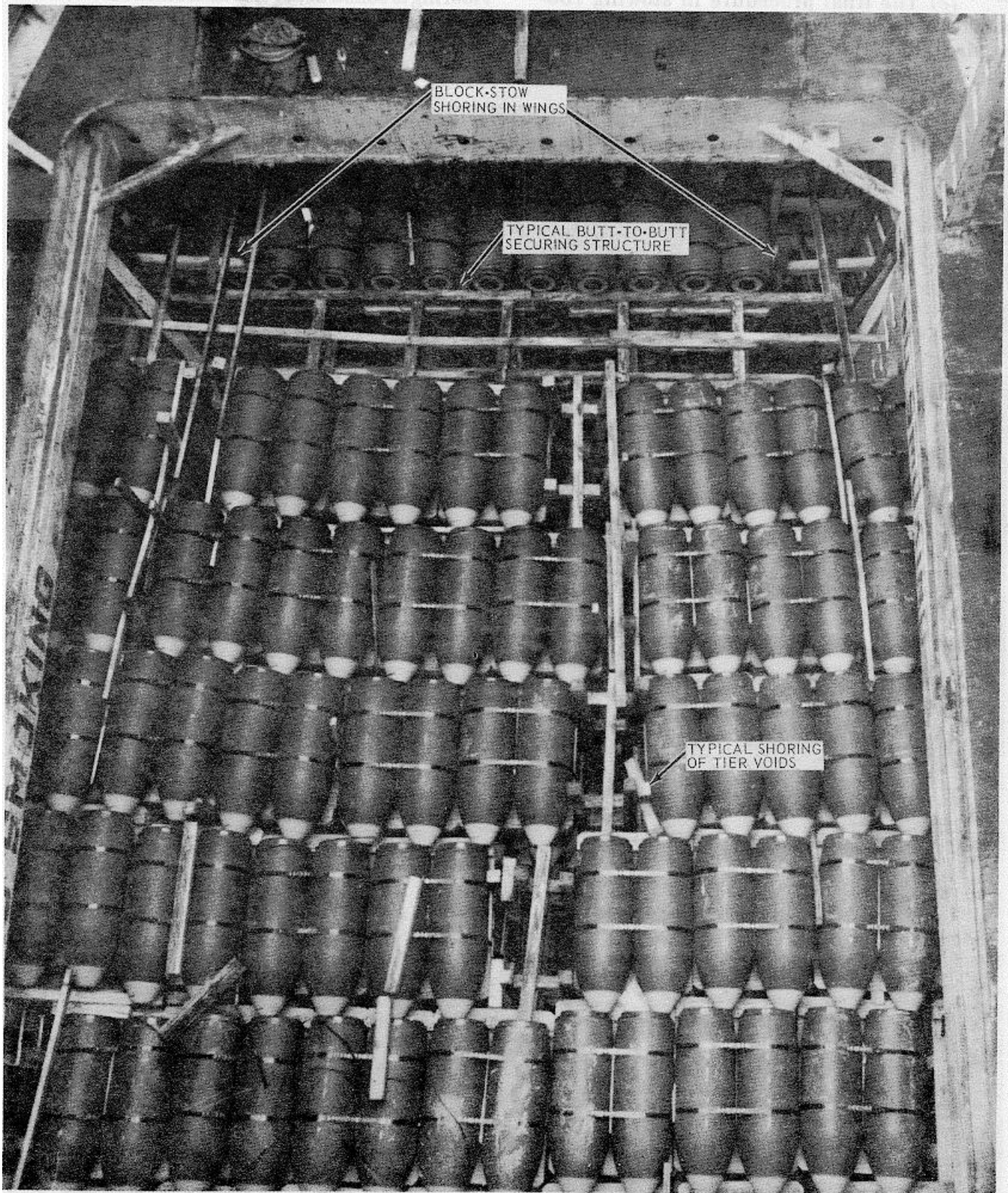


Figure 9-58. Butt-to-butt shoring and shoring of tier voids in block storage of 750-pound bombs (sweatboard blocking technique).

(c) The final procedure in stowing 750 pound bombs is the construction of a wood floor, as required, to permit overstow of additional cargo. Flooring is constructed of 2-inch stock and is laid in two crosswise courses, as shown in figure 9-59.

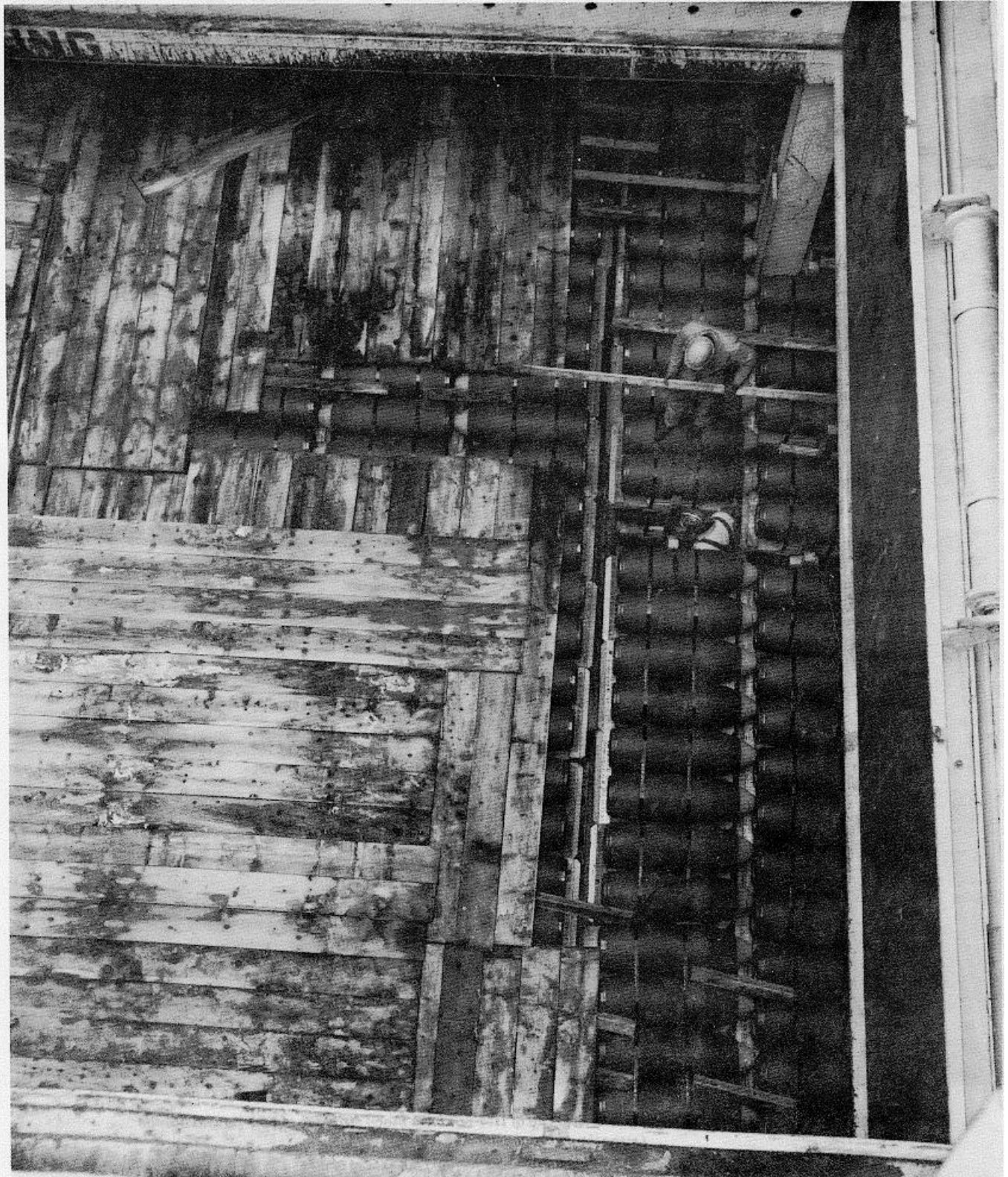


Figure 9-59. Flooring over 750-pound-bomb unit loads.

(4) *Sweatboard-to-sweatboard stowage.*

(a) Basic principles of sweatboard-to-sweatboard stowage of 750-pound bombs are illustrated in figure 9-60. Notice the large void forward of the stanchion. Frequently, large voids occur that are only slightly smaller than the unit load. As a result, a full-block structure like the one shown is required. Notice also that, at the ladder, a spacing structure of the same dimensions as the end support of the encasement is used to increase the bearing surface for the adjacent loads. Effectively, this structure is an extension of the encasement and aids in athwartship blocking of the entire row.

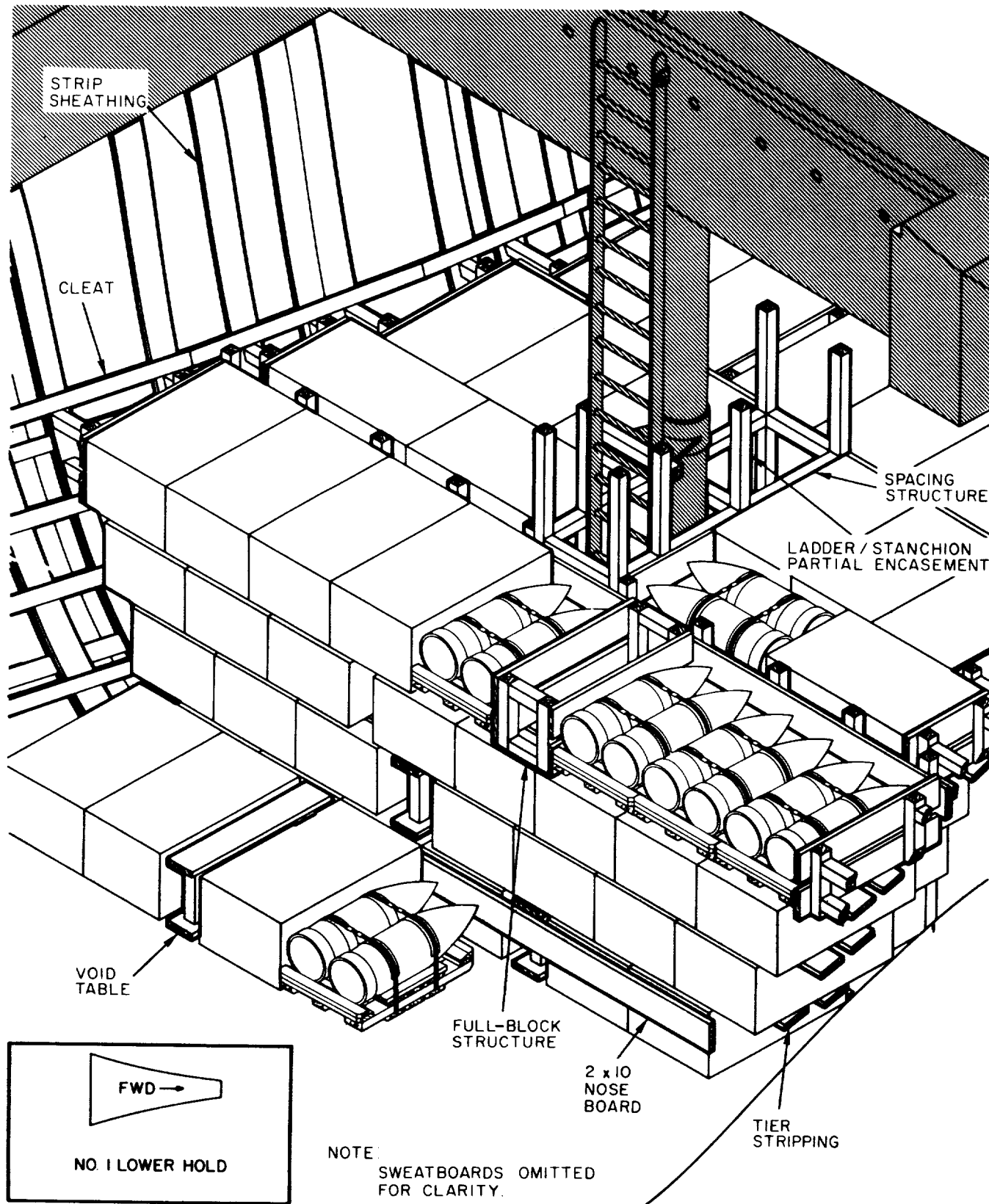


Figure 9-60. Basic sweatboard-to-sweatboard storage of 750-pound bombs, forward lower holds (sweatboard blocking technique).

(b) Aft lower holds are generally more conducive to the sweatboard-to-sweatboard stowage technique. Typical stowage of 750-pound-bomb loads in lower hold number 5 is illustrated in figure 9-61, which shows how loads can be stowed in an area having severe camber and sheer angles. Loads at the sweatboards, when properly positioned, do not require full-block structures, except the loads in the top tiers. Also, throughout the stowage in the lower tiers, voids that do not exceed one-third the width of the load above require neither tables nor blocking. All voids in top tiers throughout the stowage require full-block structures. The use of decking is illustrated due to the obstructions on the ship's deck; decking would not be required in most cases.



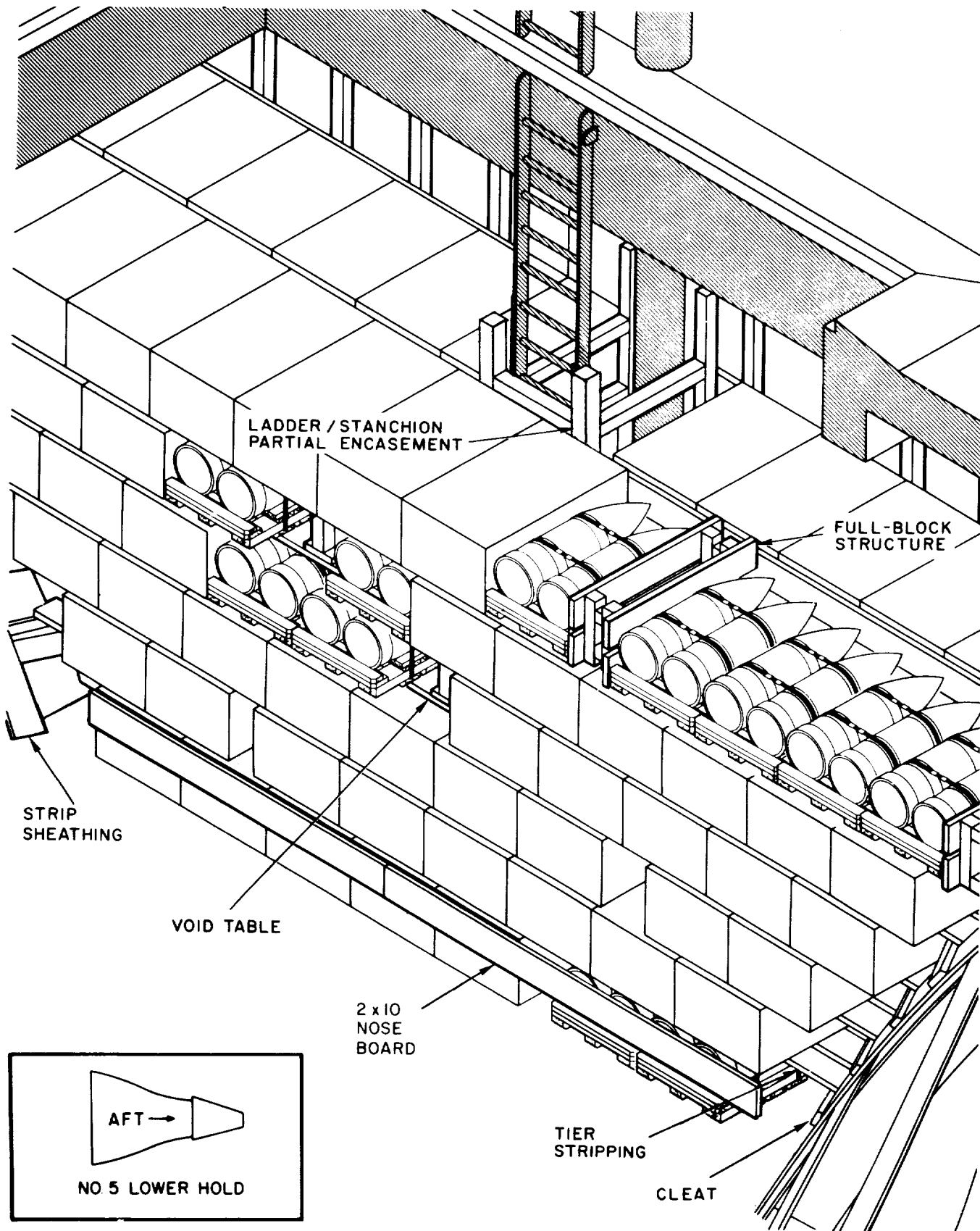


Figure 9-61. Sweatboard-to-sweatboard stowage of 750-pound bombs, aft lower holds (sweatboard blocking technique).

(c) When stowed according to sweatboard-to-sweatboard techniques in holds such as number 3 lower hold, the two bottom tiers of each row are offset, whereas the remaining tiers may be aligned nose-to-base (center). Consequently, some of the stowed loads require nose boards. Figure 9-62 illustrates the situation as caused by the ship's angular structure along the lower side of the hold. Dunnage of appropriate width is placed on the ledge of the ship's structure to a level even with the load to provide support for tier stripping, a basic characteristic of the sweatboard-to-sweatboard technique. From this point, the loads can be aligned nose-to-base. Again, decking is not required because the pallets have wooden skids.

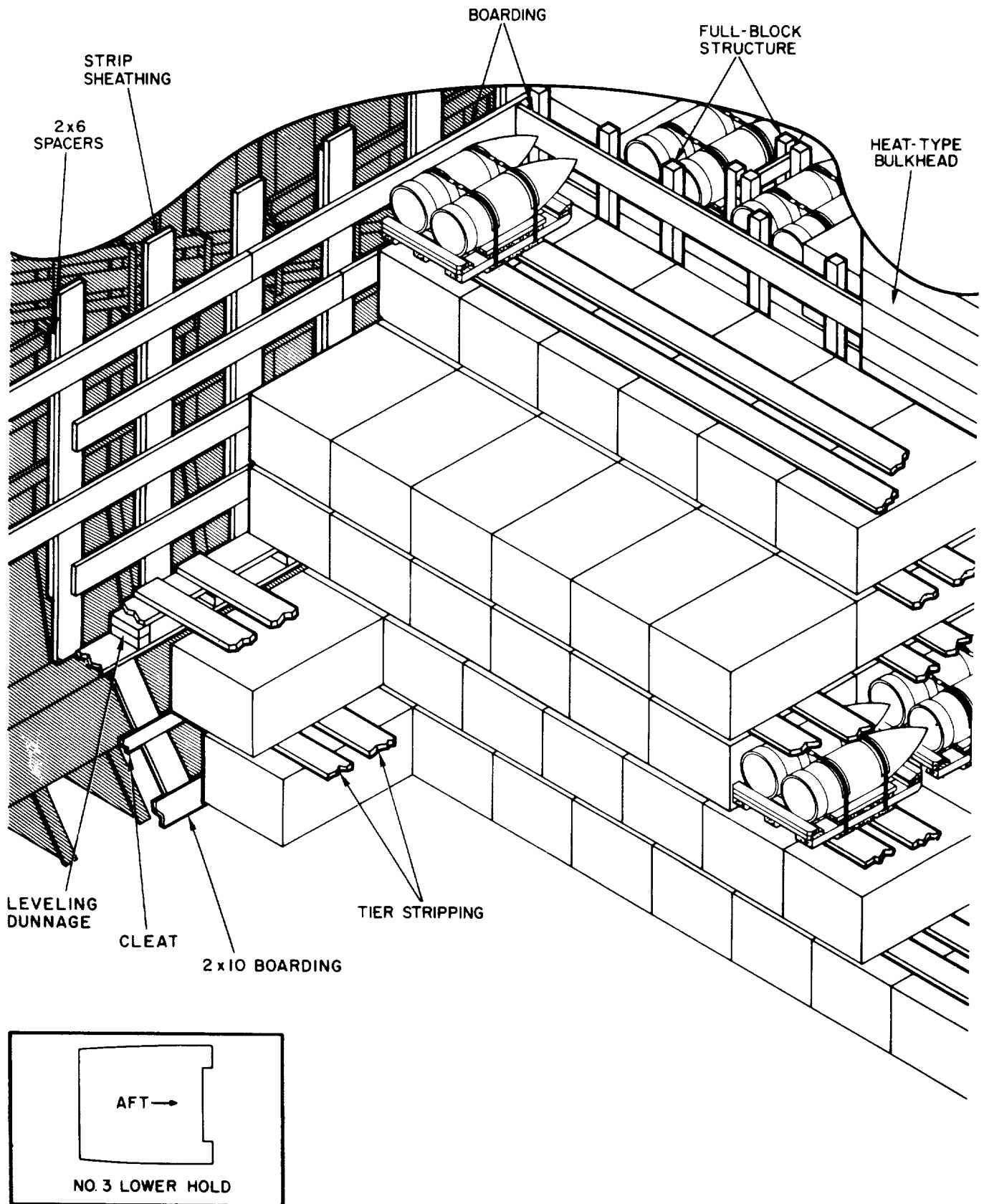


Figure 9-62. Stowing and dunnaging of 750-pound bomb, lower hold No.3 (sweatboard blocking technique).



(d) Sweatboard-to-sweatboard stowage of palletized unit loads of 750-pound bombs in the number 4 deep tank is shown in figure 9-63. Peculiar to this area is the skin framing that is required to support tier stripping and full-block structures at the sides of the tank. As in the other stowage areas described previously, the loads are positioned nose-to-base, and nose boards are used as required. Stowage along the shaft alley requires construction of a nonheat bulkhead to protect the cargo. This technique is applicable to both sweatboard-to-sweatboard stowage and block stowage.

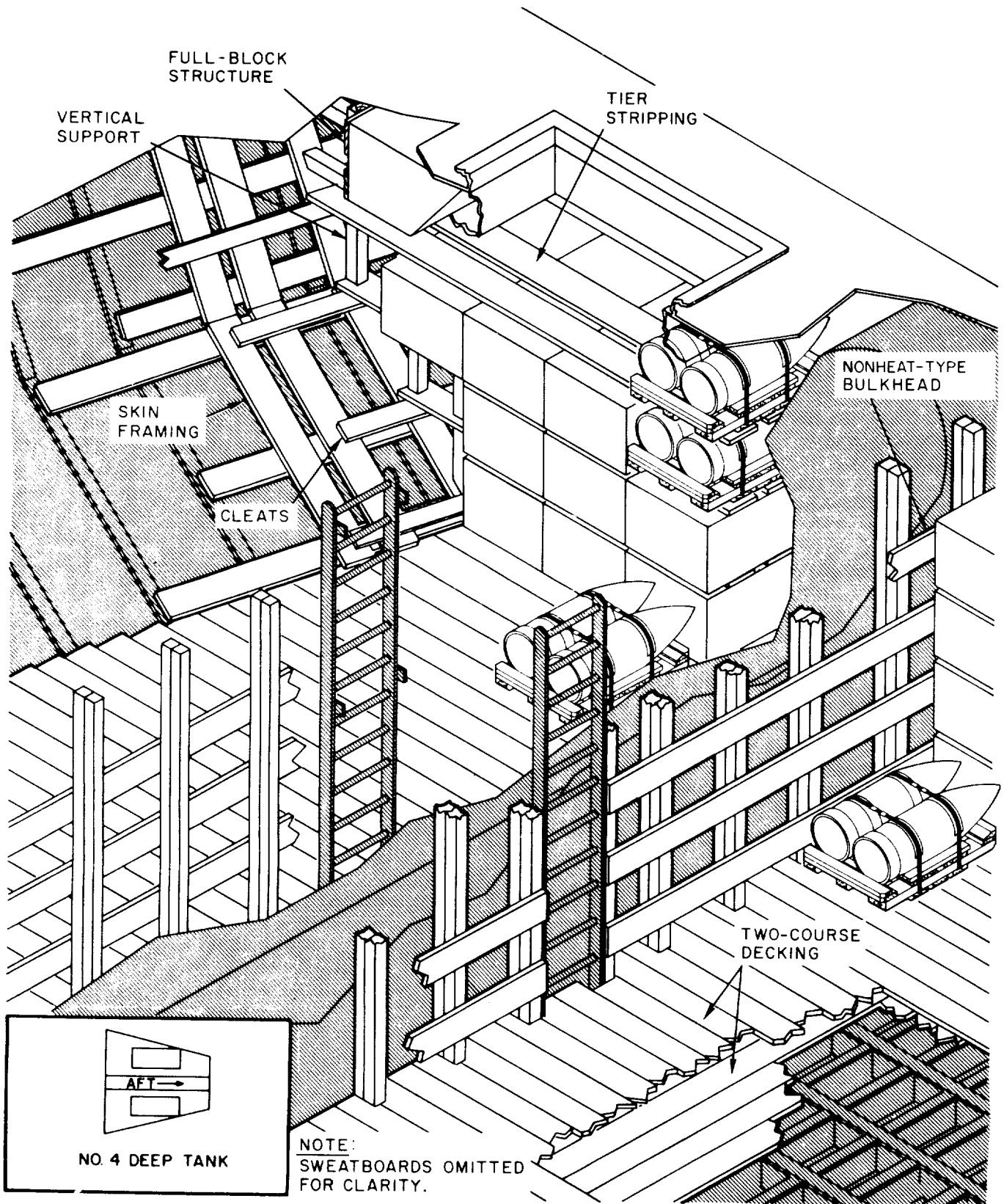


Figure 9-63. Slowing at Id dunnaging of 750-pound bomb, deep tank No. 4 (sweatboard blocking technique).

c. *2,000-Pound Bomb, Palletized Unit Load.* Unlike other bomb-unit loads, the 2,000-pound bomb unit load has four stacking pins that fit into corresponding holes in the fore-and-aft skids of the pallet. Thus, 2,000-pound-bomb loads interlocked on the stacking pins can be stowed in even tiers. This stowage pattern is most compatible in holds having sheer angles more nearly vertical and camber angles more nearly parallel with the ship's center line, such as in amidship tween-deck compartments.

