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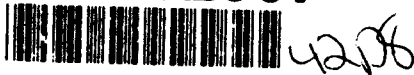
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FINAL REPORT  
AUGUST 1991

REPORT NO. 91-19

21C FIBER DRUM  
RAIL IMPACT TEST

93-02007



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Prepared for:  
U.S. Army Defense Ammunition  
Center and School  
ATTN: SMCAC-DET  
Savanna, IL 61074-9639

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VALIDATION ENGINEERING DIVISION  
SAVANNA, ILLINOIS 61074-9639



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## REPORT DOCUMENTATION PAGE

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| 1a. REPORT SECURITY CLASSIFICATION<br><b>UNCLASSIFIED</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |                                                   | 1b. RESTRICTIVE MARKINGS                                                          |                                                       |                                 |
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| 11. TITLE (Include Security Classification)<br>21C Fiber Drum Rail Impact Test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                                                   |                                                                                   |                                                       |                                 |
| 12. PERSONAL AUTHOR(S)<br>A.C. McIntosh, Jr.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |                                                   |                                                                                   |                                                       |                                 |
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| 16. SUPPLEMENTARY NOTATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |                                                   |                                                                                   |                                                       |                                 |
| 17. COSATI CODES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |                                                   | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |                                                       |                                 |
| FIELD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | GROUP | SUB-GROUP                                         |                                                                                   |                                                       |                                 |
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| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)<br><br>The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to test a loading and bracing procedure for nitroguanidine packed in 15.5"-diameter by 24.4"-high Department of Transportation (DOT) 21C fiber drums in a 50'-6"-long boxcar. Inert test samples of the DOT 21C drums were fabricated and loaded into the boxcar. The boxcar was then tested IAW TP-91-01, Transportability Testing Procedures, July 1991, for rail impacts at 4, 6, and 8.1 miles per hour (mph) in the forward direction and 8.1 mph in the reverse direction. The load was inspected after each impact for movement and damage to the cargo. Lid undercutting and drum compaction were observed at all impact speeds. Drum failure occurred at 8.77 mph. After impacting, the test load was removed from the boxcar and inspected for damage. It was noted by the observers that the drum samples had (continued) |       |                                                   |                                                                                   |                                                       |                                 |
| 20. DISTRIBUTION / AVAILABILITY OF ABSTRACT<br><input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> OTC USERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |                                                   | 21. ABSTRACT SECURITY CLASSIFICATION<br><b>UNCLASSIFIED</b>                       |                                                       |                                 |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>JEROME H. KROHN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |                                                   | 22b. TELEPHONE (Include Area Code)<br>815-273-8929                                |                                                       | 22c. OFFICE SYMBOL<br>SMCAC-DEV |

19. ABSTRACT (continued).

a soft fill. The real product has a hard fill which adds to the load's ability to eliminate or reduce the amount of compaction. As a result of testing, the load design failed due to incorrect sample preparation. The test samples will be rebuilt and retested, if requirement for approval still exists.

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL  
VALIDATION ENGINEERING DIVISION  
SAVANNA, IL 61074-9639

REPORT NUMBER 91-19

21C FIBER DRUM RAIL IMPACT TEST

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## PART 1

### INTRODUCTION

A. **BACKGROUND.** The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Transportation Engineering Division (SMCAC-DET), to test a loading and bracing procedure for nitroguanidine packed in 15.5"-diameter by 24.4"-high Department of Transportation (DOT) 21C fiber drums in a 50'-6"-long boxcar. Inert test samples of the DOT 21C fiber drums were fabricated and loaded into the boxcar. The boxcar was then tested IAW TP-91-01, Transportability Testing Procedures, July 1991, for rail impacts at 4, 6, and 8.1 miles per hour (mph) in the forward direction and 8.1 mph in the reverse direction.

B. **AUTHORITY.** This test was conducted IAW mission responsibilities delegated by U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL 61299-6000. Reference is made to Change 4, 4 October 1974, to AR 740-1, 23 April 1971, Storage and Supply Activity Operations; AMCCOMR 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. **OBJECTIVE.** The objective of this test was to test the loading and bracing in a 50'-6"-long boxcar of nitroguanidine packed in 15.5"-diameter by 24.4"-high DOT 21C fiber drums to TP-91-01, Transportability Testing Procedures, July 1991.