(1) *General stowage requirements.* Since the 2,000-pound-bomb loads have metal pallets, 1-inch minimum strip decking is required to prevent metal-to-metal contact with the ship's deck. The 2,000-pound-bomb unit load can be stowed either fore and aft or athwartships using block stowage or sweatboard-to-sweatboard techniques; however, only the aft portion of the two-way load offers adequate bearing surface for bracing by dunnage structures or support of adjacent loads.

(2) *Tween-deck stowage.* Figure 9-64 illustrates stowage of 2,000-pound(-bomb unit loads on tween deck number 3. Loads are aligned vertically with stacking pins interlocked. Those unit loads next to the heat bulkhead in the inset portion of the hold are stowed fore and aft; all other loads are stowed athwartships. A full-block structure provides an uninterrupted bearing surface extending from the sweatboards to the loads stowed athwartships along the face of the heat bulkhead as shown. Notice that the adjoining loads at the corner of the heat bulkhead are stowed so that the aft ends of the athwartship loads abut the aft sides of the fore-and-aft loads. As described previously, this technique provides greater bearing surface between adjacent loads.

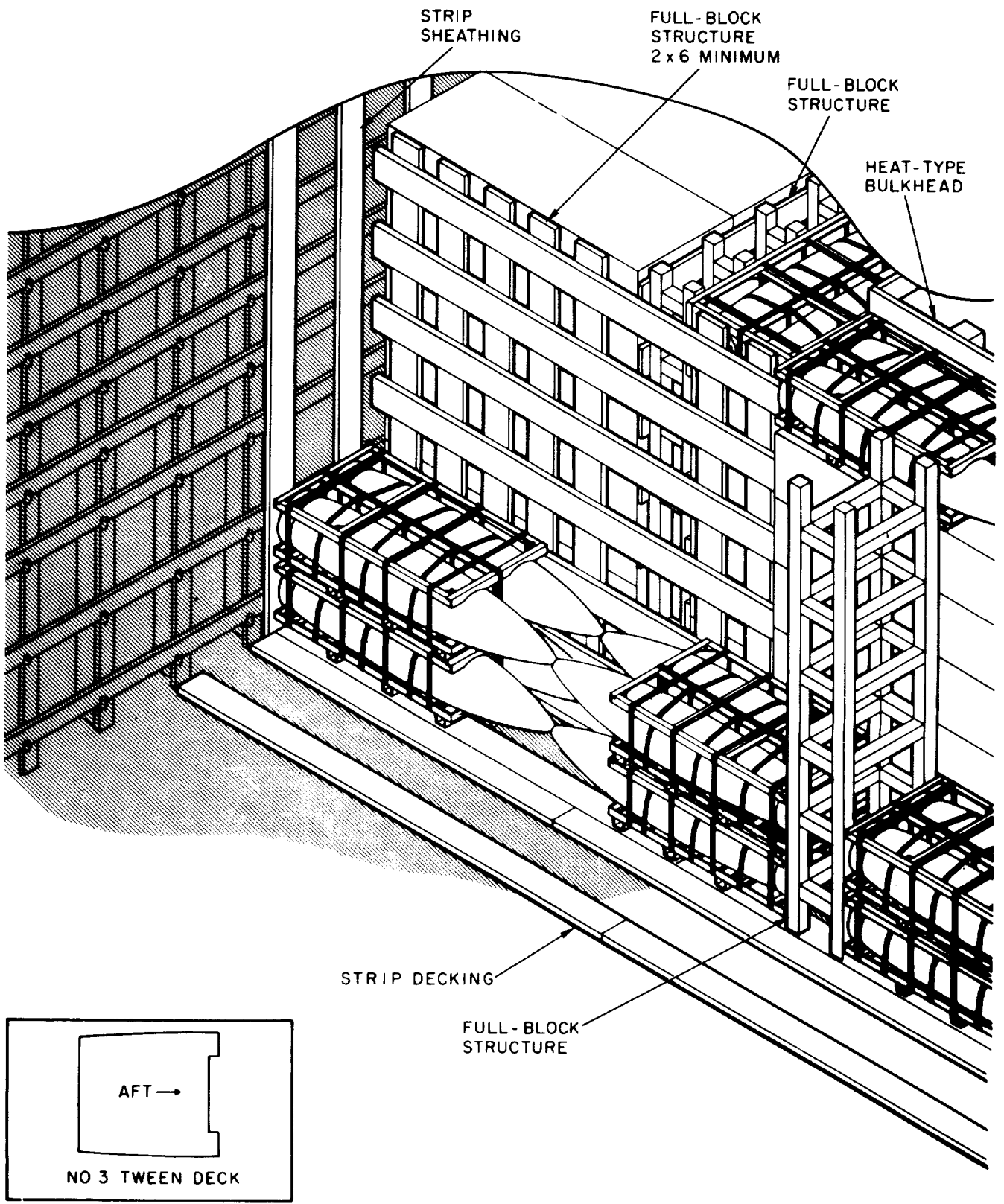


Figure 9-64. Typical stowage of 2,000-pound bomb, tween-deck compartments (sweatboard blocking technique).

(3) *Stowage in lower holds.* Stowage of the 2,000-pound-bomb unit load in lower holds is illustrated in figure 9-65. In this case, sweatboard-to-sweatboard techniques have been employed, and the stacking pins are not used to enable loads to be offset due to hull contour. For block stowage, bombs would be oriented fore and aft and dunnaged in accordance with paragraph 8-2. Since the height of the stacking pins on these loads is slightly more than 1 inch, 2-by 10-inch tier stripping is required to raise the over-stowed loads above the pins and, therefore, permit lateral displacement. As shown, nose-to-side dunnage protects the strapping of the first row of loads stowed longitudinally athwartships from those stowed fore and aft, and a full-block structure effectively fills the void in the top tier of the fore-and-aft loads. Safe forklift truck operation is assured by the installation of tier decking where required. To provide solid support for the decking over the void created by the sloping bomb noses, a technique is employed similar to that described previously for overhanging unit loads (fig 7-9). Figure 9-70 illustrated use of double 4-by 4-inch stock to provide a foundation of sufficient height to compensate for the curvature of the bomb noses. Other dunnage is positioned along the bomb, as shown, for additional support.

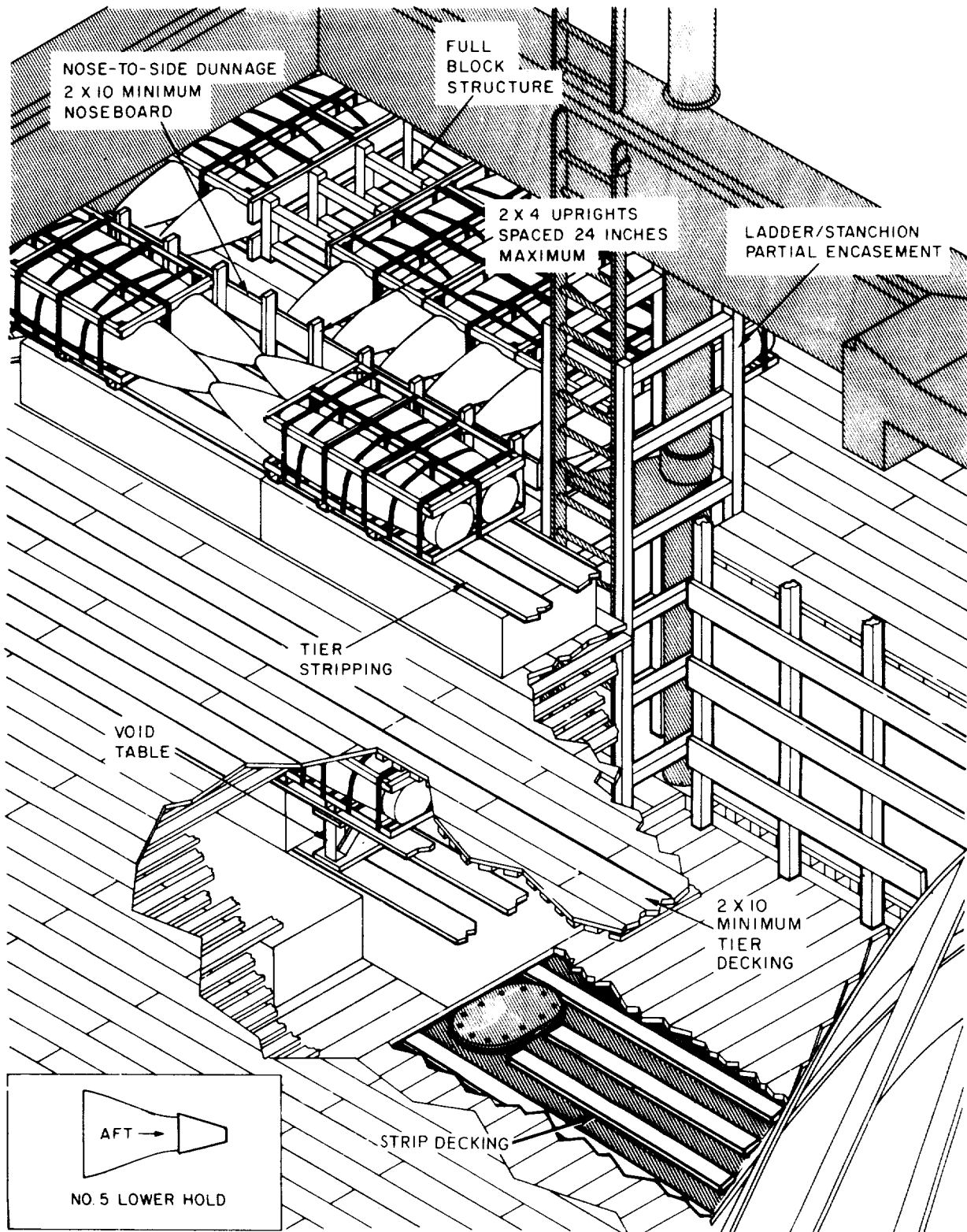


Figure 9-65. Sweatboard-to-sweatboard storage of 2,000-pound bombs, lower hold No. 5 (sweatboard blocking technique).

d. *16-Inch Gun Ammunition Unlit Loads.* With the return of battleships to the active US Navy fleet, the movement of 16-inch gun ammunition unit loads by merchant ships can be expected. There are four types of unit loads for 16-inch gun ammunition: MILSTD-1323/151, figure 9-66, which consists of six reduced-charge powder tank cans stacked vertically on an MK 12 MOD 0 pallet; MIL-STD-1323/150, figure 9-67, which consists of six full-charge powder tank cans stacked vertically on an MK 3 MOD 0 pallet; MIL-STD-1323/145, figure 9-68, which is a single armor-piercing (AP) projectile in MK 85 MOD 0 handling bands; and MIL-STI-1323/149, figure 9-69, which consists of two high-capacity (IIC) projectiles, with adapters, strapped to an MK 3 MOD 0 pallet. Both powder tank unit loads are centered on four-way entry pallets, and stowage and dunnaging procedures are similar to those for other rectangular unit loads, as detailed in section 9-2. The AP projectile, on the other hand, is a low-demand item and, normally, will not be carried aboard merchant ships. Stowage and dunnaging of unit loads of IIC projectiles, although similar to rectangular unit loads, are unique and merit separate coverage. Each unit load of 16-inch HC projectiles consists of two projectiles in a frame assembly strapped securely to a pallet. Since the pallet is located near the base end of the projectile, handling of this load is possible from only three directions: both sides and the base end. Each unit load weighs about 4,155 pounds; thus, 6,000-pound-capacity forklift trucks should be used for handling and stowage operations.

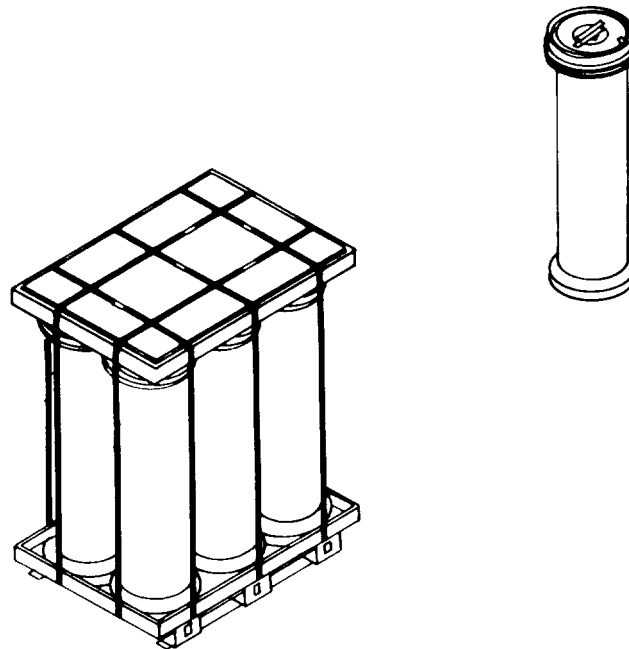


Figure 9-66. Six reduced-charge powder tank cans (MK 12 MOD 0 pallet).

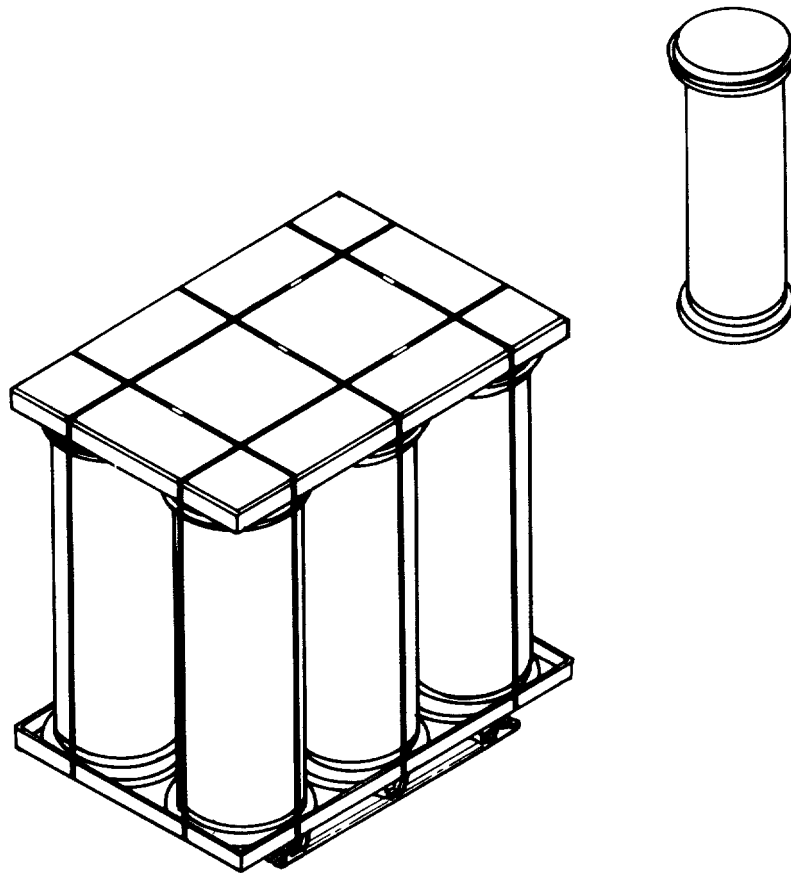


Figure 9-67. Six full-charge powder tank cans (MK 3 MOD 0 pallet).

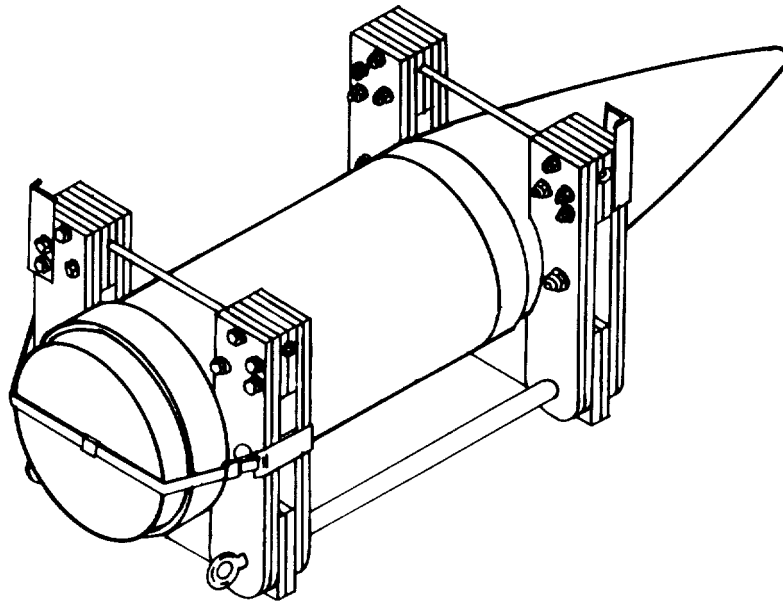
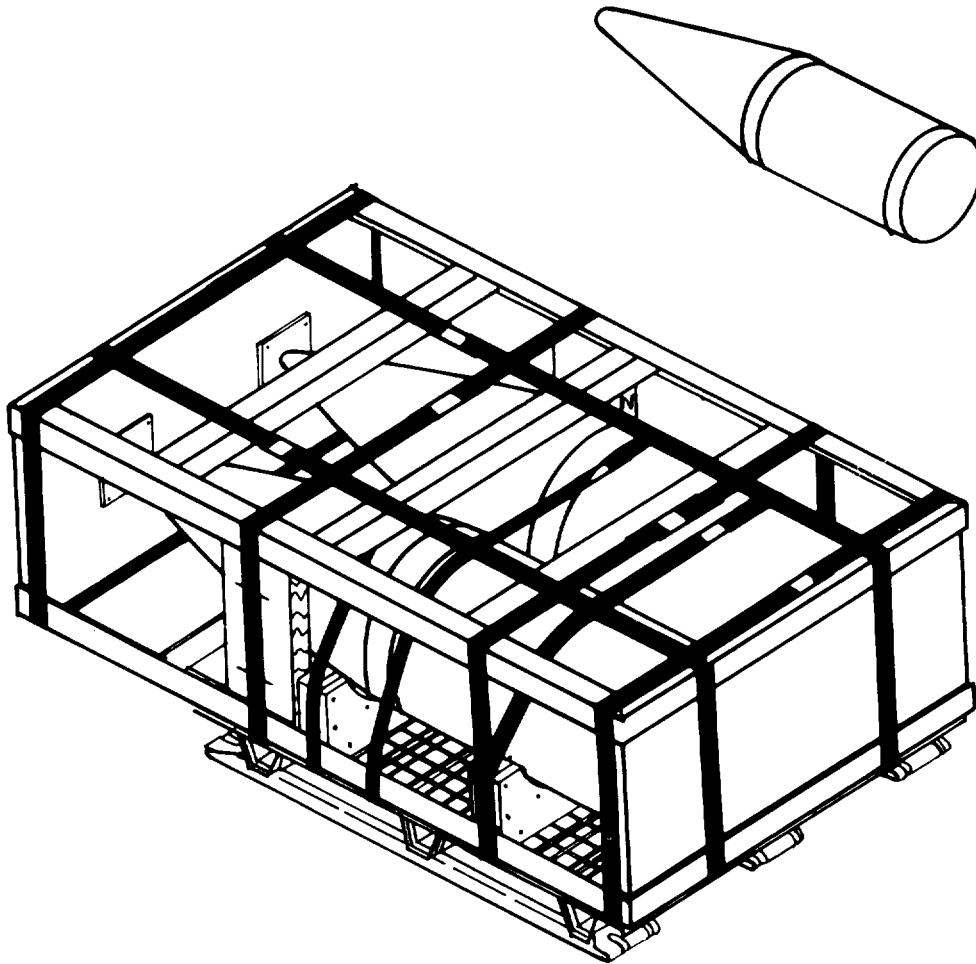


Figure 9-68. Single armor-piercing (AP) projectile (MK 85 MOD 0 handling bands).





**Figure 9-69. Two high-capacity (HC) projectiles (MK 3AMOI) 0 pallet).**

(1) For block stowage of 16-inch HC projectiles, the unit loads can be stowed nose-to-nose, nose-to-base, base-to-base, and nose/base-to-side. The top and bottom adapters and the plywood end caps provide an excellent bearing surface between loads; thus, no additional dunnage is required. All unit loads, however, must retain the same orientation when stacked vertically to assure that the on center pallets are vertically aligned for maximum stacking stability. Because of their metal pallets, these unit loads require strip decking in any compartment that has a steel deck. Care should be taken to assure that the strip decking supports all three pallet runners to prevent unit load distortion.

(2) For sweatboard-to-sweatboard stowage of HC projectiles, stowage patterns are more limited to prevent the possibility of unstable stacks. The HC unit loads can be stowed nose-to-base, base-to-base, and nose/base-to-side. Nose-to-nose stowage in the lower layers of a cargo stow is not considered acceptable, since it results in a long unsupported section of unit loads upon which the pallet end of subsequent loads might be overstowed. In addition, when subsequent tiers of projectile unit loads are offset by hull shear to such an extent that more than one-half of the pallet of the overstowed load is not over any part of the palletized end of the lower load, 2by 8-inch minimum tier stripping should be used to distribute the overstowed cargo weight. In cases where the pallets of overstowed unit loads are offset by less than one-half, tier stripping is not required. As with the block stowage technique, strip decking is required to separate the metal pallets from a ship's steel decks.

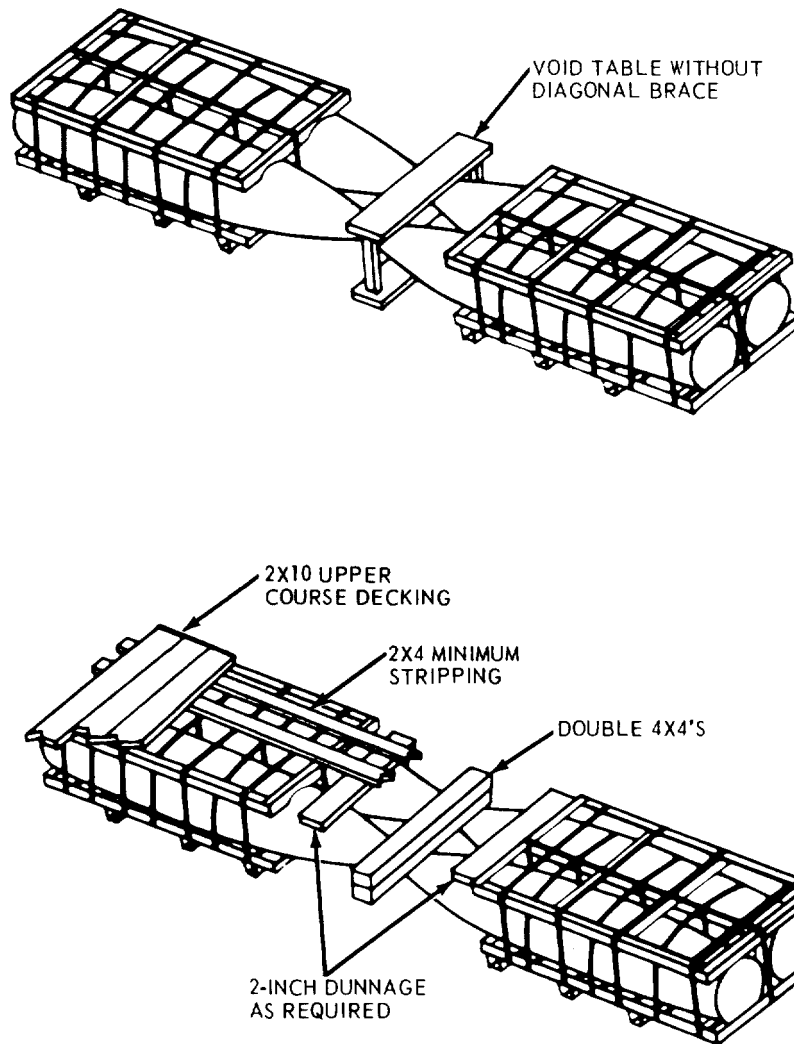


Figure 9-70. Support of tier decking for 2,000-pound bombs stowed nose-to-nose.