D. **CONCLUSION.** Rail impacting the boxcar loaded with 876 DOT 21C fiber drums at 4, 6, and 8.1 mph in the forward direction caused the load to compact 36 inches. The 36-inch displacement was measured at the center line of the boxcar, from the end of the load to the plywood liner in the nonimpact end of the car. Drum lids had undercut into adjacent drums in the direction of impact. Load compaction occurred after each impact.

After reverse impact at 8.1 mph, the load compacted 30 inches from the end wall opposite the impact end of the railcar. That is, the 36-inch displacement at the impact end of the boxcar was closed, and a 30-inch displacement opened up at the nonimpact end of the boxcar. Drum side walls were crushed at three stacks from the impacted end walls.

E. RECOMMENDATION. It is recommended that the DOT 21C fiber drums be rebuilt to resemble the actual product's physical characteristics and the rail impact test be redone, if an approved loading and bracing method is still required.

## **PART 2**

### **ATTENDEES**

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## PART 3

### TEST PROCEDURES

A. Rail impact testing is accomplished to assure regulatory compliance IAW previously approved and standardized procedures. This test was performed using inertly-loaded items which were equal in weight, correctly located at the center of gravity, and general in character to the material ultimately shipped.

B. The test load or vehicle was positioned in/on a railcar. For containers, the loaded container was positioned on a container chassis and securely locked in place using the twist locks at each corner. The container chassis was secured to a railcar. Equipment needed to perform the test included the specimen (hammer) car, five empty railroad cars connected together to serve as the anvil, and a railcar locomotive. These anvil cars were positioned on a level section of track with air and hand brakes set with the draft gear compressed. The locomotive unit pulled the specimen car several hundred yards away from the anvil cars and, then, pushed the specimen car toward the anvil cars at a predetermined speed, disconnected from the specimen car approximately 50 yards away from the anvil cars, and allowed the specimen car to roll freely along the track until it struck the stationary anvil cars. This constituted an impact.

C. Impacting was accomplished at speeds of 4 and 6 mph and at least 13 km (8.1 mph) in one direction and at a speed of at least 13 km (8.1 mph) in the opposite direction. The 4 and 6 mph impact speeds were approximate; the 8.1 mph speed was a minimum. Impact speeds were determined by using an electronic counter to measure the time required for the specimen car to traverse an 11-foot distance immediately prior to contact with the anvil cars.

D. INSPECTION AND DATA COLLECTION. At selected intervals during testing, thorough inspections of the specimen loads were made by the technically proficient personnel to collect

data on the specimen load and equipment resulting from the above test load steps. This data are recorded in part 4, following.

**PART 4**

**TEST RESULTS**

## TEST SPECIMEN AND RESULTS

### RAIL IMPACT DATA

Test No.: 1

Date: 30 JULY 1991

Specimen Load: 21C FIBER DRUM RAIL IMPACT TEST.

Boxcar No.: RBOX 39060

Lt. Wt.: 62,900 lbs.

Load and Lading:

Wt.: 49,154 lbs.

Total Specimen Wt.: 112,054 lbs.

Buffer Car (five cars) Wt.: 250,000 lbs.

| <u>Impact</u> | <u>End Struck</u> | <u>Velocity</u><br>(mph) | <u>Remarks:</u>                                                                                                                         |
|---------------|-------------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1             | A                 | 4.47                     | Load shifted 6-3/4 inches from non-impact end of car.<br>Undercutting of drum lids in the top layer.                                    |
| 2             | A                 | 6.63                     | Load shifted to 20-1/4 inches from non-impact end of boxcar.<br>Center gate shifted 6-1/2 inches from first impact. No punctured drums. |

| <u>Impact</u> | <u>End Struck</u> | <u>Velocity</u><br>(mph) | <u>Remarks:</u>                                                                                                                                                                    |
|---------------|-------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3             | A                 | 8.77                     | Load shifted to 27-1/2 inches from non-impact end of boxcar.<br>Center gate shifted 7-1/2 inches from the second impact. Some drums were partially crushed.                        |
| 4             | B                 | 9.14                     | Load closed standoff from previously non-impacted end.<br>No drums ruptured. Some damaged enough to permit the product to leak out. Center gate moved 32 inches from third impact. |

**Note:** Due to lid undercutting and drum deformation, this transportation configuration is unsatisfactory. New test samples need to be fabricated to resemble the actual material.