**9-5. Securing of Unitized Loads of Containers and Single Containers**

Size, weight, and stacking characteristics of typical container loads suggest that stowage of such items be limited preferably to amidship compartments having good accessibility and insignificant hull contour. Containers can be secured efficiently by conventional block-stow techniques since the stacking features of the unit load are such that, when tiered, the loads cannot be offset or staggered but are in alignment one directly above the other.

a. *Cluster Bomb Unit, CBU-55/B, Unitized Load of Containers.* The CBU-55/B is a typical unit load of containers. Four individual containers are stacked and unitized to form a load weighing approximately 3,700 pounds and measuring 8 1/2 feet in length, 4 feet in width, and 4 1/2 feet in height. Containers must be aligned vertically to permit stacking. Hence, to utilize space efficiently and reduce void areas near the hull, the CBU-55/B is best loaded in rectangular compartments having negligible camber and sheer angles.

(1) *Tween-deck stowage.* Figure 9-71 illustrates stowage of the CBU-55/B unit load in a typical tween-deck compartment. In the area illustrated, unitized containers are stacked three high and can be oriented either fore and aft or athwartships to achieve efficient space utilization. Prior to loading, 1-inch minimum strip decking is laid, and boarding is positioned on 2-foot centers along the sides of the compartment. Unit loads are positioned fore and aft in the recessed areas of the hold on either side of the protruding heat bulkhead. Narrow voids can be expected in these areas, and installation of 4by 4-inch securing structures is required. Unit loads are stowed athwartships along the heat

bulkhead. To level the stow and provide a flush bearing surface for ensuing rows, a securing structure of the required thickness can be constructed parallel to the heat bulkhead. Following rows are loaded athwartships in direct alignment. Voids should be planned henceforth to occur in the center of the hold and secured with full-block structures.

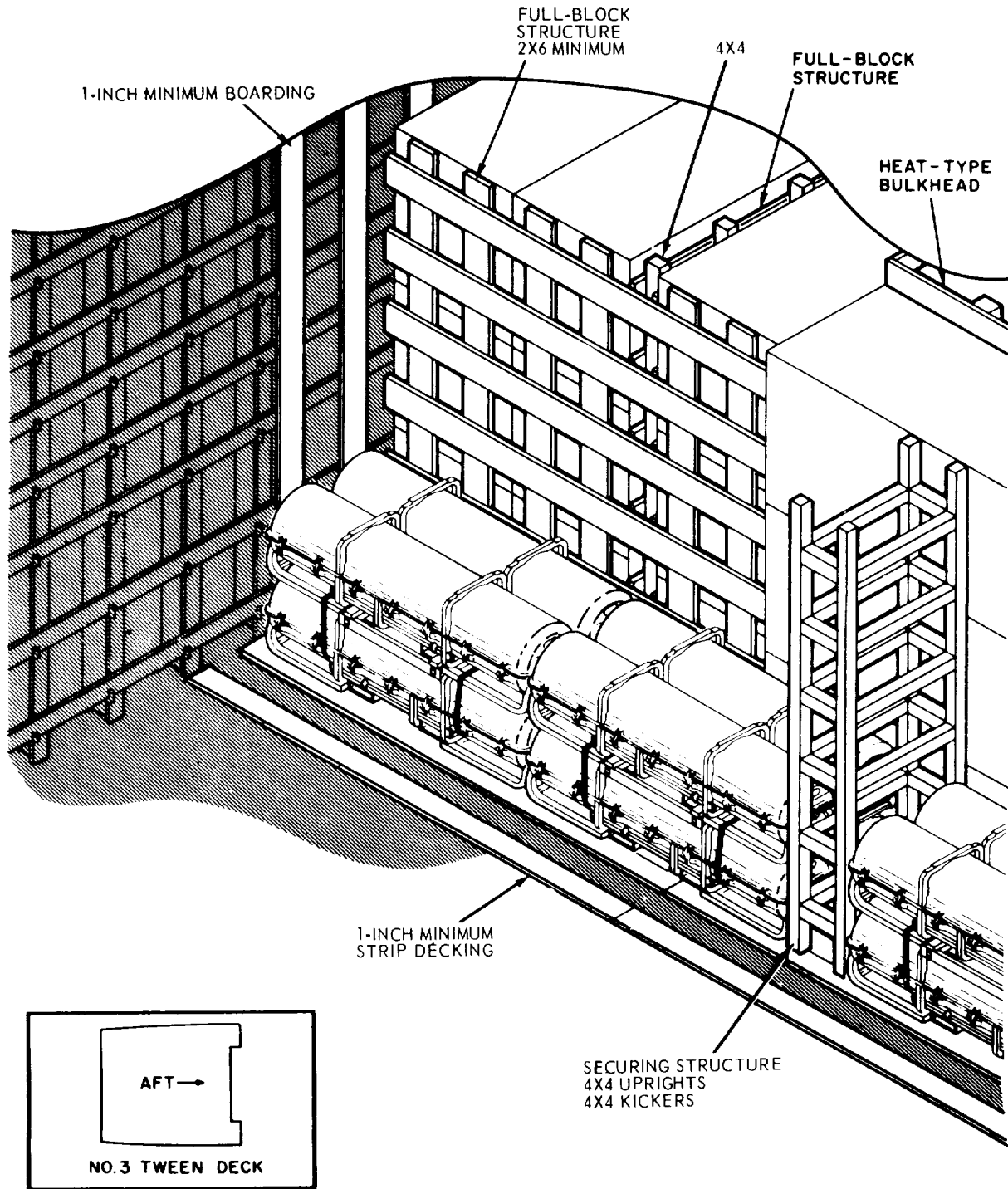


Figure 9-71. Stowing and securing of the CBU-55/B, tween deck No. 3 (swalboard blocking technique).

(2) *Stowage in tower holds.* Securement of the CBU-55/B in lower holds or in any compartment having significant hull contour is achieved by construction of the block-stow securing structure parallel with the ship's center line at either side of the hold. The unitized containers are positioned fore and aft in the securing compartment and are thereby restrained against athwartship movement. Stowage of the CBU-

**TM 55-607/NAVSEA OP 3221 Rev 2**  
55/B in such a compartment is illustrated in figure 9-72. The securing structure extends the full height and length of the containers. Uprights are spaced on 3-foot centers and contact the unit loads at three points, although twopoint contact would be permissible when stowing smaller containers of lesser weight. Construction details for block-stow securing are presented in paragraph 8-2.

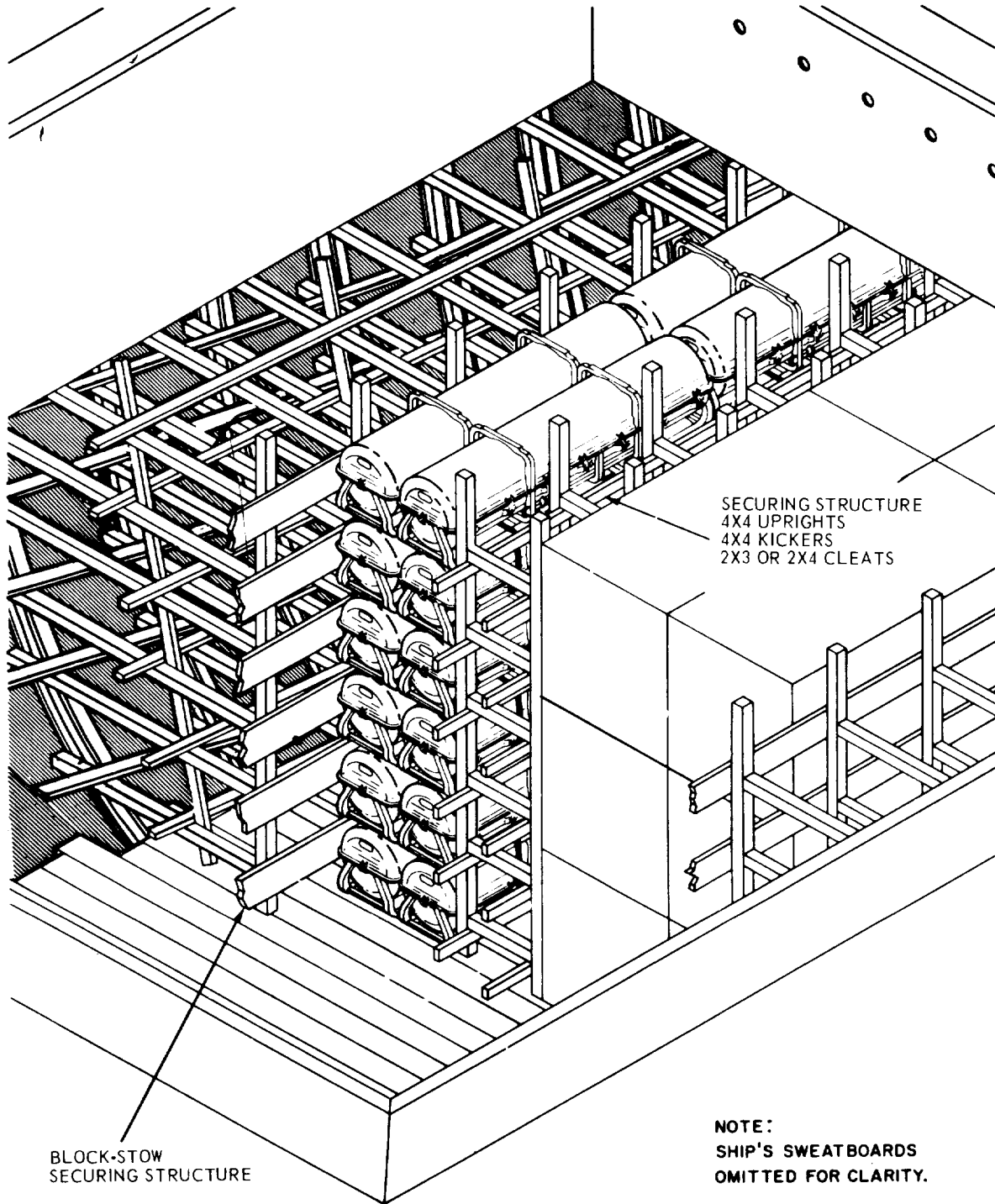


Figure 9-72. Block stowage of CBU-55/B in compartment with significant hull curvature (hull blocking technique).

*b. Cluster Bomb, CBU-25/A, Single Container.* Single containers, as represented by the CBU-25/A, are secured in the same manner as unitized containers: Stowage, when possible, should be limited to compartments where hull angle is not significant, although construction of suitable block-stow shoring, as shown in figure 9-72, permits securing of single containers in any compartment having adequate access. The CBU-25/A is mounted on wooden skids, eliminating floor stripping requirements. Generally, as for palletized loads, floor stripping need be installed only if the containers rest on metal surfaces. Figure 9-73 illustrates stowage of single CBU-25/A containers in the square of the hatch. The containers are block stowed with palletized explosives in a tight and efficient manner. Full use of the compartment is achieved by segregating the containers from lighter-weight commodities with partition bulkheads. Remaining voids are secured with standard securing structures fabricated with 4-by 4-inch vertical uprights and kickers. Flooring is not required.

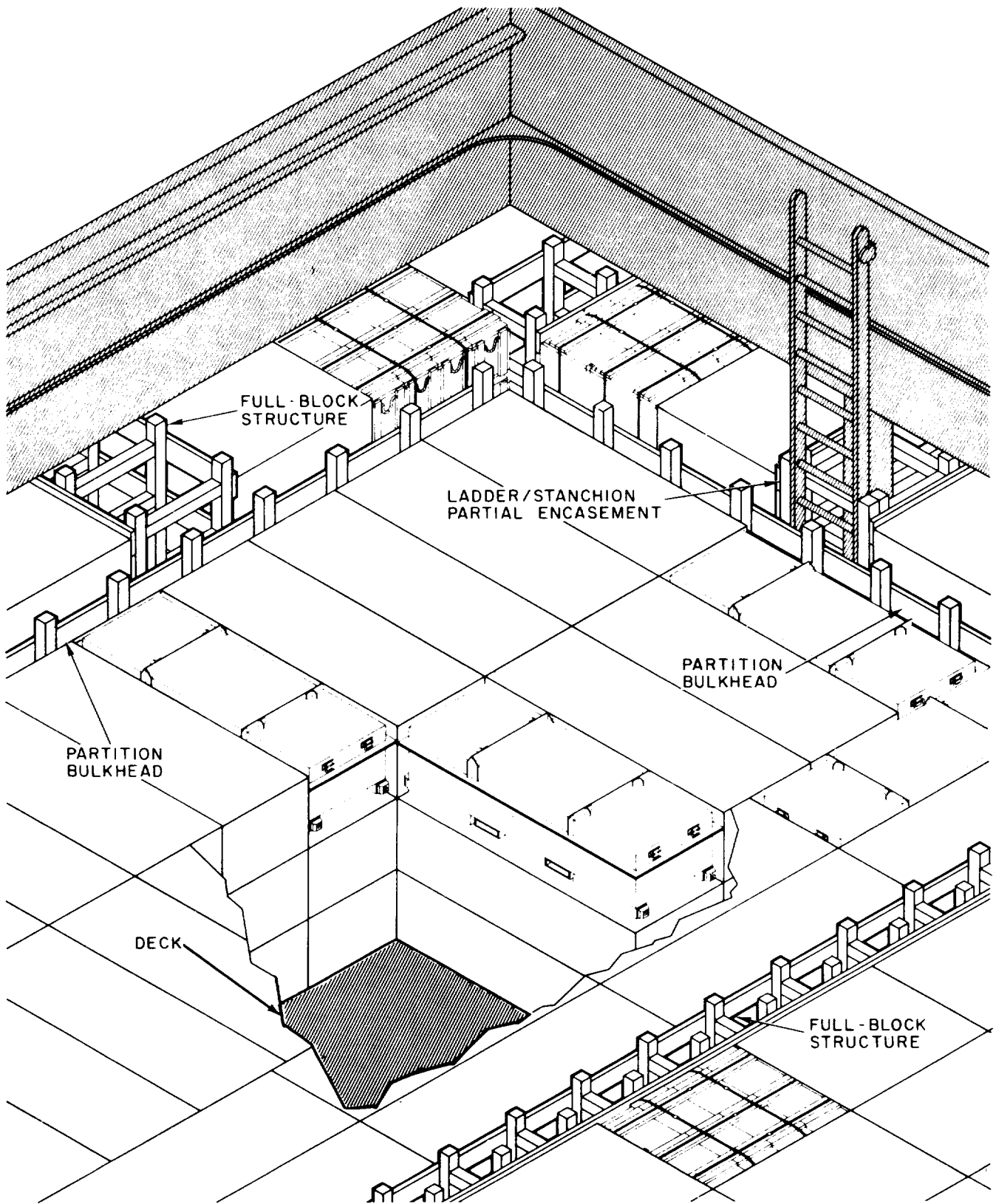


Figure 9-73. Stowage and securing of CBU-25/A single containers in square of hatch.

## CHAPTER 10

### BARGE LOADING

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#### 10-1. General

The LASH (lighter-aboard-ship) system is a concept in ocean transportation consisting primarily of a highly versatile barge-carrying ship and a fleet of cargo lighters. The principal advantage of this system is its ability to load and discharge its barges rapidly, thus minimizing port turnaround time. In addition, the shallow-draft lighters are essentially floating cargo holds, which permits service to shallow-water ports and to facilities that lack the complex cargo-handling gear required for conventional ships. Several United States shipping lines are currently utilizing the LASH ship system: Delta, Waterman, and Prudential. It can be anticipated that the increased availability of LASH ships, with their high speed and capability to discharge cargo in relatively undeveloped port areas, will lead to increasing amounts of military cargo being moved by this method of transportation in the near future. The SEABEE (sea-barge) system is similar in operational concept to the LASH; however, the military services have not as yet shipped large quantities of ammunition by SEABEE. Lykes is presently the only shipping line that has SEABEE ships. Individual SEABEE barges are similar in construction to LASH lighters, the principal differences being the SEABEE barge's greater interior height and length and its absence of interior corner posts. The general stowage techniques described in this chapter are also applicable, with minor modification, to the SEABEE system.

#### 10-2. Purpose

Information on the barge-carrying ship systems has been developed for the loading, blocking, and bracing of military explosives aboard LASH lighters. The stowage guidelines set forth in this chapter are based in part on the results of test shipments from both Army and Navy ports, and are designed to assist DOD ammunition-outloading activities in the safe, efficient utilization of LASH ships for the movement of military explosives cargo.

#### 10-3. Background

- a. The LASH system centers around a fast self-sustaining cargo ship that can accommodate both lighters and commercial containers, and families of cargo-carrying barges. Each LASHI ship carries its own gantry crane and is capable of loading or discharging its lighters at either a pier or deep water anchorage. The number of lighters that can be carried on the mother ship varies with the ship design.
- b. LASH lighters have a smooth rectangular configuration contributing to a quick, efficient stowage. Palletized and unitized loads of containers are readily stowed in any LASH lighter. Figure 10-1 illustrates the optimum space utilization achieved when stowing 500-pound bombs in a LASH lighter.



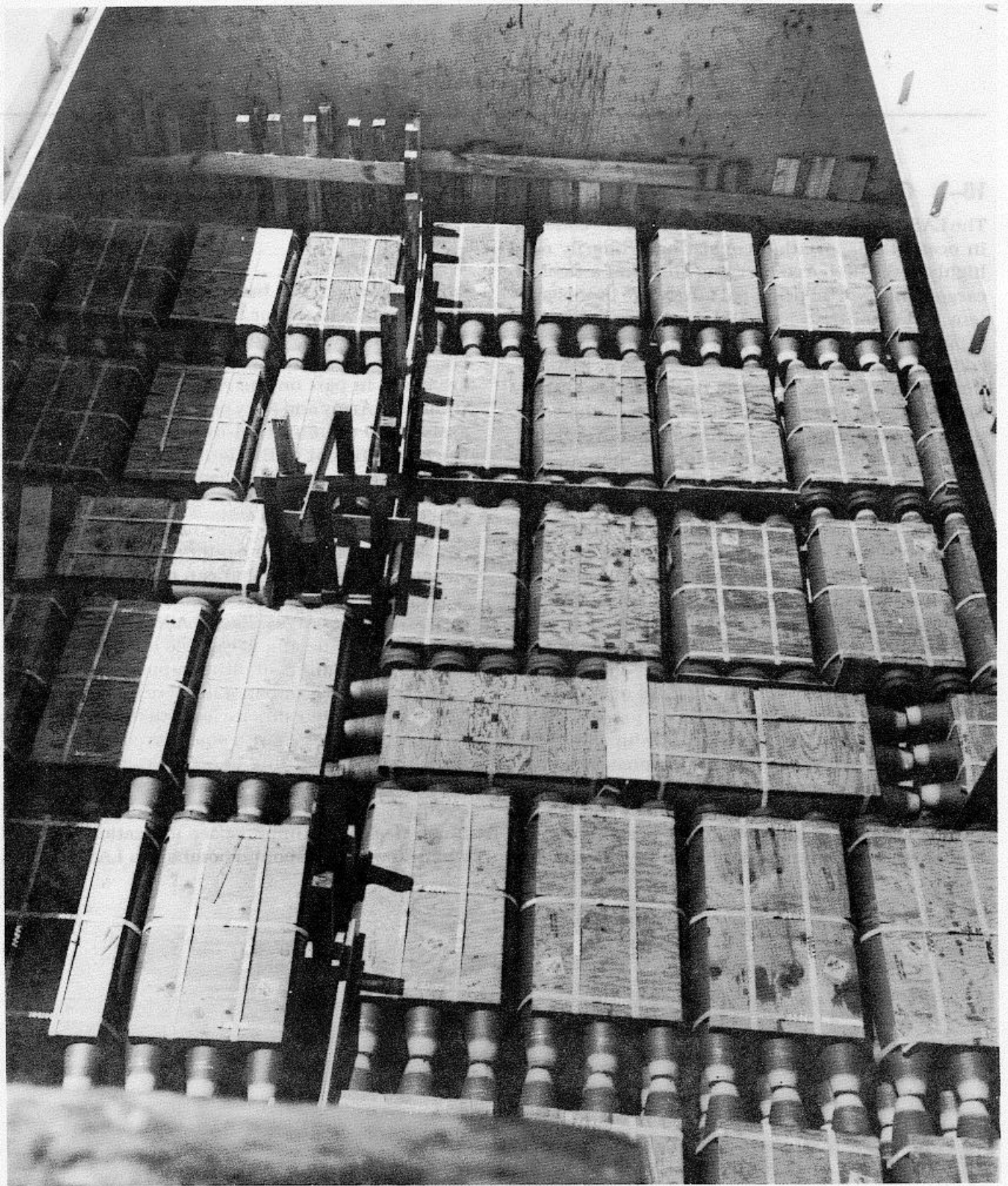


Figure 10-1. Completed slow of 500-pound-bomb unit load in a LASH lighter.

#### 10-4. Characteristics

a. LASH ships are among the largest and fastest dry cargo ships in the world. The ships feature a 500-ton gantry crane for loading and unloading lighters and, if so equipped, a self-propelled 35-ton gantry crane for loading and unloading containers. The lighter crane is designed to traverse the entire length of the main deck with lighters stowed two high on the hatch covers of each hold. It runs on heavy-duty rails located directly over the ship's longitudinal bulkheads, which extend outward at the stern in the form of twin cantilever structures. The crane's lifting frame, which operates similarly to a container lifting frame, is self-centered on the lighter's stacking posts and is equipped with positive latching arrangements to ensure a safe lift. Vertical displacement of the lighter is accommodated with an integral constant tension feature, which allows safe operation during moderate sea conditions.

b. LASH lighters are essentially floating ship holds. They are rectangular in configuration, with double hulls and either fully removable or retractable hydraulic hatch covers. Although there may be slight differences in dimensions or outfitting between manufacturers, all lighters are approximately 61 feet 6 inches by 31 feet 2 inches by 13 feet deep. Table D-2 of appendix D lists the typical characteristics of a commercial lighter equipped with three removable hatch covers. Lighters used on other commercial LASH systems are comparable. Figure 10-2 is a schematic drawing of a typical lighter. These dimensions should be taken into account by both cargo planners and shiploading personnel in order to develop the most efficient stow pattern for any given cargo and to determine whether use of prefabricated dunnage structures is feasible. LASH lighters are also designed with 36 tiedown fittings along the side walls and end bulkheads (not shown in fig 10-2). The fittings are rated at 40,000 pounds each and are useful for tomming down loose cylindrical items or securing large loads. Two levels of fittings extend around the entire interior of the lighter. The first level, with five fittings on each side and four on the ends, is 2 feet 6 inches above the deck. The second level also has five fittings on each side and four on the end(s) and is located 8 feet above the deck. Figure 10-2 also shows a cutaway view of the double hull construction, which greatly decreases the likelihood of cargo damage from flooding or collisions. LASH lighters are also equipped with fittings that can be connected to the ship's environmental-control system to provide ventilation and temperature and humidity control for sensitive explosives cargo.

#### NOTE

**Some LASH barges have stiffeners on the inside hull instead of smooth steel sheathing. These barges require 2-inch sheathing for all cargo.**

As indicated in figure 10-2, most LASH lighters have smooth steel bulkheads in the cargo stowage space. Some lighters, however, have ribbed bulkheads in the cargo stowage space. This configuration is equally acceptable for ammunition stowage, although it requires additional sheathing considerations, which are detailed in paragraph 10-6.