**PART 5**

**PHOTOGRAPHS**



|  |                                                              |
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|                                                                                                                                                                                                                      |
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| Photo No. A0317-SPN91-288-4628. This photo shows the compaction offset after a rail impact. The offset from the load to the boxcar wall was approximately two feet. Initially, the load was against the boxcar wall. |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



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Photo No. A0317-SPN91-288-4626. This is a photo of the impacted end of the test load of 21C fiber drums. Note, racking of the load. The Kraft paper was used to tie the load together. The bowing of the Kraft paper resulted from drum compression and deformation.



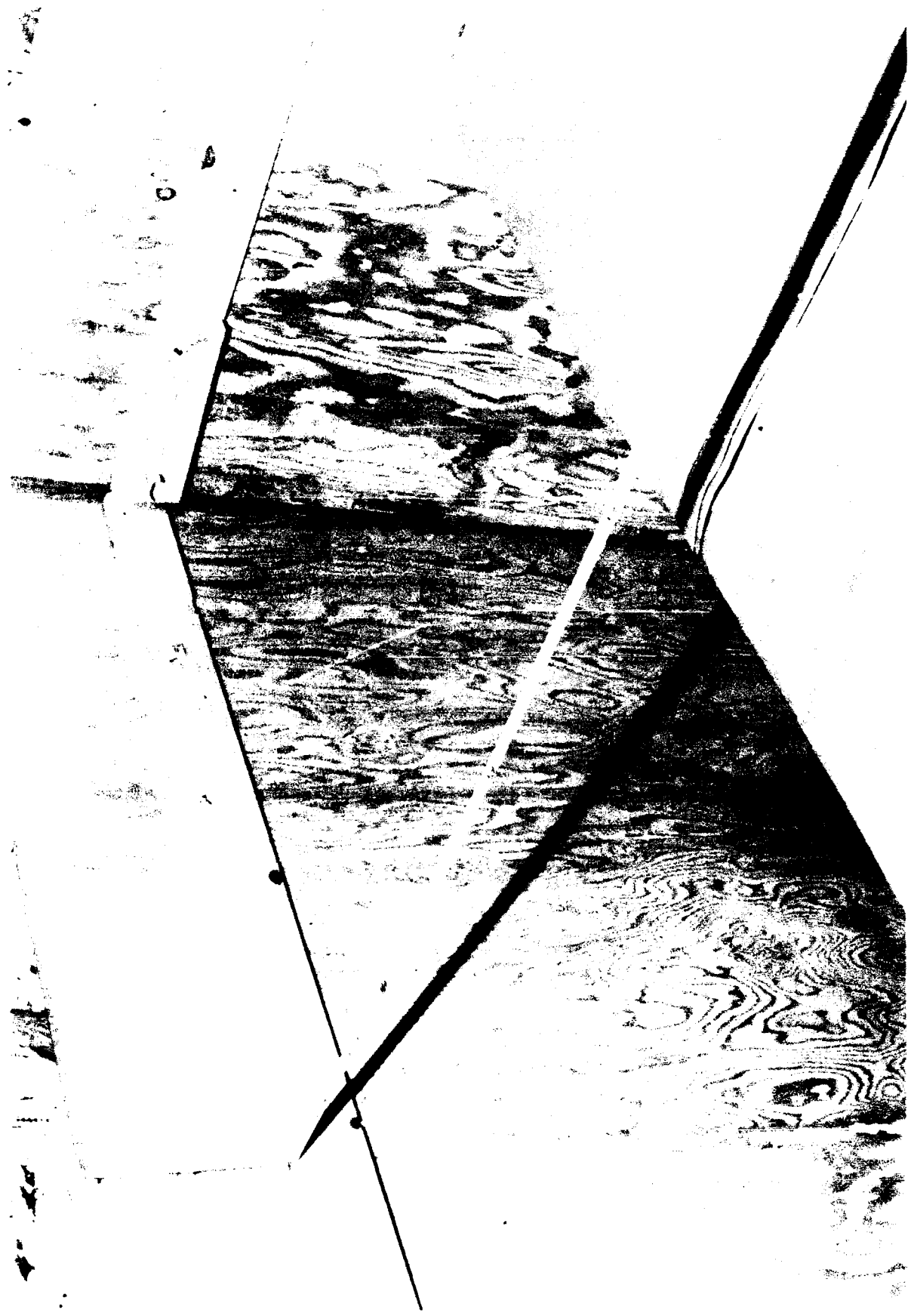
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Photo No. A0317-SPN91-288-4620. This shows the damage to the 21C fiber drums after impacting the boxcar. Note, undercutting of adjacent drums. The test samples contained a sand sawdust mixture to simulate the actual drum weight. The filler was loose versus tight in the actual product.