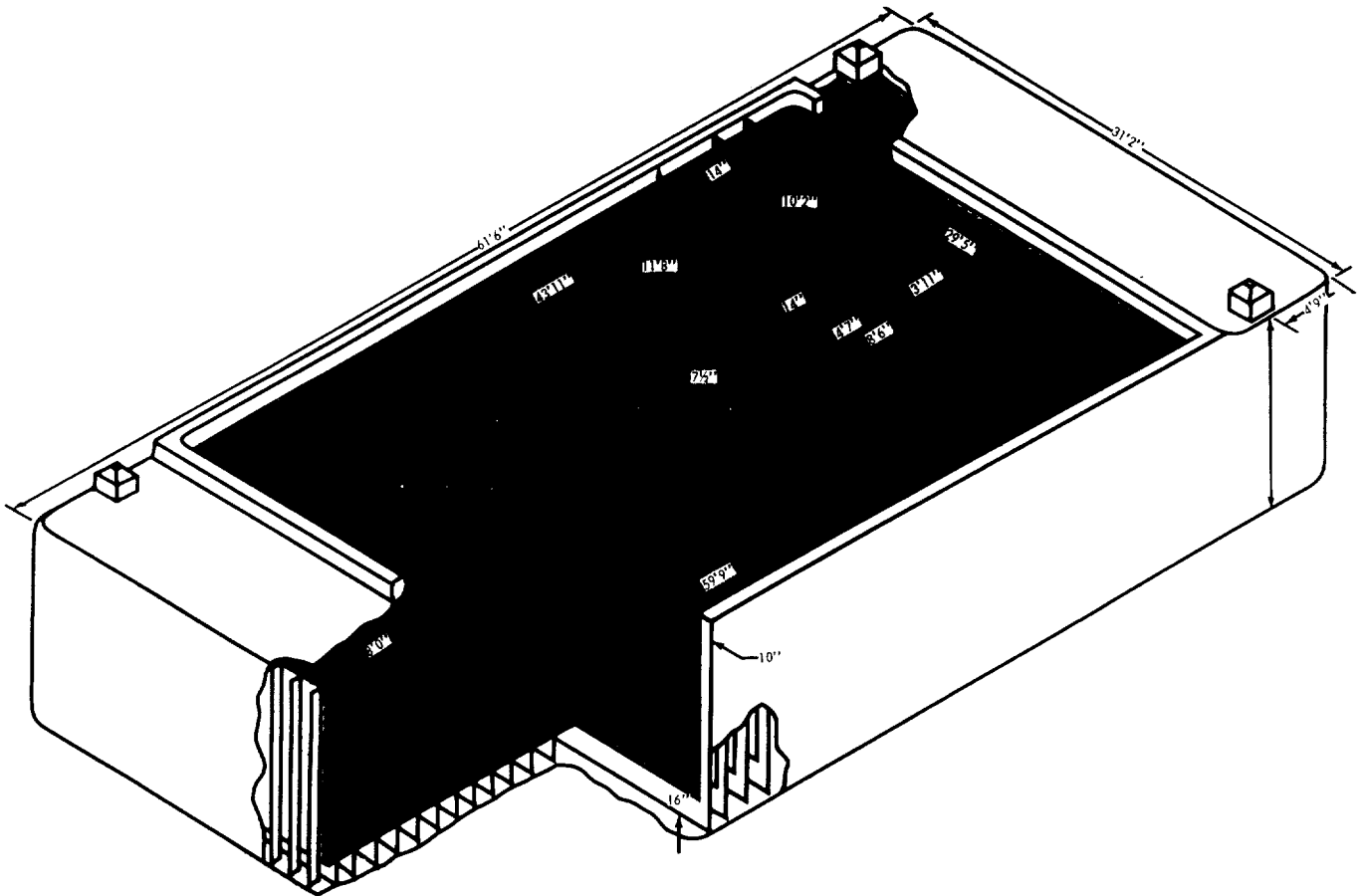


Figure 10-2. Dimensions of a typical LASH lighter.

### 10-5. Cargo Stowage

a. Preload Operations. The LASH lighter should be considered a small ship, and the principles that govern the loading of any oceangoing vessel with military explosives must be followed. Preload inspections, therefore, are similar to those outlined in paragraph 3-2, where applicable. In addition, the following special points should be checked prior to the commencement of cargo-loading operations.

(1) On lighters equipped with removable hatch pontoons, only as many covers need be removed as are necessary to load the barge safely. Leaving the remaining covers in place reduces start-up and cover-up delays in addition to providing greater protection from weather conditions. Also, hatch covers left in place make an acceptable location for the precutting or assembly of dunnage structures. Hatch covers should be removed using a four-leg sling at least 10 feet in length. Covers should always be lifted vertically since dragging them along a hatch will damage the waterproof gasket on the underside. Covers should be stacked on a flat surface to prevent distortion and additional gasket damage. Lighters arriving with damaged or missing gaskets should be reported to the shipping line, since this will result in the lighter losing its weatherproof seal.

(2) Lighters should be checked to determine if there is any leakage in the void spaces of the double hull, since any water taken on by the lighter will result in a decrease in the maximum amount of cargo weight that can be stowed. A fully loaded lighter with water in its void spaces could easily exceed the capacity of the ship's gantry crane. To determine accurately if any water is present in the void spaces, soundings may be taken through plugs on opposite corners of the lighter. Care should be taken to keep the sounding plugs tightly in place.

b. Inspection Policies. Inspection requirements for LASH lighters are identical to those for merchant-type ships, except that each lighter is considered to be a separate compartment and must be signed off individually by authorized loading personnel, inspectors, and shipping line representatives.

c. Stowage Patterns. A preliminary stowage plan based on the compatibility of the classes of explosives comprising the cargo, the load weight, and the dimensions of the individual unit loads is developed for each lighter. A typical preplan is illustrated in figure 10-3. In order to utilize the rectangular stowage area of the lighter efficiently, cargo should be block stowed. Because of the relatively narrow width of a LASH lighter, maximum space utilization may require rectangular unit loads to be oriented in different directions. In this case, the proper positioning of the loads is reflected by the preplan, as shown in figure 10-3. The final stow plan, as shown in figure 10-4, need not reflect actual orientation of unit loads; however, the commodity description, number of pieces, tonnage, and port sequence are entered as shown. Voids within the cargo stow will be caused by cargo sizes that are not even multiples of the lighter's interior dimensions or by the stacking posts and access ladders that extend into the cargo area. The different techniques of shoring these voids differentiate the types of block stow that may be used in loading LASH lighters.

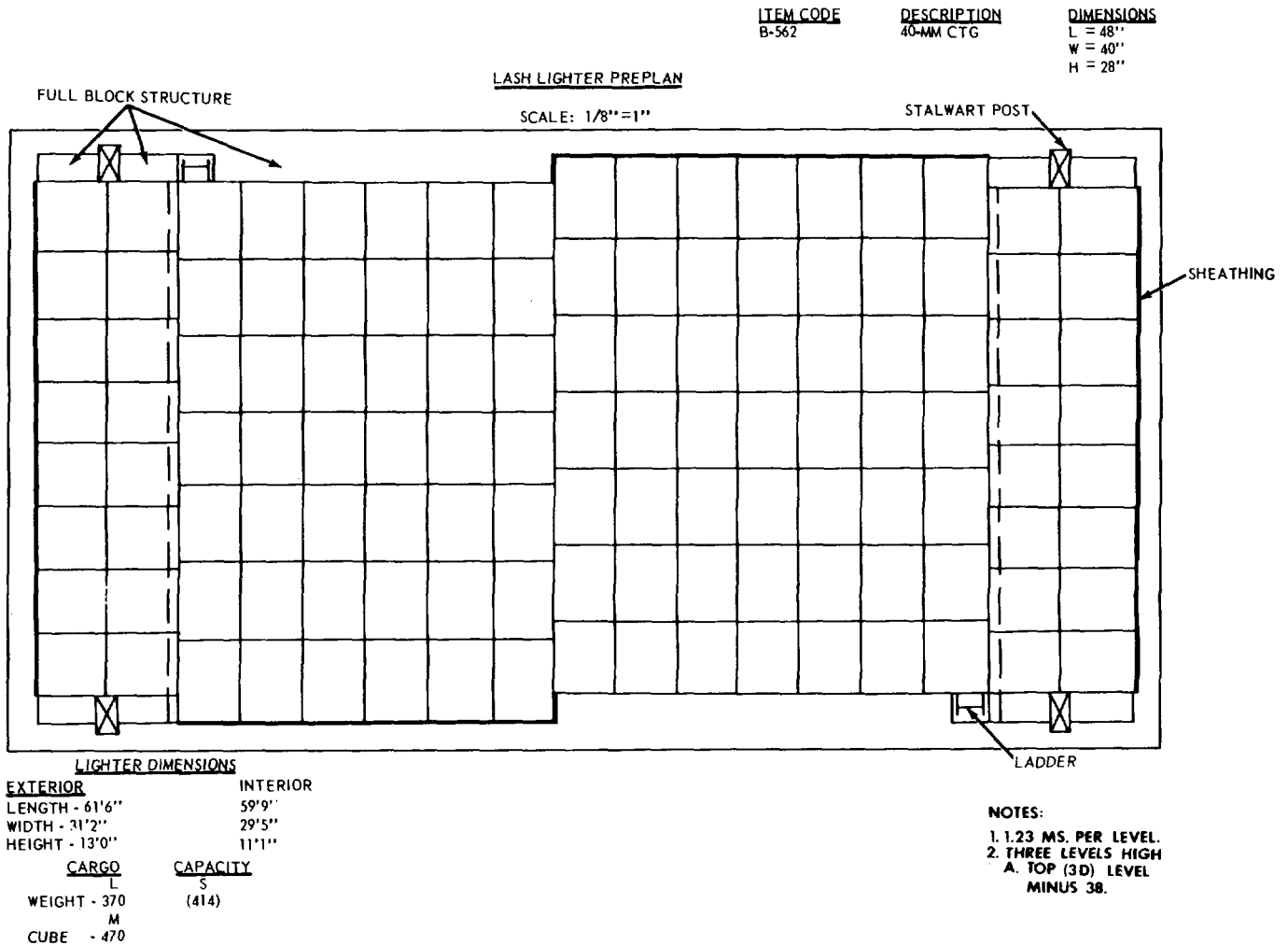
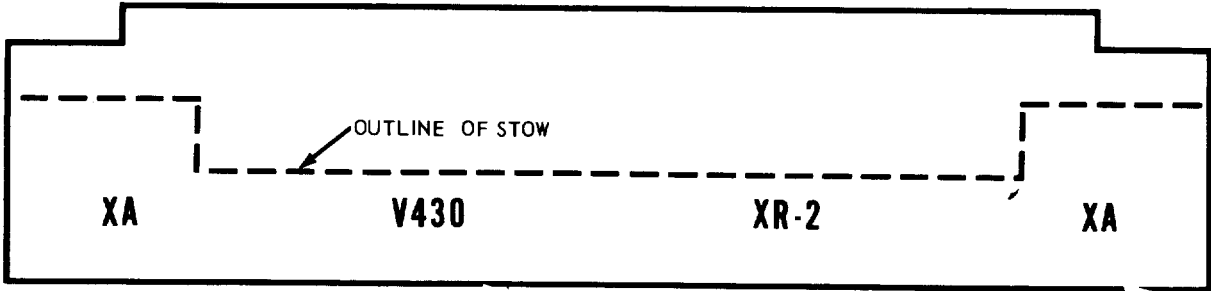


Figure 10-3. Preplan for LASH lighter.

**FINAL STOW PLAN**

**BARGE NUMBER** \_\_\_\_\_ **LOADING PORT** \_\_\_\_\_  
**PORT OF DISC** \_\_\_\_\_  
**PORT CODE** \_\_\_\_\_

**TONNAGE TOTALS:**



	USCG CLASS → <b>XA - 54 CNTRS</b>	
	ITEM → <b>W'HD SECT GM</b>	
	PORT CODE → <b>XR-2</b>	<b>V430</b> ← ITEM CODE
	TONNAGE → <b>81 S/T - 73 L/T - 259 M/T</b>	

COMMODITY	PIECES	S/T	M/T	USCG CLASS

Figure 10-4. Final stowage plan for LASH lighter.

(1) *Block stow.* Subsequent to the erection of encasement structures and the installation of sheathing material, block stowage begins at both ends of the barge. Cargo is stowed alternately against each side, and the loading progresses toward the center line. All voids are made to occur along both the athwartship and the longitudinal center line. This stowage method was described in paragraph 8-2, and for all practical purposes the LASH lighter can be considered an amidship tween-deck compartment. Figure 10-5 illustrates the development of a block stow in a LASH lighter. As described in paragraph 8-3, final blocking of the center line voids with full-block structures will take place after the cargo is in place. The advantage of this pattern is a symmetrical load pattern positioned tightly against the hull of the lighter. This results in simple sheathing requirements and basic encasement structures that can be prepared in advance because of their standard size.

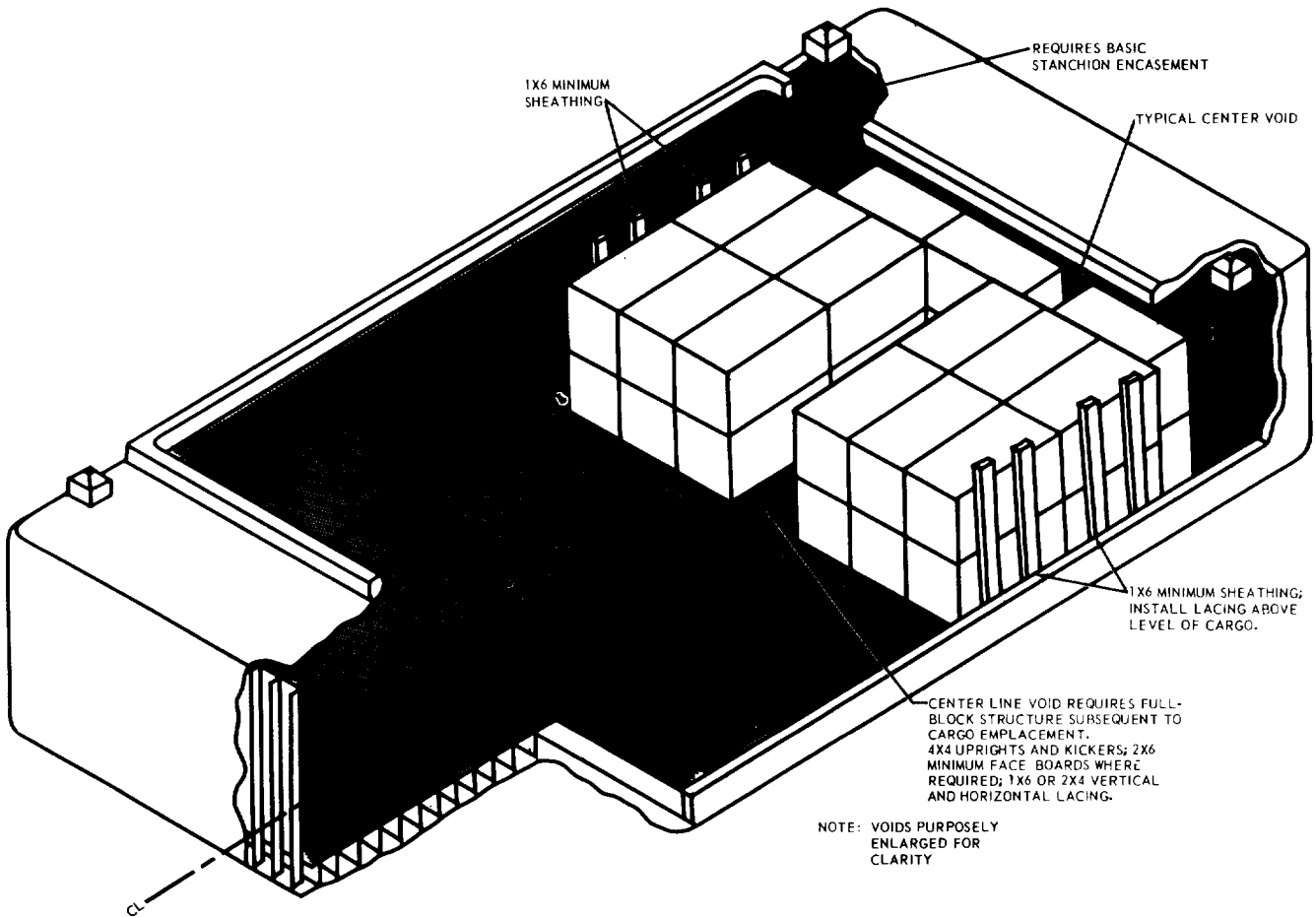


Figure 10-5. Basic block-stowage pattern.

(2) *Staggered block stow.* This variation of the conventional block-stow pattern calls for cargo to be stowed tightly against diagonally opposite side bulkheads of the lighter, starting at each end. Stowage proceeds in a tight pattern across the lighter until the last load is fitted into place. The void that remains between the completed stow and the hull of the lighter must be shored with a full-block structure similar to the one constructed on the longitudinal center line in the conventional block-stow technique. Stowage progresses in this manner back toward the athwartship center line, where any remaining voids are shored with full-block structures. Figure 10-6 illustrates the principles of the staggered block-stow pattern. The loading of 1,000pound bombs (MK 83) by the staggered block-stow method is shown in figure 10-7. By offsetting the loads in opposite directions around the longitudinal center line, the lighter remains balanced. Staggered block-stow permits efficient forklift truck operation in the square of the hatch, since stowage operations take place in opposite corners of the lighter. Sheathing and encasement structures are required only on one side and at the ends of the barge. Also, the smooth steel construction of the lighter's side bulkhead facilitates installation of the full-block structure, especially if the cargo stow consists of mixed commodities of varying dimensions. Figure 10-8 illustrates a typical void shoring structure installed at the hull when the staggered block-stowage technique is used.

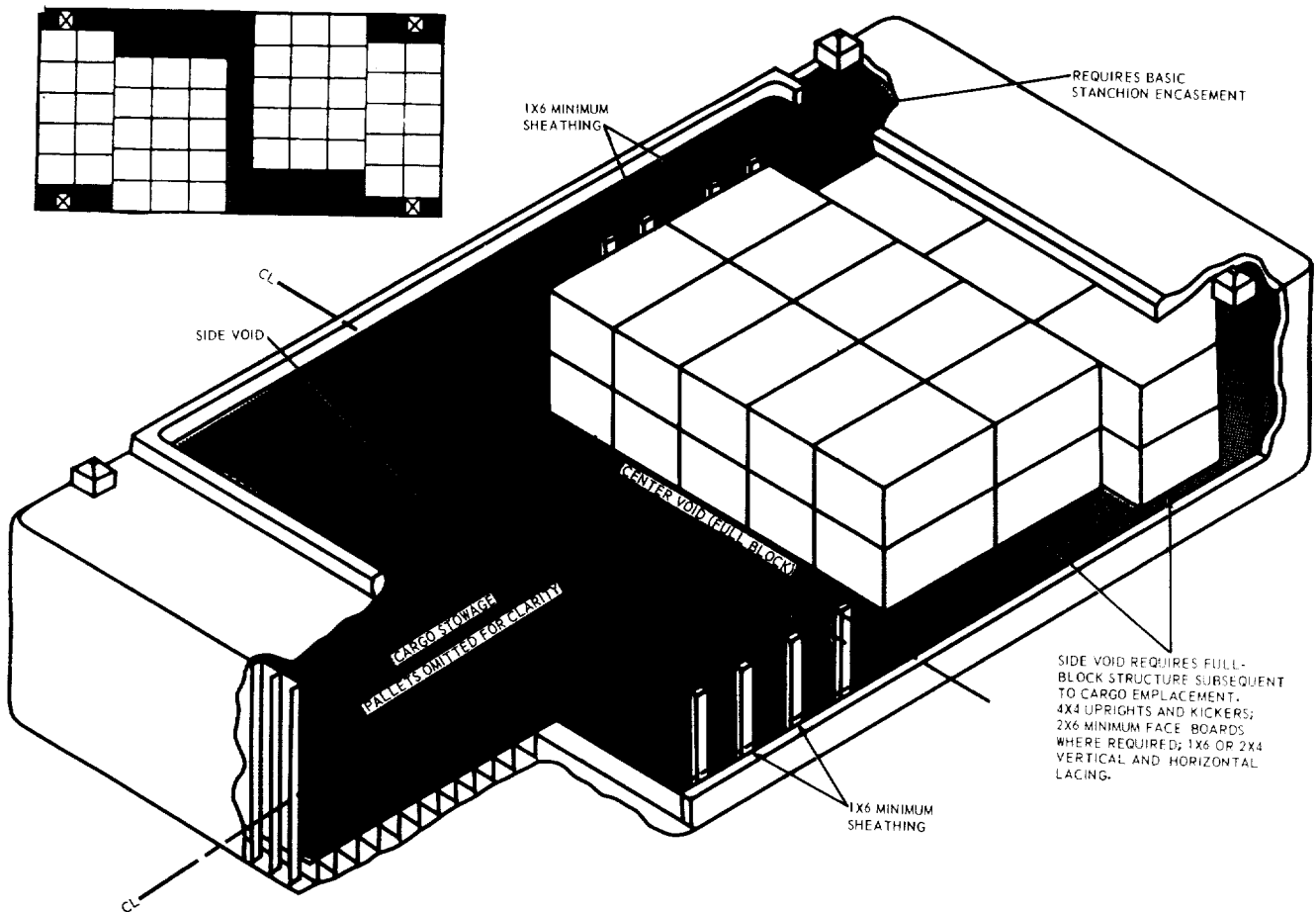


Figure 10-6. Basic staggered block-stow pattern.

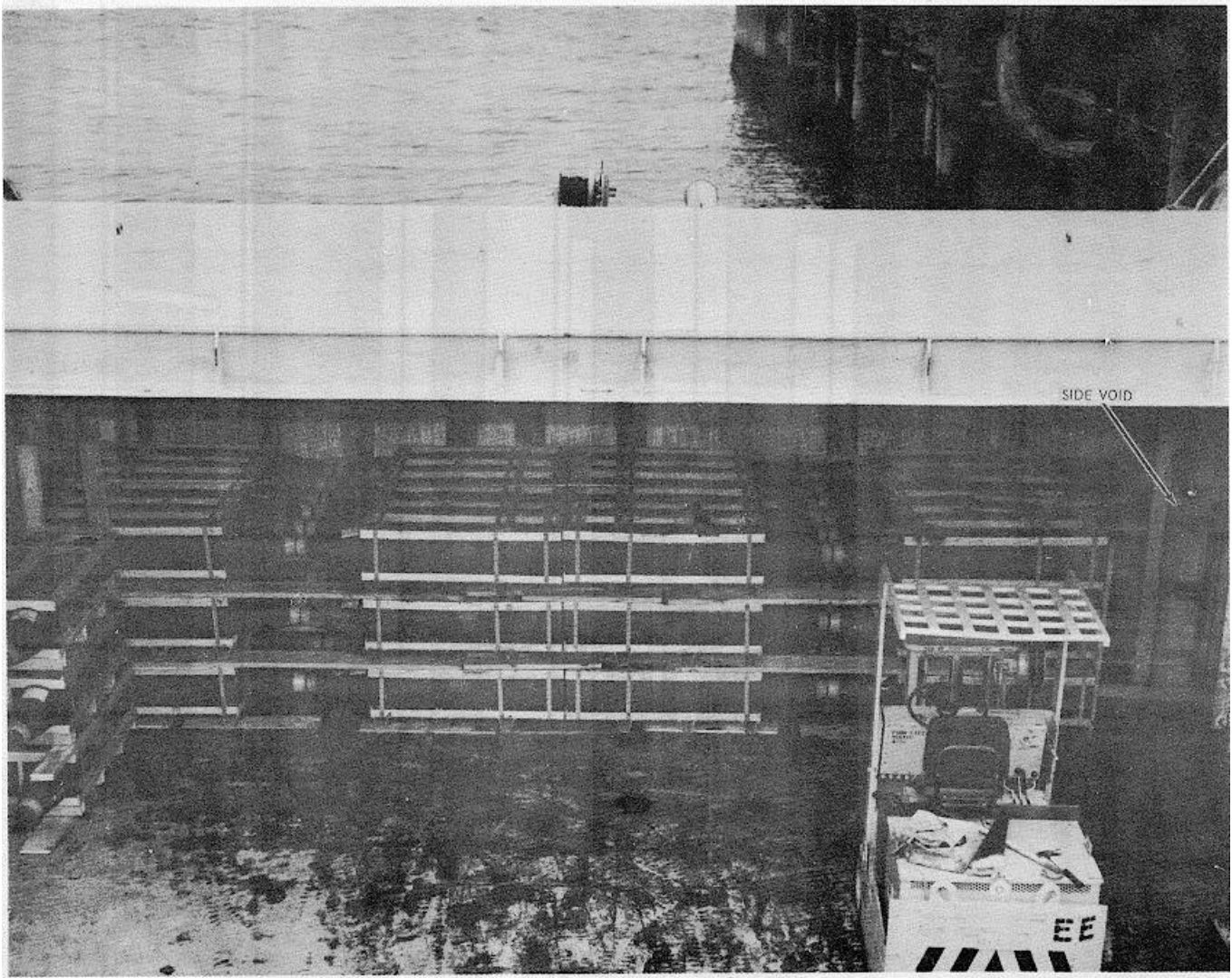


Figure 10-7. Staggered block stow of 1,000-pound-bomb unit loads, MK 83.