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Photo No. A0317-SPN91-288-4620a. This is a view of the 21C fiber drum test load after a rail impact. The drums racked and compacted, as shown by the distance of the drums from the rear wall.



|                                                                                                                                                                                     |                                                              |
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|                                                                                                                                                                                     | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL |
| Photo No. A0317-SPN91-288-4621. This photo shows 36 inches of load compaction after four successive impacts in one direction. The load was built flush against the boxcar end wall. |                                                              |



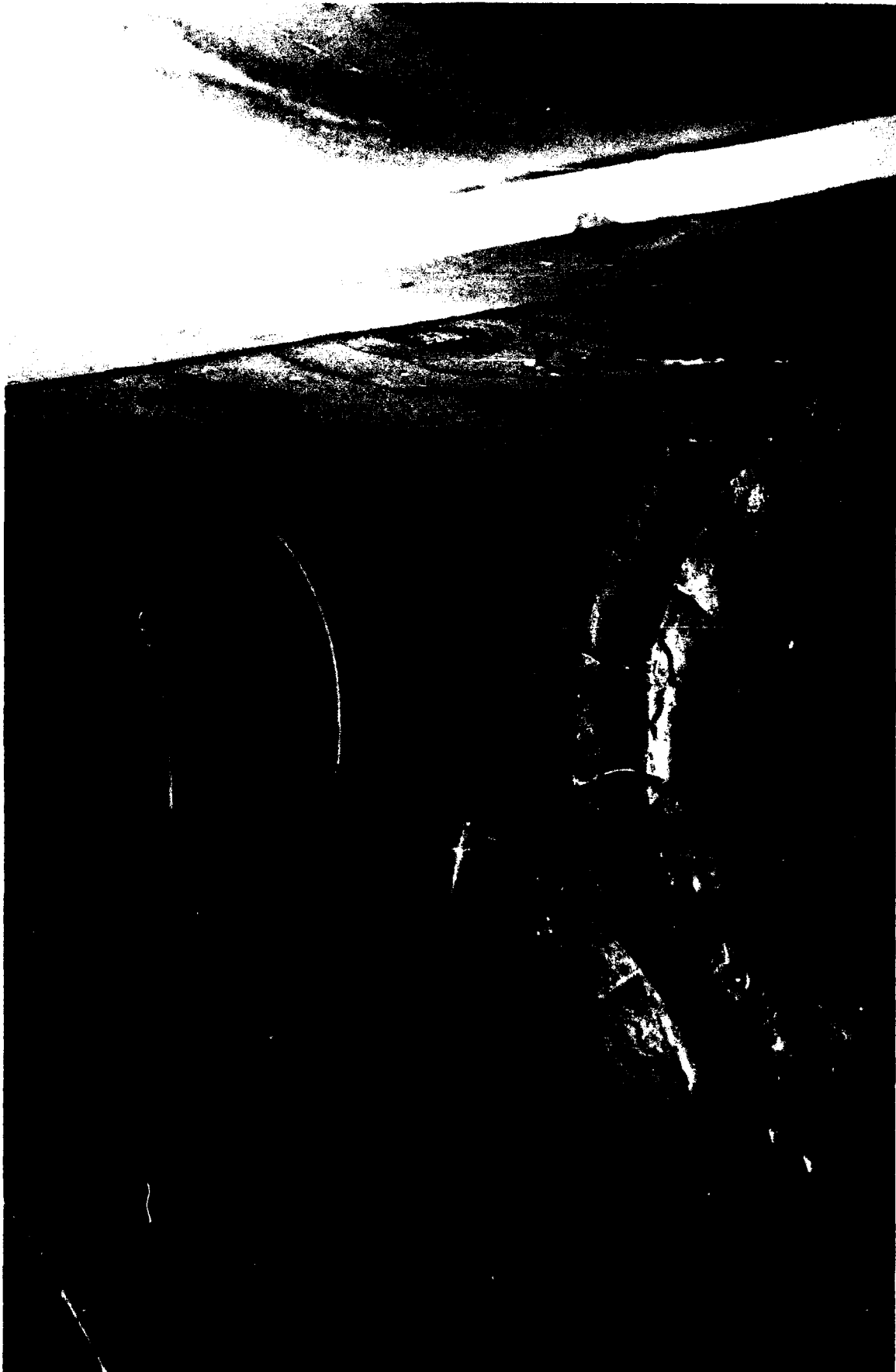
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Photo No. A0317-SPN91-288-4618. This photo shows the damaged 21C fiber drums after four successive rail impacts. Note, front to rear undercutting from container to container. This possibly could be avoided if the inert load was packed solid.