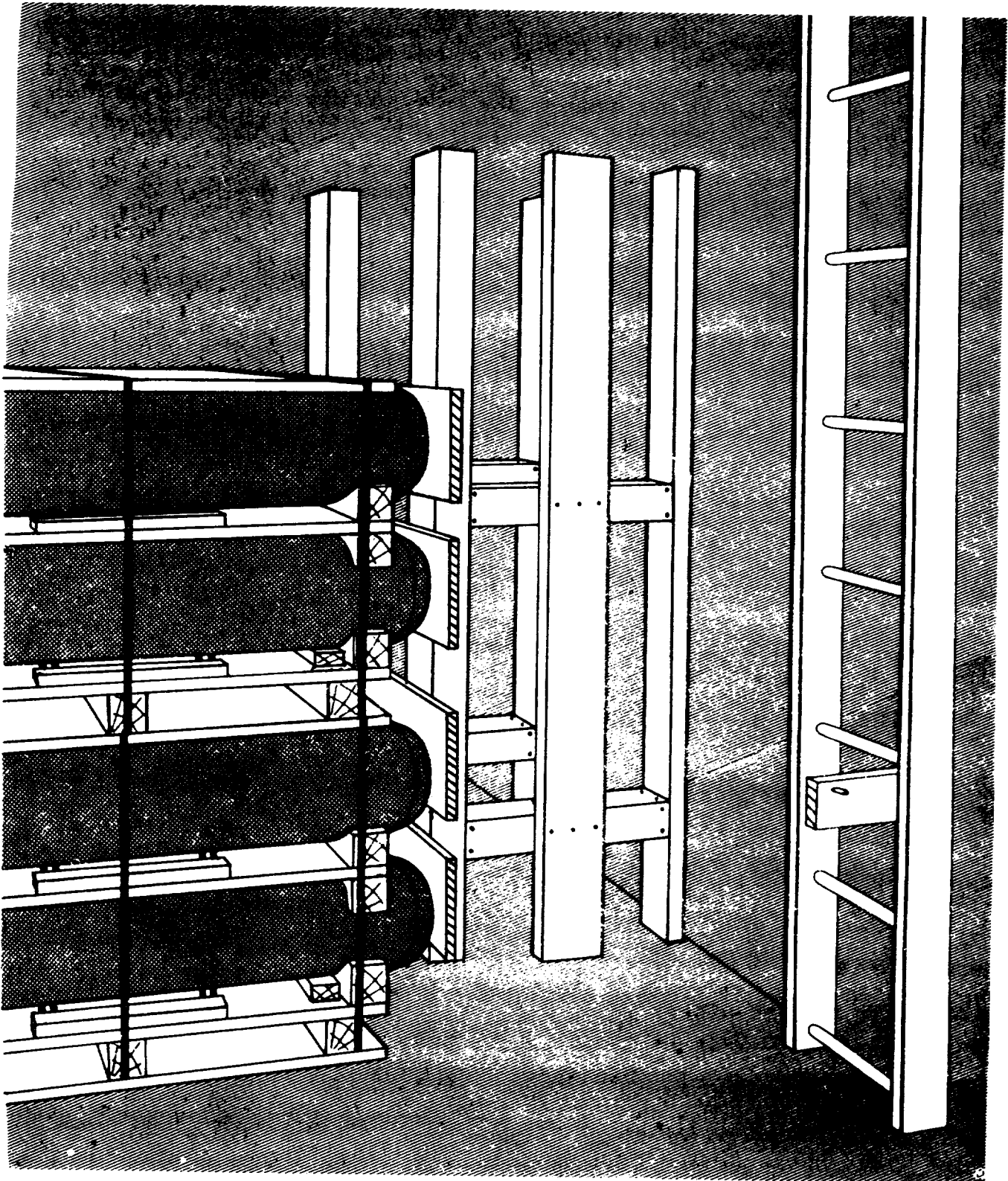


Figure 10-8. Void shoring for staggered block stowage.

(3) *Modified block stow.* It was noted previously in paragraph 9-4 that when the hull angles approach the perpendicular, then over-stowed unit loads are no longer offset and the sweatboard-to-sweatboard technique resembles block stowage. However, since the voids in the center of the stow can still be shored in accordance with the sweatboard-to-sweatboard technique, the final stowage technique to be described can be referred to as a "modified" block-stowage pattern. Utilization of this stowage pattern in a LASH lighter is illustrated in figure 10-9. As with conventional block stow, stowage operations begin at both ends of the barge with cargo being placed tight against sheathing and basic encasement structures. Voids that occur in the center of the stow are staggered between tiers so that they do not occur directly over each other. Voids in the lower tiers less than one-third the width of a TM 55-607/NAVSEA OP 3221 Rev 2 unit load do not require shoring. Large voids require vertical support, and a void table must be used. Detailed void-shoring techniques are discussed in paragraph 8-5. Only voids in the top tier require full-block structures. Unlike the conventional sweatboard-to-sweatboard stowage technique, tier stripping is not normally required, since palletized unit loads are not offset and voids never occur under two unit loads. Skidded unit loads or items palletized on metal adapters may require tier stripping for adequate support. The modified block-stowage pattern eliminates the need for large full-block structures; only basic encasement shoring, void tables, and top-tier block structures are required, and all may be prefabricated. On stows where the center voids are less than one-third the size of the unit load, void tables are not required.

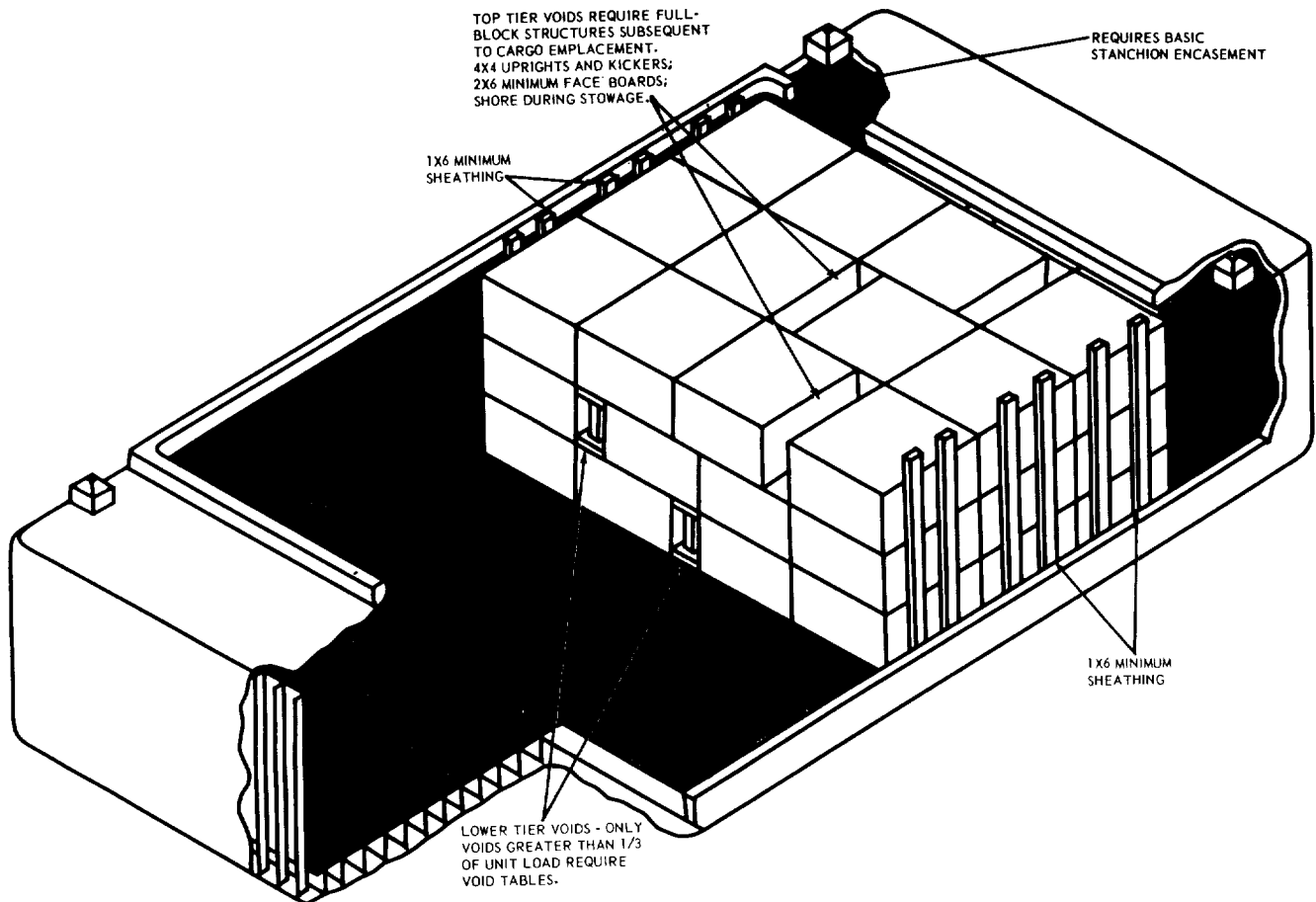


Figure 10-9. The modified block-stowage pattern.

*d. Stowage Orientation.* It should be kept in mind that barges are stowed aboard the LASH ship in the athwartship direction when cargo is stowed in LASH lighters. Thus, cargo oriented fore and aft with respect to the lighter is actually positioned athwartships with respect to the mother ship. In view of this, overhanging unit loads, which are stowed in both fore-and-aft direction and athwartships within a lighter, should be positioned with their greatest bearing surface against the sheathing.

## 10-6. Standard Block and Bracing Requirements

*a. General.* Since a LASH lighter is essentially an individual dry cargo hold, the general blocking and bracing techniques presented earlier in this manual apply. Unlike a break-bulk freighter, however, the basic interior dimensions of a LASH lighter do not vary significantly for different designs. Consequently, many dunnaging structures can be prepared in advance of the actual loadout operation. The blocking and bracing structures unique to LASH loading are discussed in the following paragraphs.

*b. Sheathing.* Sheathing is required between military explosives cargo and the smooth steel sides of a LASH lighter, since moisture condensation on the inner bulkheads may be significant. Since this material will normally be in compression between the cargo and the smooth steel sides of the barge, only 1-inch boarding is necessary. Two boarding uprights should be spaced per unit load and laced with 1by 6or 2by 4-inch material above the cargo. Two-by-four-inch or heavier material may be used if necessary based on material availability, as long as space permits. The use of reclaimed lumber is also acceptable for sheathing; however, the lumber must be inspected to ensure that all nails have been removed. Overhanging unit loads, such as MK 82 bombs, require sheathing between each projecting unit and the barge hull. In the case of MK 82 bombs, this would mean placing a vertical 1by 6-inch plank behind the base end of each row of bombs (bombs should never be stowed nose end against the hull in LASH lighters). In situations where voids occur at the hull of the barge and full-block structures must be constructed,

sheathing should be at least 2by 4-inch lumber in order to receive nails from the kickers. On ribbed LASH barges, the spaces between the ribs allow for sufficient clearance to minimize any moisture condensation problems. However, sheathing is required along the surface of the ribs, since Federal regulations require dunnage between ammunition cargo and steel ship's structures. The sheathing is in direct compression with the cargo, as with smooth-sided LASH barges, and 1-inch boarding is sufficient for most palletized rectangular unit loads. In the case of overhanging unit loads, such as low drag bombs, the projecting cargo must not make consistent contact with the ribs of the lighter. Therefore, horizontal 2-by-6-inch minimum face boards should be attached to the uprights to form a uniform bearing surface for the cargo.

*c. Encasements.* The four stacking posts and two access ladders found in LASH lighters must be encased to provide a firm bearing surface for the stowage unit loads of explosives. Whenever cargo is to be stowed tightly against these obstructions, basic encasement structures can be constructed. Since the size and location of each of these obstructions are known, the shoring structures will not vary in size and can be fabricated efficiently in advance. Figure 10-10 illustrates the construction details for a bulkhead jack needed to encase a stacking post, which protrudes approximately 14 inches into the lighter hold. These jacks should be spaced on either side of the stacking post and face-boarded with 2by 6inch minimum boarding, spaced equally with the top and bottom of the unit loads to be stowed against them, as shown in figure 10-11. The encasement structure should extend out an even number of rows of cargo. On the sides of the barge containing the access ladders, the structure may be extended out to include the ladder, which extends approximately 9/2 inches into the compartment. This situation is illustrated in figure 10-12. Normally, the encasement structure would be extended flush over the ladder as shown; however, where stowage space is at a premium, the encasement structure may be "cut back" after the stacking post, with the use of 9%-inch jacks on either side of the ladder. In any case, cargo should never be secured so that its weight will be borne by the access ladder, since the ladder is relatively weak.

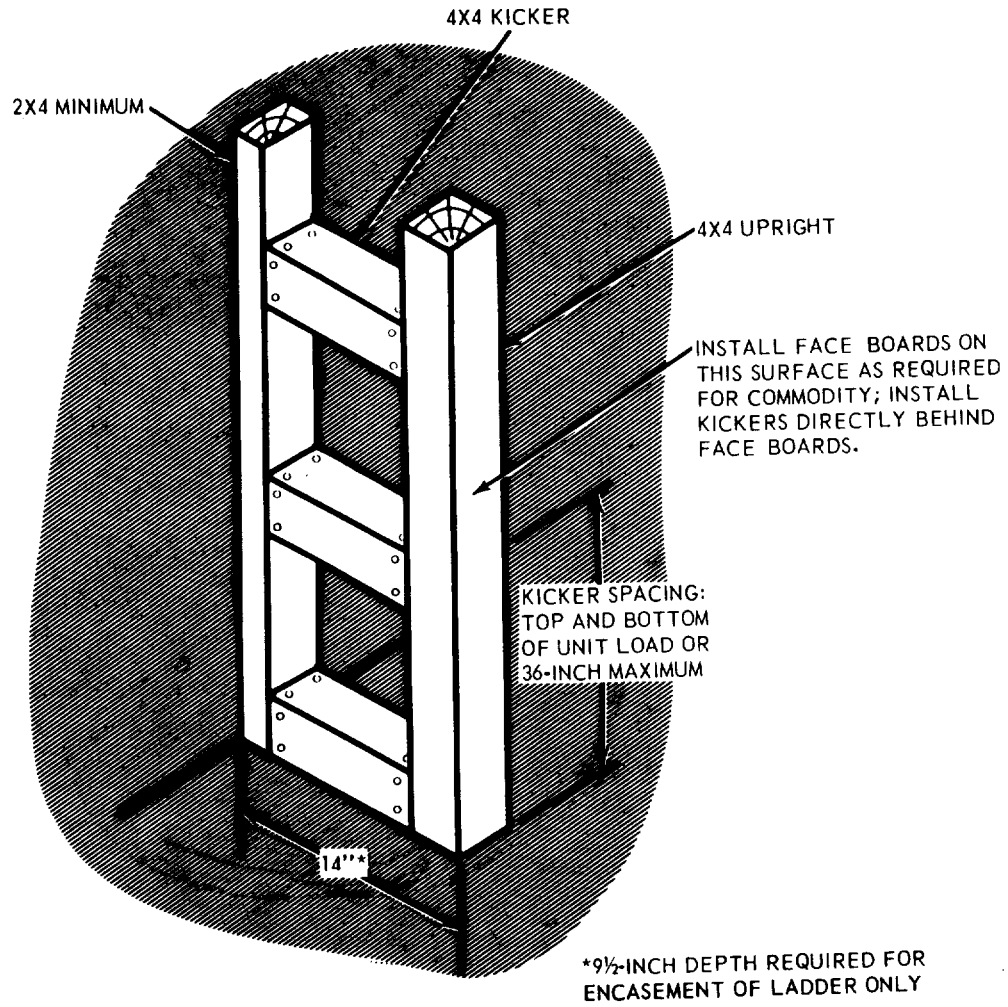


Figure 10-10. Construction details for bulkhead jack.

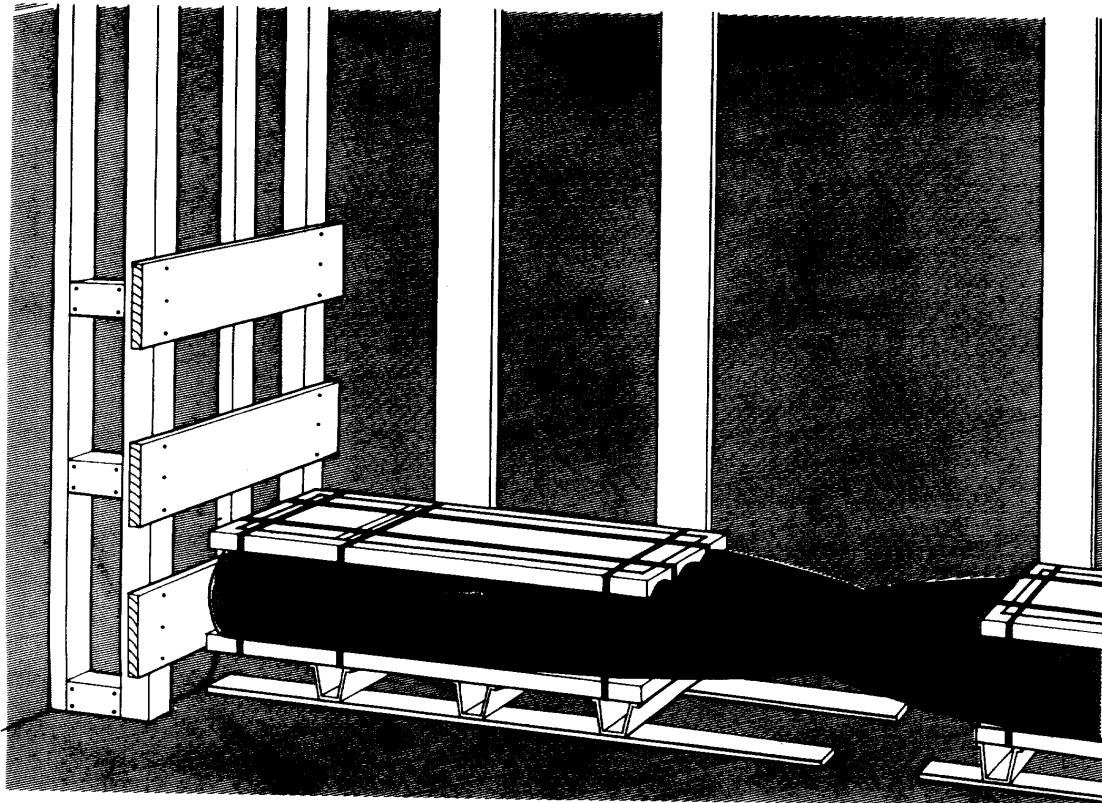


Figure 10-11 Completed encasement of stacking post.

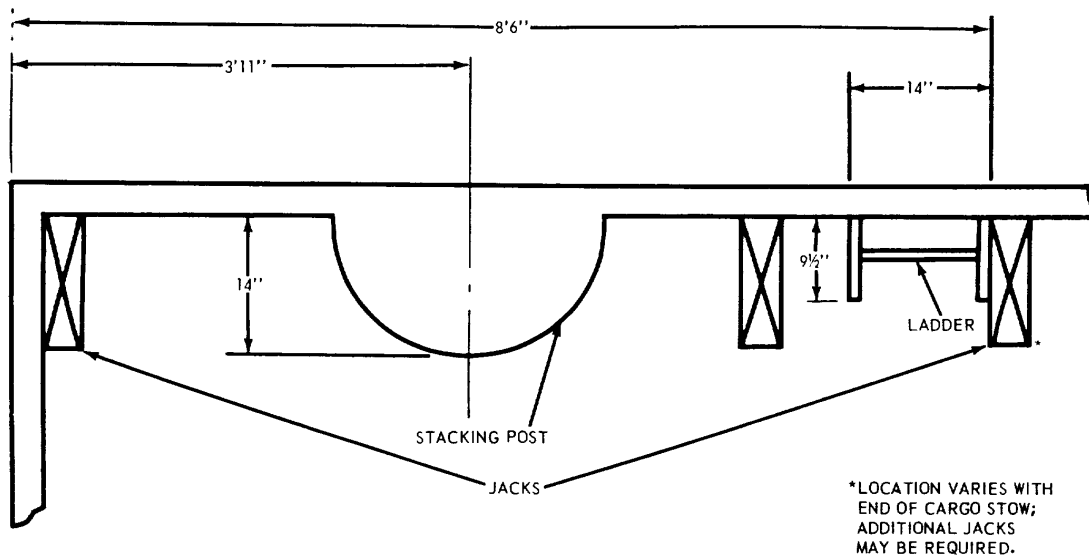


Figure 10-12. Construction details for encasement of ladder/stanchion combination with jacks.

d. *Partial Stow Bulkheads.* Normally it is advantageous to stow cargo in LASH lighters in full layers to minimize time-consuming securing of the partial top layer. For many shipments, however, maximum space utilization requires the stowage of a partial top layer. In these situations, securing of the partial top layer may be accomplished by either of the following two structures:

(1) *Step-down structure.* This structure, initially described in paragraph 7-10, is the simplest way to secure a partial top layer. Cargo is stowed the required number of tiers high to a point specified on the preplan. At this point, two 4by 4-inch uprights are placed against each stack of unit loads, and laced from behind with 1by 6or 2by 4-inch TM 55-607/NAVSEA OP 3221 Rev 2 material. Face boards are installed, prior to the placement of the uprights, when required (usually for overhanging unit loads). Cargo stowage is then resumed on the other side of the structure at a reduced height. Details of a step-down structure used to secure a partial top layer in a LASH lighter are illustrated in figure 10-13. Step-down structures are not to be used when stepping down cargo more than one tier, nor when the cargo on the lower side of the structure is of a lighter weight than the higher stowed cargo; instead, a diagonally braced bulkhead should be installed as described below. In addition, it should be noted that a step-down structure requires about 4 inches of space in the stow for insertion of uprights whenever it is used.

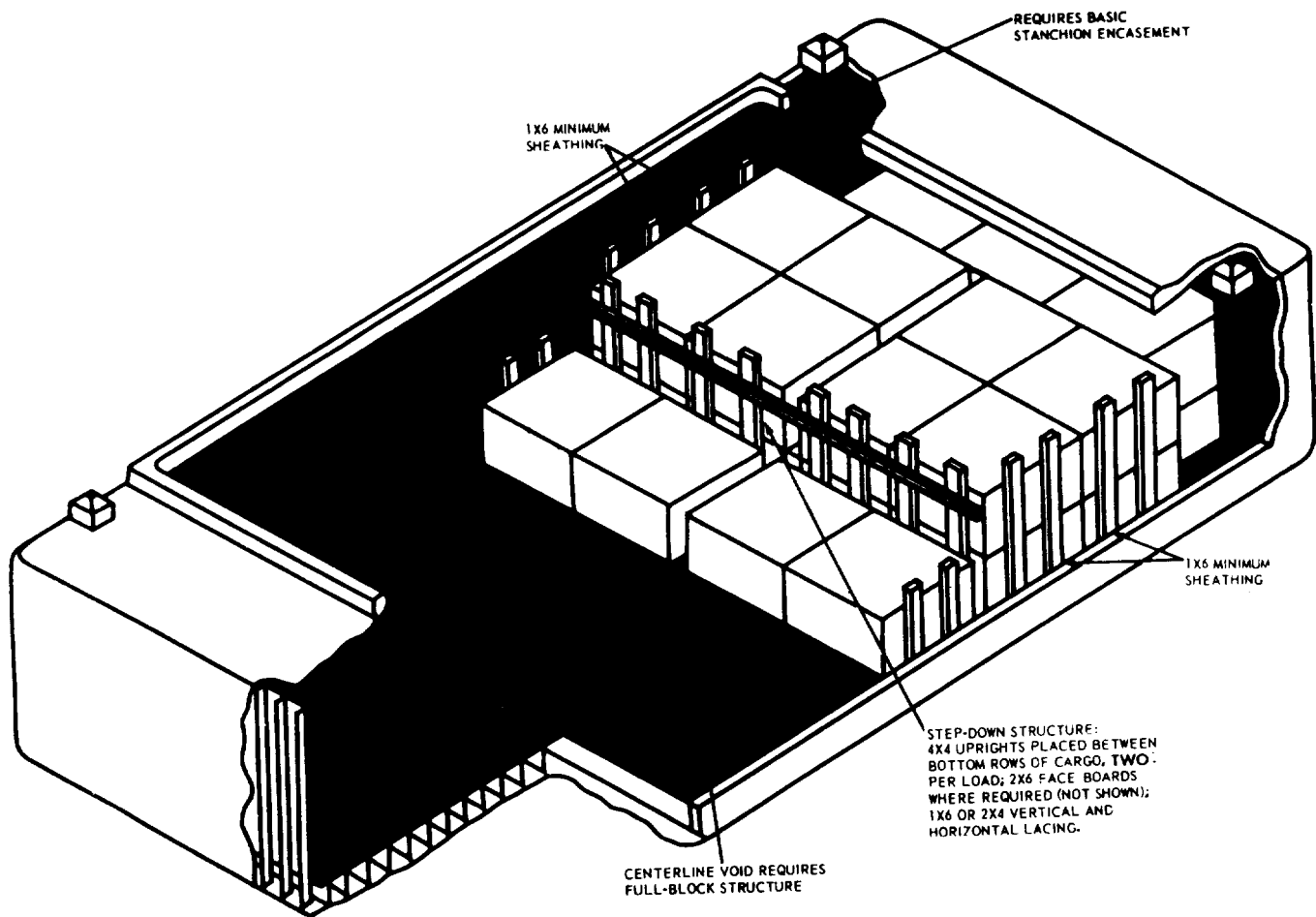


Figure 10-13. The step-down technique.

(2) *Diagonally braced bulkhead.* In addition to providing greater rigidity, the diagonally braced bulkhead can be used to secure a partial top layer in a LASH lighter where a tight stow does not permit the insertion of uprights between rows of unit loads, as required for a step-down structure. Construction details of this bulkhead and its usage in a LASH lighter are illustrated in figure 10-14. (Note that the runners of the bulkhead run to another bulkhead at the other end of the barge where the other half of the partial top layer is secured.)

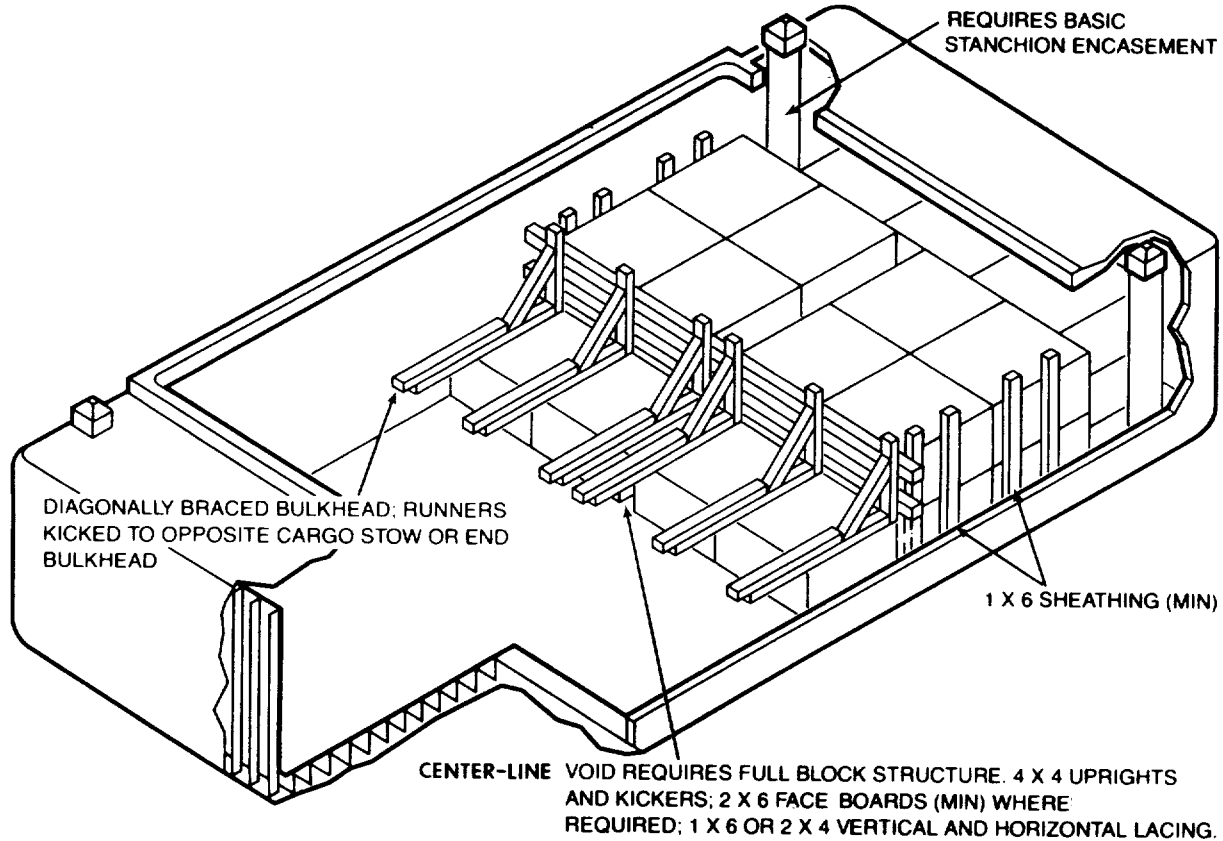


Figure 10-14. Use of diagonally braced bulkhead for securing top layer of stow.

e. *Division or Partition Bulkheads.* Division or partition bulkheads are used in LASH lighters wherever required by compatibility requirements and cargo configuration. Construction details for these bulkheads are described in paragraphs 7-5 and 7-6. For compatibility purposes, present Coast Guard policy considers a LASH lighter equivalent to a compartment on a merchant ship.

f. *Full-Block Structures.* Voids that occur within the cargo stow should be shored in accordance with the block-stow void shoring techniques detailed in paragraph 8-3c. Normally, two 4by 4-inch uprights should be positioned against each stack of unit loads on the sides of the void. The uprights are then kicked against each other, with 4by 4-inch lumber, and laced together with 1by 6or 2by 4inch material. If the staggered block-stow pattern is used, the void will occur along the side of the barge, and 2by 4-inch uprights may be used on the side of the full-block structure against the steel hull. In the event that the modified block-stow pattern is used, top tier voids can be shored with the fullblock structures described in paragraph 8-5b. It should be noted that face boards are used to resist forces in opposite direction of the kickers and must be cut to the exact width of the unit loads. As described in paragraph 8-5a, void tables are constructed where needed for lower tier voids. The height and width of the tables should match those of the adjacent unit loads. Both the full-block structure face-board assemblies and the void tables may be fabricated in advance for specific unit loads.

g. *Tomming.* The tomming of loose cylindrical, light, or shock sensitive items aboard a LASH barge is difficult because of the absence of overhead structures. The A-frame tomming structures described previously in paragraph 8-9a may be used at the fore and aft areas of the barge since the small deck area provides a limited overhead structure. For cargo that is stowed in the square of the hatch, and reaches the hatch covers in height, the tomming specified in paragraph 7-9c must be used. In other situations, the use of wire-rope tiedowns and turnbuckles is recommended. The recessed tiedown fittings located along the dull of the barge TM 55-607/NAVSEA OP 3221 Rev 2 should be used for hook-in points, and dunnage should be placed over the cargo to prevent chafing.

## 10-7. Lighters

Lighters are used at ammunition outloading activities when it is not feasible to bring the merchant or ammunition ships alongside the dock for loading or unloading. Barges can also transport ordnance from one dock to other docks or to other loading activities, or from docks to combatant ships at anchorage. The three types of lighters presently in service are YC lighters, YFN lighters, and modified YFN lighters (figs 10-15 through 10-17). Any of these lighters can be used for transporting the ammunition loads covered in this manual.

a. *YC Lighter.* This lighter is an open (uncovered) lighter normally used only during fair weather for cargo that is not weather sensitive.

b. *YFN Lighter.* This lighter has a shedlike deckhouse which protects the cargo during foul weather. It is suitable for operations when stowage aboard the lighter may last for several days. Four hatches provide access to the interior of the lighter.

c. *Modified YFN Lighter.* This lighter is an improved version of the standard YFN. Additional features include a hatch with a 12by 40-foot opening on the center line of the deckhouse to facilitate handling of long missile containers. Tiedowns are conveniently located to secure missile containers and missile component containers with cables and straps.

## 10-8. Preliminary Operations Prepare lighters for loading as follows:

a. Clear the lighter deck of all materials not required by the operation.

b. Consult the load plan for the arrangement of unit loads to be stowed aboard the lighter. In the load plan, cargo is arranged based on destination of the lighter (since unloading methods may require different hatch areas to be kept clear) as well as trim and stability of the barge. Stowage and blocking and bracing of ammunition in barges for movement in oceans, bays, and rivers must be in accordance with the Code of Federal Regulations.



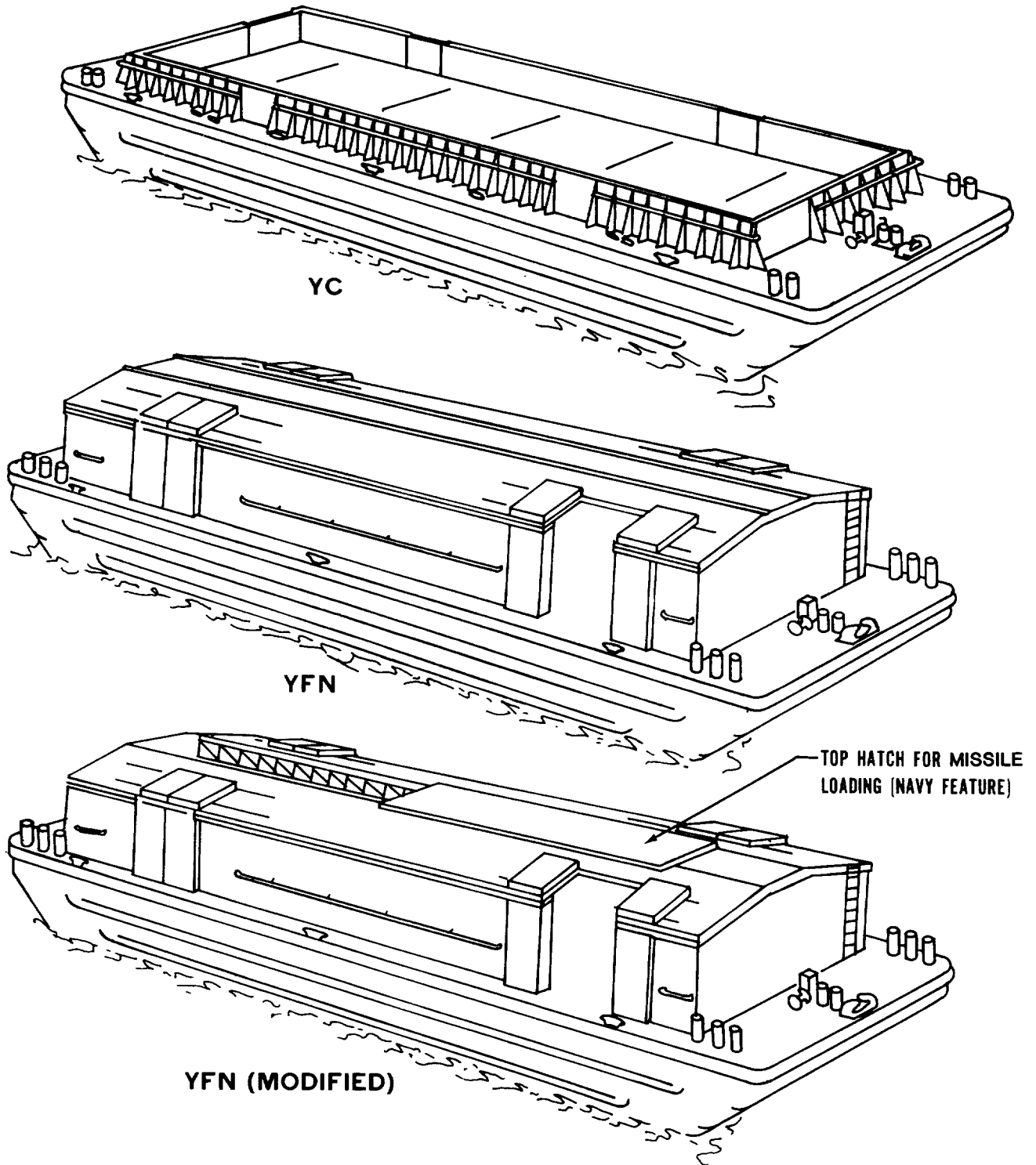
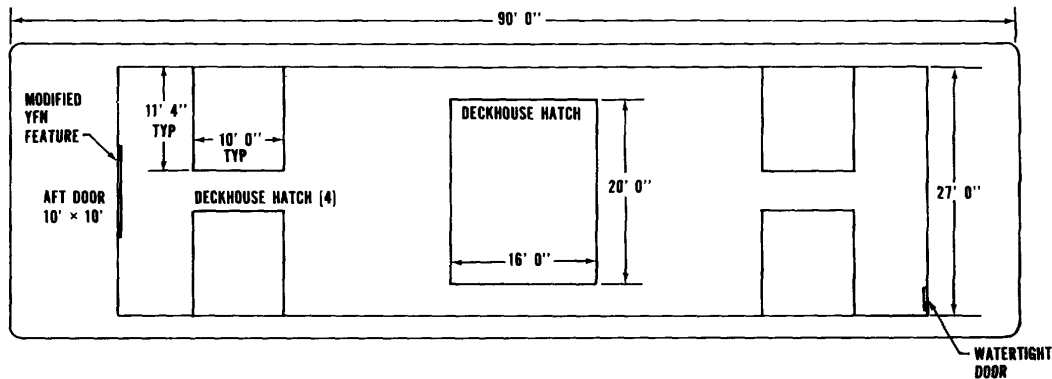
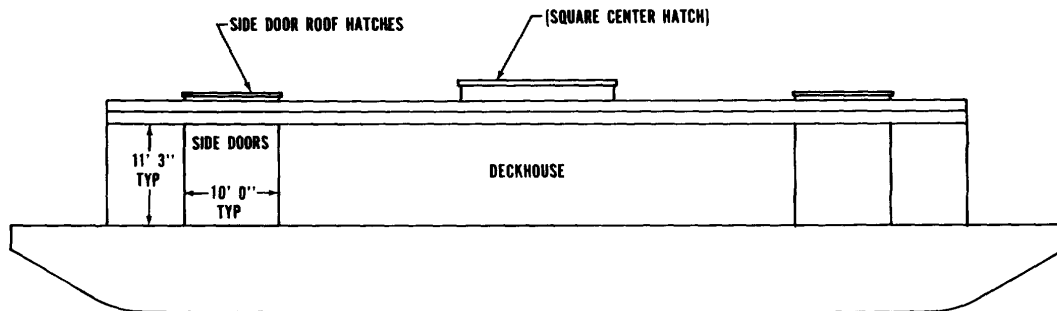


Figure 10-15. Three types of lighters.

**NOTE:**  
**1. THERE ARE NO OBSTRUCTIONS IN DECK**



**Figure 10-16. Top view of a typical YFN lighter.**



**Figure 10-17. Side view of a typical YFN (modified) lighter.**

- c. Open the hatches on the YFN and modified YFN lighters.

**10-9. Dunnage Requirements**

a. *Sheathing.* Sheathing (fig 10-18) is required to separate the ammunition cargo from the steel structure of the barges. Since the bulwark of the YC barges and the ribbed walls of the YFN barge deckhouses do not present a level shoring surface, the following sheathing procedures are recommended for YC and YFN barges:

(1) For YC barges, smooth sections of the steel bulwark may be sheathed with vertical 1by 6-inch boards. Openings in the bulwark may be shored with three horizontal 4 by 4's and 2by 6-inch minimum vertical boarding to withstand cargo forces. When barge load limits permit cargo to be stacked higher than the bulwark, the perimeter shoring and sheathing functions can be combined into one structure. When cargo height exceeds the bulwark by more than one-half of the top unit load, perimeter shoring of 4by 6-inch uprights, spaced not more than 36 inches apart, should be erected. Face boards of 2by 6-inch, minimum, should then be attached to the uprights at a spacing not to exceed 24 inches.

(2) Since the steel deckhouse walls on YFN barges are not strong enough to support the loads imposed by the ammunition cargo during severe sea conditions, sheathing structures must be designed to transmit these loads directly to the main structural beams of the deckhouse. Two different methods of sheathing YFNs are currently in use, although both depend upon transmitting cargo forces to the three horizontal beams that are part of the deckhouse walls. One method calls for attaching 4 by 4's to the horizontal beams with steel strapping. Then 2by 6-inch, minimum, face boards are attached to the 4-by-4's at a spacing not

to exceed 2 inches. The closely spaced face boards allow this sheathing structure to interface with unit loads of various configurations without any modifications. The other method calls for the use of 4by 4-inch, minimum, uprights, spaced 6 feet apart, with 2by 12-inch face boards, spaced to fit the configuration of the cargo to be stowed against it.

(3) Since these barges have steel decks, all ammunition unit loads with steel pallets require 1by 6-inch minimum strip decking to prevent metal-to-metal contact.

*b. Void Shoring.* Normal loading practice for YCs and YFNs (fig 10-18) is to start cargo stowage at the fore and( aft bulkheads and work toward the center. On YFNs, however, cargo is not normally stowed adjacent to the doors; it is stowed in the center area between both sets of doors. For lightly loaded YFNs, it may be preferred to load only the center portion of the barge. Shoring of the voids within the cargo stow should be in accordance with the following guidelines:

(1) For one-high stowage, all voids must be fully blocked as detailed in chapter 8. Similarly, all void space must be shored for block stowage of cargo more than one unit load high. For voids distributed throughout the stow based on the sweatboard-to-sweatboard technique, full blocking is required only for top layer voids. Lower layer voids should be shored as indicated in paragraph 8-4c.

(2) The void areas between doors on YFNs and at the end of cargo stows on all barges can be shored with deck framing if cargo is one unit load high, or with the appropriate bulkhead structure if cargo is two or more unit loads high. Normally, for one-high stowage, 4by 4-inch bearers are placed against the cargo or barge structure and kicked with 4by 4inch kickers spaced the width of the unit loads, or not more than every 6 feet. It may be more desirable to shore directly off the cargo for overhanging unit loads. In this case, larger dunnage, such as the 2 by 12's (fig 10-18) should be used for bearers. However, care should be taken to make sure the kickers are sized to contact the bearers in the area that is against the cargo. For cargo that is stowed more than one-high, nonheat bulkhead structures should be constructed and kicked against each other o;, as appropriate, barge structures as dictated by the situation. The kicking can be accomplished with horizontal 4by 4-inch kickers at the top and bottom of each tier of unit loads, or with the diagonal brace "A" or frame structures illustrated in figures 7-15 and 7-16.

(3) Shoring structures should not be run to the side doors on YFN barges because the doors are not strong enough to resist the cargo forces that could be imposed on them. For maximum strength, both sheathing and blocking structures should be directed to the vertical steel beams on either side of the doors (fig 10-19).

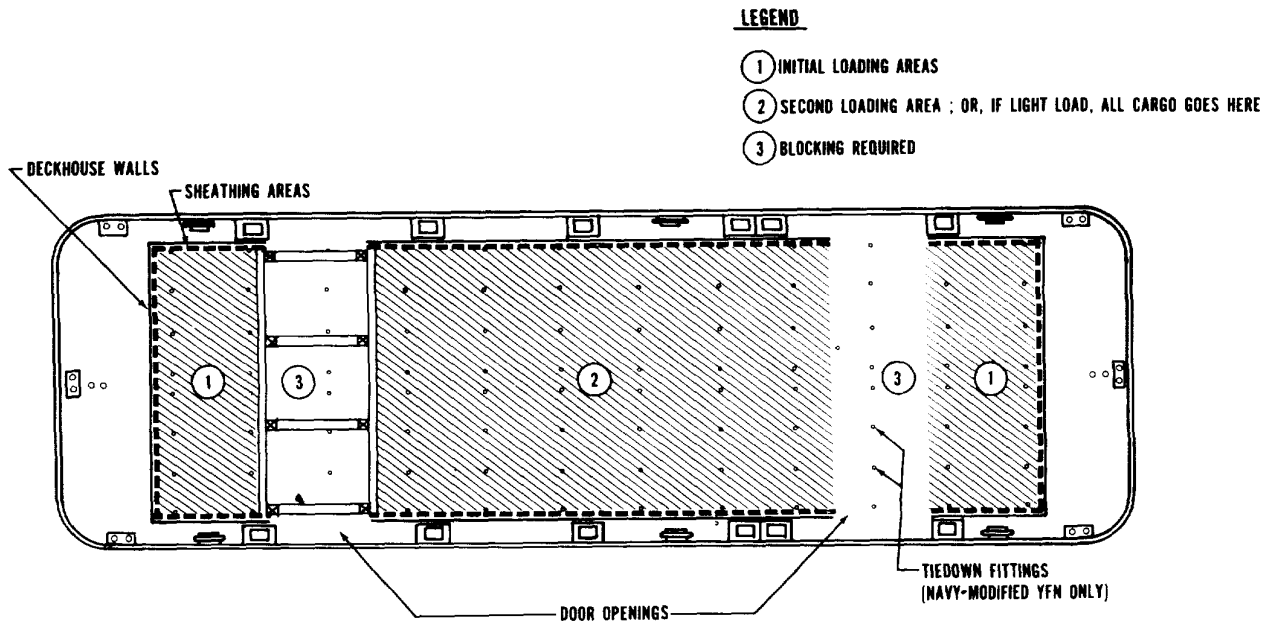


Figure 10-18. Sheathing and loading areas.



Figure 10-19. Interior of YFN (modified) during loading operations.

**APPENDIX A**  
**REFERENCES**

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**A-1. Department of Defense (DOD) Regulations**

4500.32-R (Vol II)      Military Standard Transportation and Movement Procedures (MILSTAMP).

**A-2. Army Regulations (AR)**

55-38                      Reporting of Transportation Discrepancies in Shipments (NAVSUPINST 4610.33C; AFR 75-18; MCO P4610.19D; DLAR 4500.15).

55-228                     Transportation by Water of Explosives and Hazardous Cargo.

55-355                     Military Traffic Management Regulation (NAVSUPINST 4600.70; AFM 75-2; MCO P4600.14A; DLAR 4500.3).

385-14                    Accident/Incident Report--Shipments of Conventional Explosives and Dangerous Articles by Commercial Carriers.

740-1                      Storage and Supply Activity Operations.

**A-3. Army Field Manuals (FM)**

55-15                      Transportation Reference Data.

55-17                      Terminal Operations Specialist's Handbook.

**A-4. Department of the Army Pamphlets (DA PAM)**

700-3                      When and How to Use SF-364 to Report Packaging Discrepancies.

**A-5. Other Publications**

a. *Code of Federal Regulations*, Title 46-Shipping, Part 146.

b. *Commercial Publications* National Design Specification for Stress-Grade Lumber and Its Fastenings, Washington, DC, National Forest Products Association, 1973.

APPENDIX B

GENERAL PROPERTIES OF DUNNAGE LUMBER

Table B-1 Properties of Structural Lumber Commonly Used in Dunnaging

Nominal size b(in.)h•	Standard dressed size b(in.)h•	Weight in pounds per linear foot (when weight of wood in pounds per cubic foot equals):					
		25	30	35	40	45	50
1 x 3	3/4 x 2½	0.33	0.39	0.46	0.52	0.59	0.65
1 x 4	3/4 x 3½	0.46	0.55	0.64	0.73	0.82	0.91
1 x 6	3/4 x 5½	0.72	0.86	1.00	1.15	1.29	1.43
1 x 8	3/4 x 7¼	0.94	1.13	1.32	1.51	1.70	1.89
1 x 10	3/4 x 9¼	1.20	1.45	1.69	1.93	2.17	2.41
1 x 12	3/4 x 11¼	1.47	1.76	2.05	2.34	2.64	2.93
2 x 3	1½ x 2½	0.65	0.78	0.91	1.04	1.17	1.30
2 x 4	1½ x 3½	0.91	1.09	1.28	1.46	1.64	1.82
2 x 6	1½ x 5½	1.43	1.72	2.00	2.29	2.58	2.87
2 x 8	1½ x 7¼	1.89	2.27	2.64	3.02	3.40	3.78
2 x 10	1½ x 9¼	2.41	2.89	3.37	3.85	4.34	4.82
2 x 12	1½ x 11¼	2.93	3.52	4.10	4.69	5.27	5.86
2 x 14	1½x 13¼	3.45	4.14	4.83	5.52	6.21	6.90
4 x 3	3½ x 2½	1.52	1.82	2.13	2.43	2.73	3.04
4 x 4	3½ x 3½	2.13	2.55	2.98	3.40	2.83	4.25
4 x 6*-	3½x 5½	3.34	4.01	4.68	5.35	6.02	6.68
4 x 8*	3½x 7¼	4.40	5.29	6.17	7.05	7.93	8.81
6 x 6-	5½ x 5½	5.25	6.30	7.35	8.40	9.45	10.50

• b = Breadth in inches of beam face opposed to or to which the force or load is applied.  
h = Height or depth in inches of beam face parallel with the direction of the action of the force or load.

\* \* Not recommended for general use.