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Photo No. A0317-SPN91-288-4617. This photo shows the damaged 21C fiber drums after four successive rail impacts. Note, front to rear undercutting from container to container. This possibly could be avoided if the inert load was packed solid.



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| Photo No. A0317-SPN91-288-4619. This photo shows damaged 21C fiber drums at the boxcar side wall. Most damage occurred in the longitudinal direction (direction of impact). Side to side damage was minimal. |
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| Photo No. A0317-SPN91-288-4616. This photo shows the damaged 21C fiber drums after four successive rail impacts. Note, front to rear undercutting from container to container. This possibly could be avoided if the inert load was packed solid. |
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Photo No. A0317-SPN91-288-4615. This photo shows the damaged 21C fiber drums after four successive rail impacts. Note, front to rear undercutting from container to container. This possibly could be avoided if the inert load was packed solid.



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Photo No. A0317-SPN91-288-4614. This photo shows the damaged 21C fiber drums after four successive rail impacts. Note, front to rear undercutting from container to container. This possibly could be avoided if the inert load was packed solid.



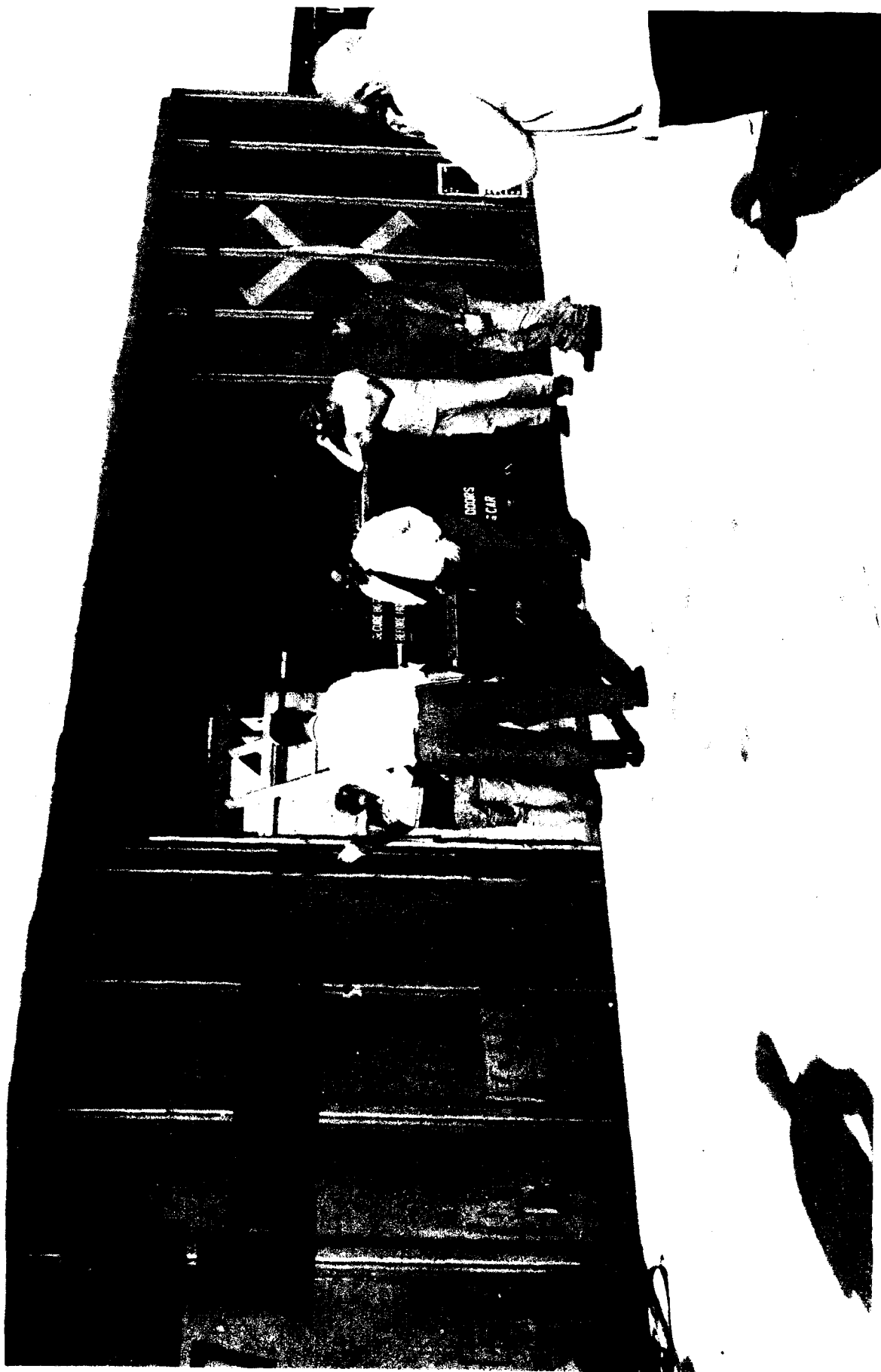
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Photo No. A0317-SPN91-288-4605. This photo is a closeup of the interface of the 21C fiber drums and the Kraft paper used to bond the three layers at the boxcar end wall. Note, lid undercutting from front to back as a result of drum racking.