Table B-2. Commercial Lumber Grading Associations and Publications

Association	Association abbreviation	General subject
Appalachian Hardwood Manufacturers, Inc. Walnut St Cincinnati, OH	AHMI	Grading rules for eastern hemlock 414 lumber
Redwood Inspection Service' 576 Sacramento Street San Francisco, CA	RIS	Grading rules for redwood lumber
National Hardwood Lumber Association 59 E. Van Buren St. Chicago, IL	NHLA	Grading rules for hardwoods, cypress, aromatic red cedar lumber
Northeastern Lumber Manufacturers Association 271 Madison Avenue New York, NY spruce,	NELMA	Grading rules for northern white pine, Norway pine, balsam fir lumber
Northern Hardwood and Pine Manufacturers Association Northern Building Green Bay, WI	NHPMA	Grading rules for eastern hemlock, tamarack, northern white pine, 207 Norway pine, jack pine, balsam fir, northern white cedar, eastern spruce lumber
Southern Cypress Manufacturers Association 2133 Kings Avenue Jacksonville, FL	SCMA	Grading rules for tidewater red cypress
Southern Pine Inspection Bureau <sup>2</sup> P.O. Box 1170 New Orleans, LA	SPIB	Grading rules for southern pine lumber
West Coast Lumber Inspection Bureau <sup>3</sup> 1410 S.W. Morrison St. Portland, OR	WCLIB	Grading rules for Douglas-fir (coast type), Sitka spruce, west coast hemlock, western red cedar lumber
Western Wood Products Association Yeon Bldg Portland, OR 97204	WWPA	Grading rules for ponderosa pine, 700 western larch, Douglas-fir, Engelman spruce, incense cedar, western red cedar, mountain hemlock, Idaho white pine, sugar pine, lodge-pole pine lumber
American Plywood Association 1119 A Street Tacoma, WA 98401	APA	Grading rules for softwood plywood

<sup>1</sup> Affiliated with the California Redwood Association.

<sup>2</sup> Affiliated with the Southern Pine Association.

<sup>3</sup> Affiliated with the West Coast Lumberman's Association.

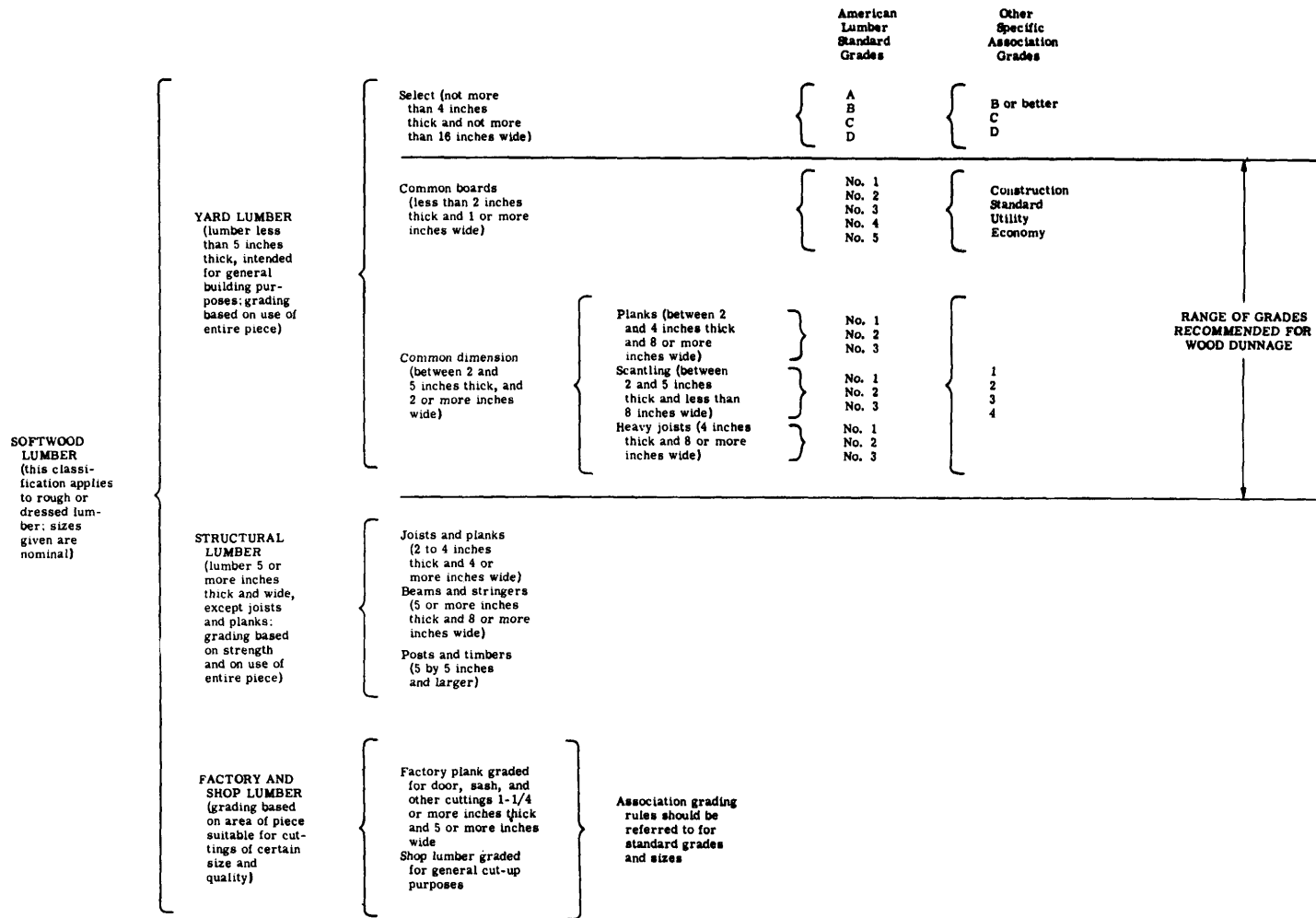


Figure B-1. General classifications of softwood lumber.



**Table B-3. Grouping of Species for Determining Allowable Loads for Nails and Screws**

Group	Wood species	Specific gravity (G) <sup>•</sup>
I	Ash, commercial white .....	0.62
	Beech .....	0.68
	Birch, sweet and yellow .....	0.66
	Hickory and pecan .....	0.75
	Maple, black and sugar .....	0.66
	Oak, red and white .....	0.67
II	Douglas fir-larch .....	0.51
	Southern pine .....	0.55
	Sweetgum and tupelo .....	0.54
III	Aspen, northern .....	0.42
	California redwood (close grain) .....	0.42
	Douglas fir south .....	0.48
	Eastern hemlock, tamarack.....	0.45
	Eastern spruce .....	0.43
	Hemlock, fir .....	0.44
	Idaho white pine .....	0.42
	Lodgepole pine .....	0.44
	Mountain hemlock .....	0.47
	Northern pine .....	0.46
	Ponderosa pine, sugar pine .....	0.42
	Red pine .....	0.42
	Sitka spruce .....	0.43
	Southern cypress .....	0.48
	Spruce, pine, fir .....	0.42
Western hemlock .....	0.48	
Yellow poplar .....	0.46	
IV	Aspen .....	0.40
	Balsam fir .....	0.38
	California redwood (open grain).....	0.37
	Coast sitka spruce and coast species .....	0.39
	Cottonwood, black .....	0.33
	Cottonwood, eastern .....	0.41
	Eastern white pine .....	0.38
	Engelman spruce .....	0.37
	Northern species .....	0.36
	Northern white cedar .....	0.31
	Subalpine fir .....	0.34
	Western cedars .....	0.36
Western white pine .....	0.40	

• Based on weight and volume when oven-dry.

APPENDIX C

TYPES AND CHARACTERISTICS OF COMMON NAILS AND WOOD SCREWS

Table C-1 Sizes of Common Wire Nails and Spikes

Pennyweight (d)	Length (in.)	Wire diameter (in.)	No/lb (approximate)
	<i>Nails</i>		
6	2	0.113	170
8	2½	0.131	95
10	3	0.148	65
12	3¼	0.148	60
16	3½	0.162	46
20	4	0.192	28
30	4½	0.207	20
40	5	0.225	17
50	5½	0.244	13
60	6	0.263	10
	<i>Spikes</i>		
10	3	0.192	NVAL
12	3¼	0.192	NVAL
16	3½	0.207	NVAL
20	4	0.225	NVAL
30	4½	0.244	NVAL
40	5	0.263	NVAL
50	5½	0.283	NVAL
60	6	0.283	NVAL

Table C-2. Sizes of Threaded, Hardened Steel-Type Nails

Pennyweight (d)	Length (in.)	Wire diameter (in.)
6	2	0.120
8	2½	0.120
10	3	0.135
12	3¼	0.135
16	3½	0.148
20	4	0.177
30	4½	0.177
40	5	0.177
50	5½	0.177
60	6	0.177

**Table C-3. Allowable Withdrawal Loads for Nails and Spikes-Normal Duration**

Allowable load in withdrawal in pounds per inch of penetra- into side grain of member holding point.

d=pennyweight of nail or spike, G=specification gravity of the wood based on weight and volume when oven-dry.

Specific gravity G	Size of common nail (d)										Size of threaded nail (d)•						
	6	8	10	12	16	20	30	40	50	60	30	40	50	60	70	80	90
.75	76	87				127	138	150	162	174	127	127	127	127	150		150
.68	60	69	78	78	85	101	109	119	128	138	101	101	101	101	119		119
.67	57	66	75	75	82	97	105	114	124	133	97	97	97	97	114		114
.66	55	64	72	72	79	94	101	110	119	128	94	94	94	94	110	110	110
.62	47	55	62	62	68	80	86	94	102	110	80	80	80	80	94	94	94
.55	34	39	44	44	49	57	61	67	73	79	57	57	57	57	67	67	67
.67																	
.54	32	38	42	42	46	54	58	64	70	75	54	54	54	54	64	64	64
.51	29	34	38	38	42	49	53	58	63	68	49	49	49	49	58	58	58
.48	25	29	33	33	36	42	46	50	54	58	42	42	42	42	50	50	50
.47	24	27	31	31	34	40	43	47	51	55	40	40	40	40	47	47	47
.46	22	26	29	29	32	38	41	45	48	52	38	38	38	38	45	45	45
.45	21	25	28	28	30	36	39	42	46	49	36	36	36	36	42	42	42
.44	20	23	26	26	29	34	37	40	43	46	34	34	34	34	40	40	40
.43	19	22	25	25	27	32	35	38	41	44	32	32	32	32	38	38	38
.42	18	21	23	23	25	30	33	35	38	41	30	30	30	30	35	35	35
.41	17	20	22	22	24	29	31	33	36	39	29	29	29	29	33	33	33
.40	16	18	20	20	22	27	28	31	33	35	27	27	27	27	31	31	31
.39	15	17	19	19	21	25	26	30	32	34	25	25	25	25	30	30	30
.38	14	16	18	18	20	24	25	28	30	32	24	24	24	24	28	28	28
.37	13	15	17	17	19	22	24	26	28	30	22	22	22	22	26	26	26
.36	12	14	16	16	17	21	22	24	26	28	21	21	21	21	24	24	24
.34	10	12	14	14	15	18	19	21	23	24	18	18	18	18	21	21	21
.31	9	10	12	12	13	15	16	18	20	21	15	15	15	15	18	18	18

• Loads for threaded, hardened steel nails, in 6d to 20d sizes, are the same as for common nails.

	SIZE OF COMMON SPIKE									
	10	12	16	20	30	40	50	60	5/16 in.	1/8in.
.75	127	127	138	150	162	174	188	188	205	250
.68	101	101	109	119	128	138	149	149	164	198
.67	97	97	105	114	124	133	143	143	158	190
.66	94	94	101	110	119	128	138	138	152	183
.62	80	80	86	94	102	110	118	118	130	156
.55	57	57	61	67	73	79	84	84	93	111
.54	54	54	59	64	70	75	81	81	88	106
.51	49	49	53	58	63	68	73	73	80	96
.48	42	42	46	50	54	58	62	62	69	83
.47	40	40	43	47	51	55	59	59	65	78
.46	38	38	41	45	48	52	56	56	62	74
.45	36	36	39	42	46	49	53	53	59	70
.44	34	34	37	40	43	47	50	50	55	66
.43	32	32	35	38	41	44	48	48	52	63
.42	30	30	33	35	38	41	45	45	49	59
.41	29	29	31	33	36	39	42	42	46	56
.40	27	27	28	31	33	36	39	39	42	51

Table C-3. (Continued)

SIZE OF COMMON SPIKE										
	10	12	16	20	30	40	50	60	5/16 in.	1/8in.
.39	25	25	26	30	32	34	37	37	40	48
.38	24	24	25	28	30	32	35	35	38	46
.37	22	22	24	26	28	30	33	33	36	43
.36	21	21	22	24	26	28	30	30	34	40
.34	18	18	19	21	23	24	26	26	29	35
.31	15	15	16	18	20	21	22	22	25	30

**Table C-4. Allowable Lateral Loads for Nails and spikes, Normal Duration**

Allowable lateral loads (shear) in pounds for nails and spikes penetrating 10 diameters in Group I species, 11 diameters in Group 11 species. 13 diameters in Group III species, and 14 diameters in Group IV species. into the member holding the point. d = pennyweight.

(For species in each group see table 13)	Size of common nail										Size of threaded nail.*							
	d=	6	8	10	12	16	20	30	40	50	60	30	40	50	60	70	80	90
Group I		78	97	118	116	132	171	191	218	249	278	171	171	171	171	218	218	218
Group II		63	78	94	94	107	139	154	178	202	223	139	139	139	139	176	176	176
Group III		51	64	77	77	38	113	128	144	165	182	113	113	113	113	144	144	144
Group IV		41	51	82	62	70	91	101	116	132	146	91	91	91	91	116	116	116

\* Loads for threaded, hardened steel nails, in 6d to 20d sizes, are the same as for common nails.

	Size of common spike										
	d=	10	12	16	20	30	40	50	60	5/16	3/8
GROUP I		171	171	191	218	249	276	306	306	357	469
GROUP II		139	139	155	176	202	223	248	248	289	380
GROUP III		113	113	128	144	165	182	202	202	238	310
GROUP IV		91	91	101	116	132	146	162	162	189	248

**Table C-5. Allowable Withdrawal Loads for Wood Renewals—Normal Duration. (See Table B3 for Species of Wood).**

Allowable load in withdrawal in pounds per inch of penetration of threaded part into side grain of member holding point.

g = gauge of screw. D = shank diameter in inches.  
G = specific gravity of the wood based on weight and volume when oven-dry.

Specific gravity	Size											
	g=	6	7	8	9	10	12	14	18	18	20	24
G	D=	0.138	0.151	0.184	0.177	0.190	0.218	0.242	0.288	0.294	0.320	0.372
.75		222	242	283	284	306	347	388	430	471	514	597
.68		182	199	218	233	251	285	319	353	387	422	490
.67		177	193	210	227	243	276	310	343	376	410	476
.66		171	188	204	220	238	268	300	333	365	397	461
.62		151	166	180	194	208	237	285	294	322	351	407
.55		118	130	141	152	164	186	208	231	253	275	320
.54		114	128	138	147	158	180	201	224	245	286	310
.51		102	112	121	131	141	160	179	199	218	237	276
.48		91	99	108	118	125	142	159	176	193	210	244
.47		87	95	103	111	120	136	152	169	185	201	234
.46		83	91	99	107	115	130	146	162	177	193	224
.45		80	87	95	102	110	125	140	155	170	185	215
.44		76	83	91	97	105	119	133	148	162	177	205
.43		73	80	86	93	100	114	127	141	155	169	196
.42		69	76	82	89	95	109	121	135	148	161	187
.41		66	72	79	85	91	103	116	128	141	153	178
.40		65	71	77	83	89	102	113	126	138	151	175
.39		61	66	72	78	84	95	106	118	130	141	164
.38		57	62	67	73	78	89	99	110	121	132	153
.37		54	59	64	69	74	84	94	104	115	125	145
.36		51	56	60	65	70	80	89	99	109	118	137
.34		46	50	54	58	63	71	80	88	97	105	123
.31		38	42	45	48	53	59	67	73	81	88	103

Approximately two-thirds of the length of a standard wood screw is threaded.

**Table C-6. Allowable Lateral Loads for Wood strews—Normal Duration**

Allowable lateral loads (shear) in pounds for screws embedded to approximately 7 times the shank diameter into the member holding the point. For less penetration, reduce loads in proportion. Penetration should not be less than 4 times the shank diameter.

(For species in each group see table B 3)	Size of screw											
	g=	6	7	8	9	10	12	14	16	18	20	24
	D=	0.138	0.151	0.164	0.177	0.190	0.216	0.242	0.288	0.294	0.820	0.372
	7D=	9.66	1.057	1.148	1.239	1.330	1.512	1.894	1.878	2.058	2.240	2.804
	4D=	.552	.604	.656	.708	.760	.864	.988	1.072	1.176	1.280	1.488
Group I	=	91	109	129	150	173	224	281	345	415	492	664
Group II	=	75	90	106	124	143	185	232	284	342	406	548
Group III	=	62	74	87	101	117	151	190	233	280	332	448
Group IV	=	48	58	88	79	91	118	148	181	218	258	349

## APPENDIX D SHIP CHARACTERISTICS

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### D-1. Purpose

This appendix provides a summary of the current US flag merchant fleets available for the transport of breakbulk ammunition and explosives. Since the stowage procedures described in this manual are developed for general classes of ships and explosives cargo, it is desirable that the user recognize the fundamental differences between the classifications. It is not the intent of this appendix to provide specific shiploading diagrams for individual compartments of various designs of ships. Diagrams and other detailed information of this type are available from the Military Sealift Command, Washington, DC, or the Maritime Administration.

### D-2. General

a. Table D-1 lists the average characteristics of the current US flag breakbulk fleet. The merchant dry cargo vessels most frequently used for shipping military ammunition and explosives from military loading activities are C3 and C4 types. Not all types are configured solely for breakbulk cargo. Certain C3, C4, and C5 vessels have been modified from full breakbulk vessels to partial container ships while retaining some breakbulk capacity. Vessels known as ex-C4-types are encountered commonly; however, most of these vessels have been modified extensively, usually to full container ships. Most V2 (Victory) and EC (Liberty) vessels are currently in reserve fleets; V3 hulls are encountered infrequently. However, it is emphasized that obsolete or reserve-type ships are still encountered at ammunition terminals, usually under foreign flag.

D-1



Table D-1 Average Characteristics of Principal Types of UB Flag Break-bulk Dry Cargo Merchant Ships

Maritime Administration design	Design	No. of holds	Breadth (ft)	Length overall (ft)	Speed (knots)	Deadweight (tons)	Dry cargo capacity (thousands cu ft) bale	Remarks
C882	C8-S 82a	...	106	874	20.0	27050	1774	SEABEE
C881	C8—S-81b	6	100	820	22.5	29820	1516	LA8B
C575	C5-8-75a	7	82	605	20.8	22208	1018	Pt cont/S <sup>a</sup>
C537	C5~37e	5	69	592	17.4	14286	790	Pt cont/S
C466	C4-S 66a	6	76	540	20.0	18808	750	
C485	C4-S 65a	7	61	560	20.0	12699	480	Pt cont/S
C464	C4 S-64a	6	75	544	21.0	13264	504	Pt cont/S
C460	C4-S-60a	6	75	551	21.0	12763	577	Pt cont/S
C458	C4-S-58a	7	75	572	20.0	12728	680	
C457	C4-S-57a	6	75	561	21.0	18585	572	
C41a	C4-S-1a	7	76	564	20.0	13498	786	
C41u	C4-8-lu	6	76	565	20.0	14349	678	
C4	C4-S B5	7	72	520	17.0	15371	712	Reserve fleet
C376	C3-S-76a	6	70	522	18.6	11150	603	
C346	C3-S-46a	6	73	493	18.5	12629	668	Pt cont/S: Cont/S <sup>b</sup>
C343	C3-S-43a	7	70	506	18.0	18116	682	
C338	CS-S-38a	6	78	493	18.5	10967	575	
C837	C3-S-37c	5	69	495	18.0	11SS6	565	
C8S7	C8-8-37d	5	69	495	18.0	11867	546	
C333	C3-S-33a	5	66	463	18.0	12402	425	
C3	CS-S-A2	5	70	492	16.5	1234S	672	
C2A5	C2-S-AJ5	5	63	459	15.5	10497	449	
C1A	C1A	5	60	412	14.0	7992	446	Reserve fleet
C1B	C1B	5	60	418	14.0	9381	487	Reserve fleet
V2	VC2-S-AP2	5	62	455	15.5	10700	458	Reserve fleet
V3	VC2-S AP3	5	62	455	16.5	10700	45S	Majority in reserve
EC2	EC2~C1	5	57	442	11.0	10750	459	Reserve fleet

a Pt cont/S Partially configured for containers, self-sustaining.  
 b cont/S Substantially configured for containers, nonself-sustaining.

The Military Sealift Command Ship Register, published semiannually by Commander, Military Sealift Command (MSC), Washington, DC 20390, shows the principal characteristics of United States Navy Ships operated by MSC that are commonly used for carrying ammunition and explosives.

b. A major difference between the victory hull and the C hull is the use of deep tanks in the latter for cargo stowage. As shown in figures D-1 and D-2, access to the deep tanks in the C2 and C3 hulls is provided through deep-tank hatches that are large enough to accommodate unit loads of ammunition. However, space in the deep tank of hold number 4 is restricted greatly by the shaft alley that bisects this hold. Deep tanks aboard the victory hulls are not used for cargo stowage; and, therefore, the shaft alley presents no obstruction to stowage operations. Figures D-3 and D-4 illustrate the newer, more common C3 and C4 hulls.

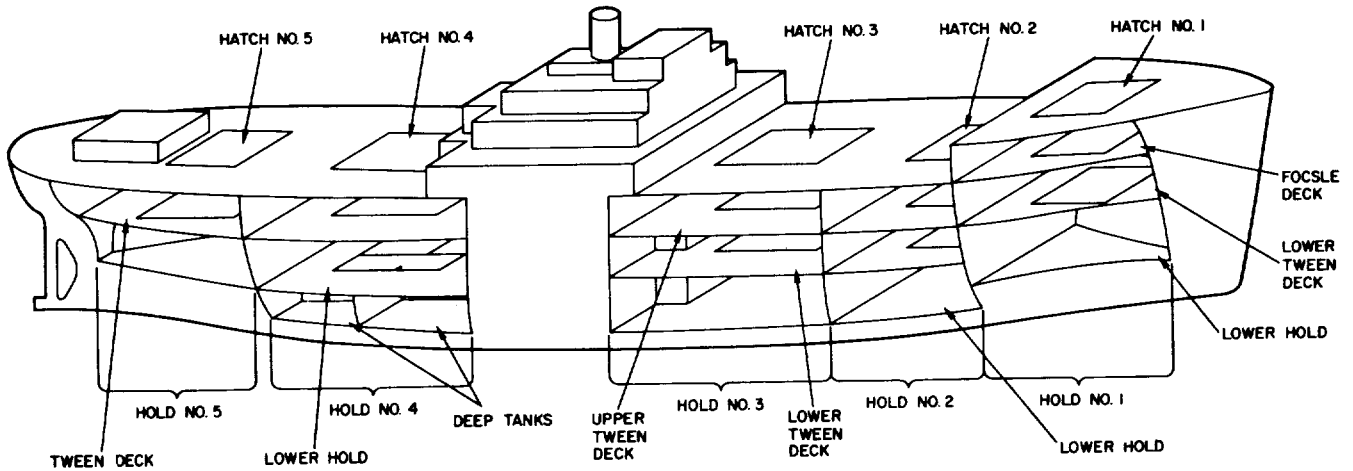


Figure D-1 VC2 (Victory) hull configuration.

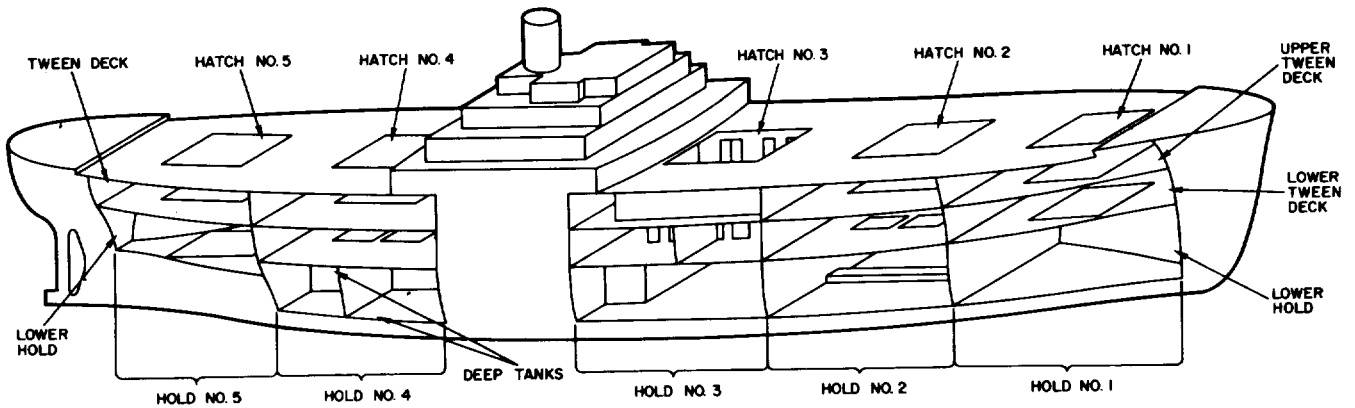


Figure D-2. C2 hull configuration.

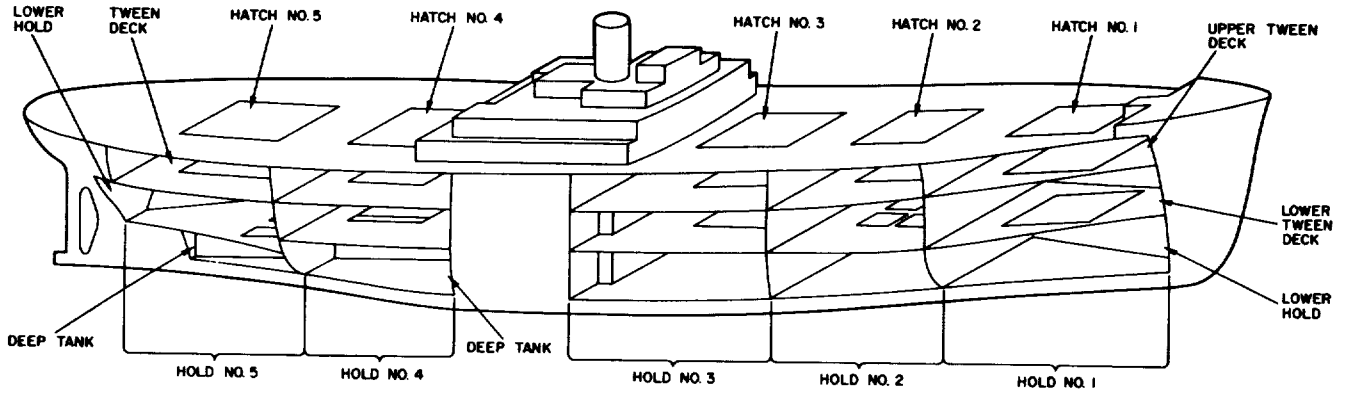


Figure D-3. C3 hull configuration

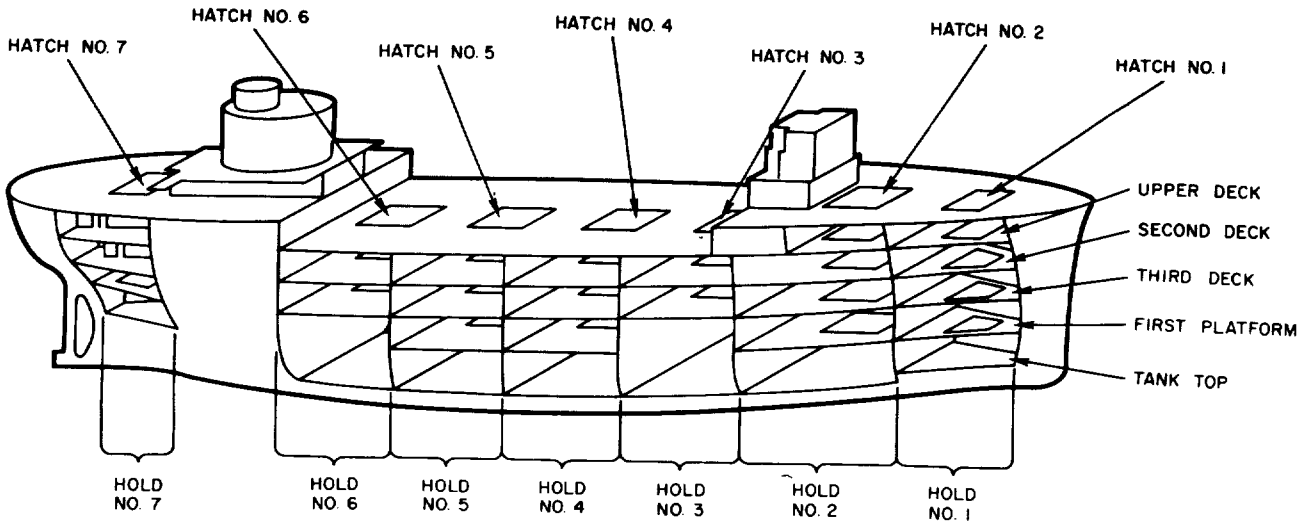


Figure D-4. C4 hull configuration.

c. Other merchant ships used for the transport of break-bulk ammunition include those of the C8 class, or barge carriers. The lighters are lifted aboard the mother ship and secured for ocean transport. Characteristics of typical LASH (lighteraboard-ship) lighters are listed in table D-2. Detailed ammunition-stowage procedures for lighters are presented in chapter 10.

**Table D-2. Characteristics of Typical Commercial Steel LASH Lighters**

Barge Type: three hatch covers (removable)	Dimensions		
	ft	in.	m
Length overall, outside .....	61	06.0	18.75
Beam, outside .....	31	02.0	9.50
Interior length of hold .....	59	09.0	18.21
Interior width of hold .....	29	05.0	8.97
Interior depth under pontoons .....	11	08.0	3.56
Interior depth under deck, fore and aft.....	10	02.0	3.10
Clear hatch opening length .....	43	11.0	13.39
Clear hatch opening width .....	29	05.0	8.97
Light draft, saltwater .....	1	10.5	0.57
Light draft, fresh water .....	1	11.0	0.58
Full load draft, salt water .....	8	07.5	2.63
Full load draft, fresh water .....	8	10.0	2.69
	Weight		
	STON	LTON	MT
Empty barge without covers .....	78.0	69.6	70.8
Each hatch cover .....	3.0	2.7	2.7
Total of barge and covers .....	87.0	77.7	78.9
Maximum allowable (lifting) .....	500.0	446.0	453.6
Cargo carrying capacity .....	413.0	368.7	374.7
Bale capacity of barge .....	19,500 cu ft		552.24 cu m
Grain capacity of barge .....	19,800 cu ft		560.74 cu m
	lb/sq in.		kg/sq m
Maximum on hatch covers .....	35		7.2
Maximum on bottom deck .....	750		153.6
Maximum of forklift allowable on bottom of barge .....	14,000 lb		6,350.3 kg

APPENDIX E

SHIP'S CARGO-HANDLING GEAR

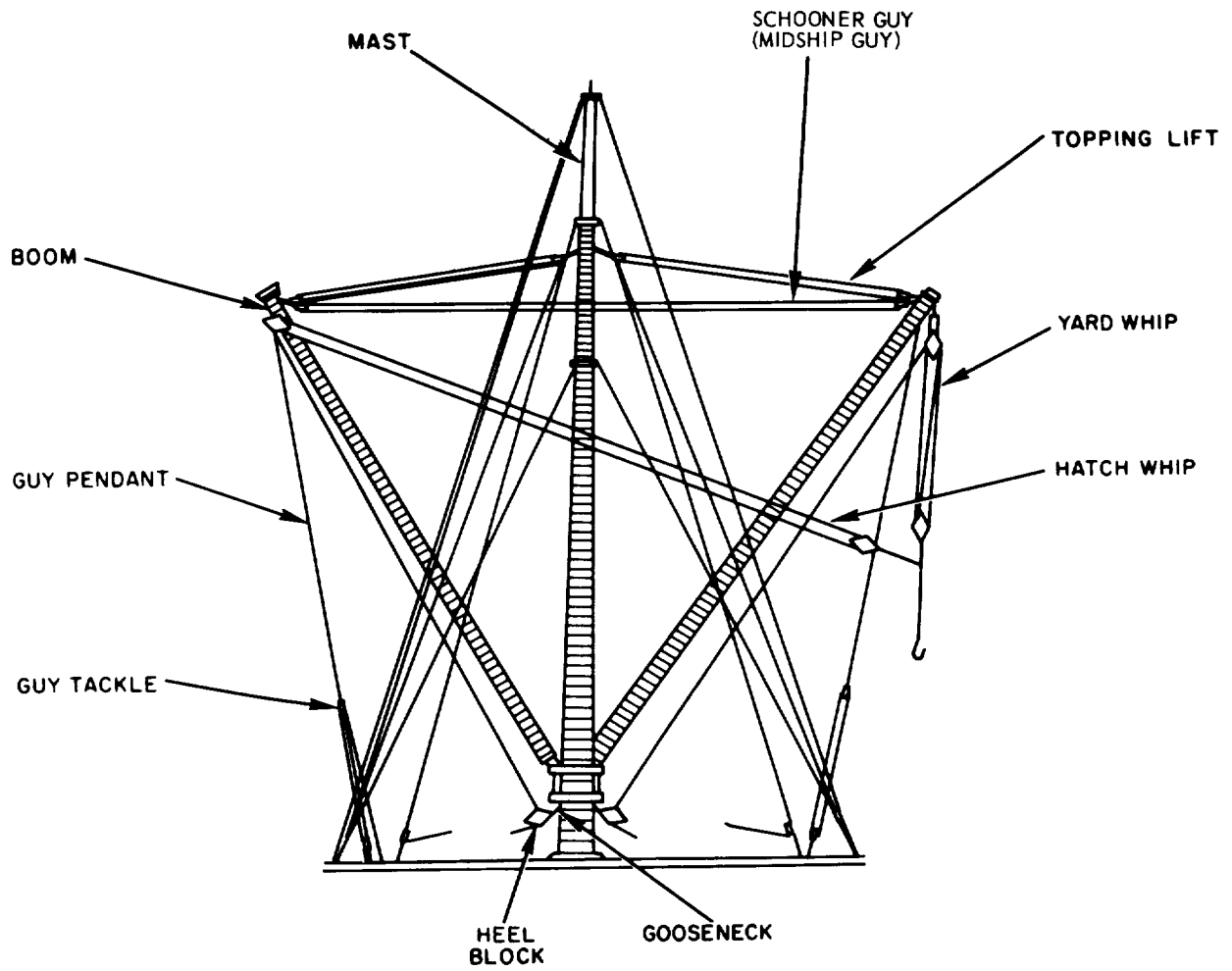


Figure E-1. Typical mast rigging.

E-1

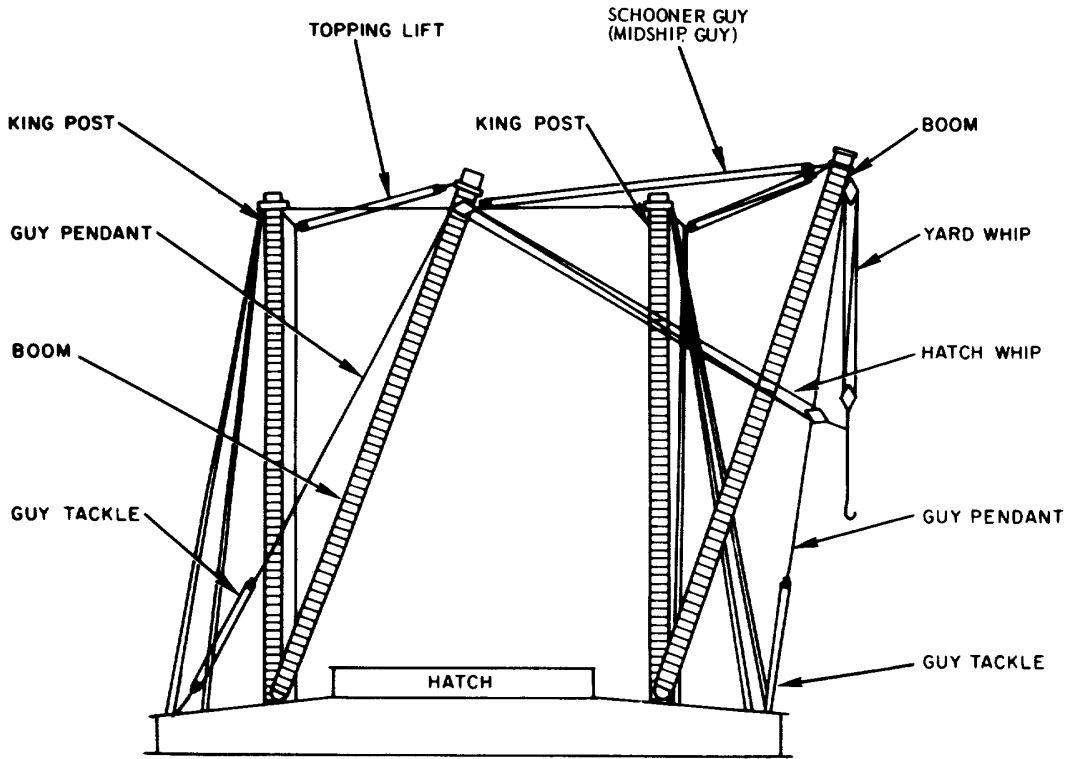


Figure E-2. Typical kingpost rigging.

Table E-1 Ship's Cargo-Handling Gear Inspection

Gear	Item inspected
Booms .....	Not bent or severely dented Gooseneck free Topped up by ship Positioned to highest angle for minimum stress, yet does not hamper cargo loading/off-loading
Topping lifts .....	Wires without flat spots, broken wires, kinks, or suspected weak spots Bull chain secured to deck with shackle and shackle pin seized Bull chain in visibly good condition Swaged sockets in visibly good condition Bull wire secured to cleat
Vang guys .....	Manila line: Minimum circumference of 3.5 inches Free of frayed areas Reeved without overlays Eyes have thimbles, splices have minimum of three tucks and show no evidence of parting Not twisted and no evidence of dry rotting (reject if dry rotting is evident) Adequate length for position of boom No short or long splices Blocks: Cheeks free of cracks, breaks, burrs Sheaves free to turn Sheaves free of visible cracks, breaks, burrs or gouges Attached to pendants with shackle and shackle pin seized

Table E-1 (Continued)

Gear	Item inspected
	Pendants: Thimbles placed in eyes Splices or fittings forming eyes not wrapped, but open for constant inspection Free of kinks, broken wires, flat spots, or suspected weak spots Mechanical fittings in good visible condition Secured to bulwark in such a manner as to produce minimum stress on guy and prevent boom from jack-knifing All slack removed Secured to bulwark by D ring Shackle pins seized Bitter end made up on cleat, and excess line neatly made up
Preventers .....	Secured to head of boom so as not to chafe on head block, shackles Free of kinks, broken wires, flat spots, or suspected weak spots Minimum diameter of 3/ inch Eye for securing to bulwark formed with minimum of four rope clips Properly secured to bulwark, shackle seized Slacked to allow vang guy to stretch, yet share load Tails, fittings, or other means of making preventer fast on deck or bulwark are of strength equal to that of preventer itself
Schooner or midship guy ....	All slack removed Free of frayed or worn areas Made up and secured to cleat Line of sufficient length and minimum circumference of 3.5 inches
Heel block .....	Running free Secured so as not to fall when runner is slack Runner will not chafe on cheeks Attachments in visibly safe condition Preventer installed on heel block
Runners/whips/falls	Free of kinks, broken wires, flat spots, or suspected weak spots Secured to winch drum with clamps, "U" bolts, shackles, or some equally strong method All splices uncovered Secured to safety cargo book with two wire-rope clamps Minimum of five turns remaining on drum when cargo hook is in lower hold and on the pier No chafing on any standing rigging or other parts that cause excessive wear Reeved on drums so as to follow winch control levers Reeves through blocks properly Minimum diameter of 3/4 inch
Winches .....	Controls work freely and provides control at all speeds; levers are secured to shafts Surrounding area free of grease and oil Moving parts that present hazards have installed guards No apparent electrical hazards visible
General items .....	All wire-rope clips installed with "U" section in contact with dead end of wire Gantlines, rags are clear of running gear "Save all" nets rigged at each hatch All screw-pin shackles properly seized

## GLOSSARY

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- Bearer*-Lumber laid on the deck, under the ends of vertical uprights (studs), to receive and distribute the vertical load to the deck.
- Blocking*-The installation of solid pieces of wood, or blocks, to a deck, bulkhead, or overhead so that they bear directly against cargo in such a manner that free movement of the cargo in a given direction is restricted.
- Boarding*-The cargo-bearing surface of bulkhead or securing structure.
- Brace*-A structural member used to transmit, divert, or resist weight or pressure.
- Bracing*-The installation of a wooden structure so that it extends from a deck, bulkhead, or overhead and bears directly against the cargo to restrict the free movement of the cargo in a given direction.
- Bulkhead*-1. Permanent structural steel partitions separating compartments on a ship. 2. Wooden partitions constructed athwartships to subdivide a compartment or to separate cargo from structural end bulkheads.
- Bull chain*-Chain used for securing topping lift tackle.
- Bull wire*-Wire rope used for operating topping lift tackle.
- Camber*-As related to securing practices, the hull curvature fore and aft as viewed from above; not to be confused with the technical definition (that is, the convex curvature of a deck athwartship).
- Cleat*-A secondary member that is added to reinforce, hold in position, or provide additional support to primary dunnage members. Used mostly with bracing and as horizontal members attached to strip sheathing to support the ends of stripping laid over stowage.
- Crew*-A subdivision of a contract labor gang that performs a single function of the loading operation.
- Decking*-General term for dunnage laid over metal ship's decking to protect the cargo; also termed flooring.
- Diagonal*-Wood bracing placed at an angle.
- Draft*-Any load or combination of loads hoisted into or out of a vessel in a single lift.
- Dunnage*-The lumber (blocks, braces, bulkheads, decks, encasements, frames, jacks, magazines, sheathing, and stripping) and lashing gear used to secure cargo for the purpose of preventing damage during transport; also referred to as securing material.
- Dunnaging*-The process by which military explosives are effectively blocked, braced, and tommed aboard merchant-type vessels; also known as securing.
- Face board*-Boarding affixed to bulkheads, block-shoring structures, or other securing structures to provide a bearing surface for the cargo.
- Factory and shop lumber*-One of the three main classes of softwood lumber, consisting of lumber intended to be cut for use in further manufacture. It is graded on the basis of the percentage of the area that will produce a limited number of cuttings of a specified or a given minimum size quality.
- Falls*-The part of tackle that is made up of wire cable.
- Fillers*-Small pieces of lumber used to fill small spaces throughout the load to obtain a tighter stow.
- Flooring*-Dunnage lumber laid over the ship's metal deck to protect the cargo; also termed decking.
- Force*-A group of personnel that is organized to perform a specific type of operation, usually including both military personnel and gangs of contract laborers, as required.
- Gang ((carpenter) blocking/bracing)*-A group of from 6 to 20 contract laborers with a header, whose primary function is to secure the cargo.
- Gang (loading and stowing)*-A group of about 16 to 20 contract laborers usually consisting of breakout men, dock men, winchmen, and a hold man.
- Gang (Civil Service)*-A group of about 16 to 20 personnel usually consisting of ordnance men, blockers and bracers, winchmen, riggers, and signalmen whose job is to load, stow, and dunnage the cargo.
- Gantline*-Light, general-purpose ropes, such as top-mast gantline, that is used to support a man in a bosun chair, to send gear aloft, or for other such jobs.
- Guy pendant*-A pendant that connects the head of a boom with a guy tackle and serves to shorten the length of the guy tackle.
- Hatch*--An opening in the weather deck and in all decks below in the same vertical plane through which cargo is passed.
- Header*-1. Lumber placed between the tops of vertical uprights (studs) and the overhead. 2. Individual in authority over a single contract labor gang.



- Heel block*-A block located at the foot of a boom and fastened to a mast or kingpost. One of the blocks through which the main cargo falls is reeved.
- Hold*-A space allotted entirely to the carriage of cargo bounded by permanent steel bulkheads, decks, and the shell of the ship. Deck openings are provided with a means of effectively closing the hold against the weather, and for closing off each hold. The compartment above the deep tanks is termed the lower hold.
- Jacks*-Structures placed along the ship's bulkhead to support boarding in bulkhead construction.
- Kickers*-Primarily, relatively short lengths of lumber nailed in a horizontal position and spaced between uprights, or uprights and permanent ship's structures, to add rigidity and strength to dunnage structures.
- Lacers*-Long lengths of narrow-width lumber laid across and nailed to a series of braces or kickers in a symmetrical dunnage structure to maintain the position of the braces or kickers, and thus the integrity of the structure.
- Lading*-The load or cargo being shipped.
- Layer*-A course or stratum of the lading parallel to the deck of the vessel that is one container or unit load high.
- Leader*-Individual in authority over a single Civil Service gang.
- Machinefloor*-A full double-layer floor of 2-inch lumber installed over a tier or tiers of cargo on which MHE or heavy equipment may be driven for stowage of cargo; see also "tier deck."
- Overstow*-Any individual item of cargo, or, in general, all items of cargo emplaced above the lower layer(s) of stowage, in a particular compartment or stowage area. (Not to be confused with double handling in port rotation.)
- Pallet*-A platform or skid on which lading is placed and secured that is used to facilitate handling of small commodities by materials handling equipment.
- Pendant*-Short line or wire having an eye spliced in each end. Pendants are usually named according to use, such as guy pendant.
- Preventers (guys and stays)*-Heavy wire ropes used to supplement the regular guys and stays as a safety precaution when handling heavy cargo.
- Reeve*--To pass rope or wire rope around the sheaves of a block or the drum of a winch.
- Rib*-Any of the curved crosspieces extending from the keel to the top of the hull in a ship, thereby forming its framework.
- Row*-Unit loads usually extending athwartships one load in width.
- Scantling*-Softwood yard lumber graded as common dimension because of its size; that is, from 2 inches to under 5 inches thick and less than 8 inches wide; also, a general term applied to the vertical uprights (studs) of these lumber sizes that are used in dunnage structures such as magazines.
- Schooner guy*-Also called midship guy and span guy. The tackle that spans the ends of two booms.
- Securing*-The process by which military explosives are effectively blocked, braced, and tommed aboard cargo vessels; also known as dunnaging.
- Securing material*-The lumber (blocks, braces, bulkheads, decks, encasements, frames, jacks, magazines, sheathing, and stripping) and lashing gear used to secure cargo for the purpose of preventing damage during transport; also referred to as dunnage.
- Securing structure*-General term for dunnaging structures not otherwise classified as bulkheads, magazines, encasement, or decking.
- Sheathing*-1. The wood covering, solid or stripped lumber or plywood, placed over the studding in magazine interiors. 2. The vertical risers nailed to the sweatboards for protection of the stow or to permit attachment of the appropriate securing structure.
- Sheer angle*-As related to dunnaging practices, the angle produced at a given location by the upward curve of a vessel's sides from keel to main deck. This is not to be confused with the technical definition: the angle produced at a given location by the fore-and-aft curvature from bow to stern of a ship's deck, as viewed from a side elevation.
- Shoring*-The securing of cargo so that it cannot move sideways or downward. Compare with "tomming."
- Skin (of ship)*-The plates of a ship; the side of the hull.
- Sleeper*-A plank of board nailed to decking and bearing against the base of a dunnage structure so that movement of the structure toward the plank is blocked.
- Spacers*-Lengths of lumber secured between unit loads or containers to create sufficient space to prevent their chafing together.
- Spotting*-The positioning of cargo at points along the berth adjacent to the ship's hatches to permit handling by shipboard cranes.

*Square of the hatch*-The hatch opening.

*Stiffeners*-The vertical metal columns employed in the ship's structure to stiffen a permanent bulkhead.

*Stringers*-Long lengths of wide lumber connecting and supporting uprights in a frame to maintain the integrity of the structure.

*Stripping*-Lumber laid over the stow for protection from the overstow.

*Strip sheathing*-The vertical risers nailed to the sweatboards for protection of the stow and to permit attachment of the appropriate dunnage structure.

*Structural lumber*-One of the three main classes of softwood lumber. It is graded on the basis of strength and its intended use in applications.

*Sweatboards*-Lumber running horizontally and mounted in hangers along the skin of the ship to protect cargo from contact with moisture or sweat, which condenses on the interior of the hull; also termed sweatbattens.

*Tier*-A course or stratum of unit loads parallel to the deck and one unit load in height. The first tier (or bottom tier) is the tier of unit loads stowed on the deck.

*Tier deck*--A full floor capable of supporting forklift equipment installed to facilitate stowage of additional cargo; also termed "machine" floor at certain shiploading activities.

*Tomming*-The securing of cargo so that it cannot move upwards. Compare with "shoring."

*Topping lift*--Tackle that supports the head of a boom.

*Void*-Spaces between units of cargo in stowage and between units of cargo and ship's structure.

*Void table*-Prefabricated structure used in voids for supporting load above.

*Whaler*-Length of board fastened to a series of uprights on the side opposite the load-bearing surface for the purpose of stiffening and aligning the structure.

*Whips*-The portion of the cargo-hoisting falls that fastens to the cargo hook and is usually identified as either the yard whip or the hatch whip. The yard whip is on the inshore boom; the hatch whip is on the offshore boom.

*Wings*-The outboard area of the ship's compartment near the hull.

*Yard lumber*-One of the three main classes of softwood lumber. It consists generally of lumber that is less than 5 inches in thickness and that is intended for general building purposes.

**GLOSSARY-3**

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