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Photo No. A0317-SPN91-288-4606. This photo is a closeup of lid undercutting.



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Photo No. A0317-SPN91-288-4607. This photo shows personnel preparing to enter the boxcar load of 21C fiber drums to inspect the load for damage and compaction.

**PART 6**

**DRAWINGS**

LOADING AND BRACING IN 50'-6" LONG BOX CAR OF  
NITROGUANIDINE PACKED IN 15.5" DIAMETER BY  
24.4" HIGH DOT 21C FIBER DRUMS

CAUTION: CARS EQUIPPED WITH MECHANICAL BRACING DEVICES MUST  
NOT BE USED FOR SHIPMENT OF NITROGUANIDINE AS IT IS LIABLE TO  
SIFT OR BECOME LODGED IN THE MECHANISM OF THE LOADING AND  
BRACING DEVICE IN THE EVENT OF A CONTAINER FAILURE.

Prepared during December 1990 by:  
U.S. Army Defense Ammunition  
Center and School  
ATTN: SMCAC-DET  
Savanna, IL 61074-9639

## GENERAL NOTES

- A. THIS DOCUMENT HAS BEEN PREPARED AND ISSUED IN ACCORDANCE WITH AR 740-1 AND AUGMENTS TM 743-200-1 (CHAPTER 5)
- B. THE OUTLOADING PROCEDURES SPECIFIED IN THIS DRAWING ARE APPLICABLE FOR THE SHIPMENT OF NITROGUANIDINE IN DOT 21C FIBER DRUMS.

### C. DETAIL OF DRUM:

DIMENSIONS - - - - - 15.5 DIA" X 24.4" HIGH  
GROSS WEIGHT - - - - - 57 POUNDS (APPROX).  
CUBE - - - - - 2.7 CUBIC FEET.

- D. THE SELECTION OF RAIL CARS FOR THE TRANSPORT OF THE DESIGNATED ITEM IS THE RESPONSIBILITY OF THE CARRIER AND THE SHIPPER. ONLY CARS WHICH HAVE "SOUND" FLOORS AND ARE OTHERWISE IN PROPER CONDITION TO SAFELY TRANSPORT THE LADING TO DESTINATION WITHOUT DAMAGE WILL BE SELECTED. EVERY EFFORT SHOULD BE MADE TO OBTAIN BOX CARS THAT DO NOT HAVE BONED END WALLS. HOWEVER, CARS HAVING ONLY SLIGHTLY BONED ENDS CAN BE USED.

- E. IT IS RECOMMENDED THAT CARS EQUIPPED WITH END-OF-CAR CUSHIONING DEVICES BE USED, PROVIDING THESE CARS ALSO COMPLY WITH THE RESTRICTIONS AND SAFETY REQUIREMENTS SET FORTH BY THE "CAUTION" NOTE ON THE COVER PAGE.

- F. A BOX CAR EQUIPPED WITH 10'-0" WIDE "THRU" PLUG TYPE DOORS IS SHOWN. HOWEVER, THE DEPICTED PROCEDURES ARE ALSO APPLICABLE FOR CARS EQUIPPED WITH OTHER WIDTH "THRU" OR STAGGERED PLUG TYPE DOORS OR "THRU" OR STAGGERED CONVENTIONAL SLIDING DOORS. CAUTION: DAMAGE MATERIAL MUST NOT BE NAILED TO ANY PLUG DOOR, WHETHER AUXILIARY OR MAIN. ALSO, AFTER THE PLUG DOORS ON A CAR ARE CLOSED AND READY FOR THE INSTALLATION OF CAR SEALS, A PIECE OF WIRE OF SUITABLE SIZE WILL BE USED IN ADDITION TO, AND IN CONJUNCTION WITH, EACH CAR SEAL TO SEAL THE CAR. THE WIRE WILL BE THREADED THRU THE HOLES IN THE DOOR LATCH ASSEMBLY ONE OR MORE TIMES, AND THE WIRE ENDS WILL BE TWISTED TOGETHER.

- G. ALL-STEEL CARS (I.E., CARS WITH STEEL LINING AND STEEL FLOORS, EITHER NAILABLE OR NON-NAILABLE) MUST HAVE THE FLOOR COVERED AND MUST HAVE THE WALLS COVERED WITH PLYWOOD OR TEMPERED HARDBOARD TO AT LEAST 12" ABOVE THE LADING HEIGHT.

## MATERIAL SPECIFICATIONS

NAILS - - - - - FED SPEC FF-N-105: COMMON.

STRAPPING, STEEL - - - - - FED SPEC QQ-S-781: CLASS 1, TYPE 1 OR IV, HEAVY DUTY, FINISH A, B (GRADE 2), OR C.

SEAL, STRAP - - - - - FED SPEC QQ-S-781: TYPE D, STYLE 1, II, OR IV, CLASS H, FINISH A, B (GRADE 2) OR C.

STAPLE, STRAP - - - - - COMMERCIAL GRADE.

PAPER - - - - - FED SPEC UU-P-268.

23 STACKS

22 STACKS

INDICATES A PLUG DOOR

START 6-WIDE AT THIS END.

PLAN VIEW

50'-6" LONG BY 9'-2" WIDE BOXCAR.  
A 3-LAYER LOAD IS SHOWN.

START 7-WIDE AT THIS END.

LOAD AS SHOWN

| ITEM       | QUANTITY | WEIGHT (APPROX) |
|------------|----------|-----------------|
| FIBER DRUM | 876      | 49,932 LBS      |
| DUNNAGE    |          | 252 LBS         |

TOTAL WEIGHT - - - - - 50,184 LBS (APPROX)

KEY NUMBERS

1. KRAFT PAPER END-OF-LOAD PROTECTION FOR THE SECOND LAYER OF DRUMS (REQUIRED AT 2 PLACES). SEE THE "STEP 1" THRU "STEP 4" DETAILS ON PAGE 6 FOR INSTALLATION GUIDANCE.
2. KRAFT PAPER END-OF-LOAD PROTECTION FOR THE THIRD LAYER OF DRUMS (REQUIRED AT 2 PLACES). SEE THE "STEP 5" THRU "STEP 9" DETAILS ON PAGES 6 AND 7 FOR INSTALLATION GUIDANCE.
3. DOORWAY PROTECTION FOR THE SIDE OPPOSITE THE LOADING SIDE OF CAR (1 RECD). SEE THE "DOORWAY PROTECTION A" DETAIL ON PAGE 11. PIECES MARKED (3) AND (5) ARE ONLY FOR PLUG DOOR CARS. SEE THE "DOORWAY PROTECTION C", "D", OR "E" DETAILS ON PAGE 12 IF CAR IS EQUIPPED WITH SLIDING DOORS.
4. CENTER FILL (1 RECD). SEE THE "CENTER FILL A" DETAIL ON PAGE 8.
5. DOORWAY PROTECTION FOR THE LOADING SIDE OF THE CAR (1 RECD). SEE THE "DOORWAY PROTECTION B" DETAIL ON PAGE 11 FOR INSTALLATION GUIDANCE.

BILL OF MATERIAL

| NAILS                     | NO    | RECD       | POUNDS  |
|---------------------------|-------|------------|---------|
| 4d (1-1/2")               | 140   |            | 3/4     |
| 6d (2")                   | 72    |            | 1/2     |
| STEEL STRAPPING 1-1/4"    | 153   | RECD       | 22 LBS  |
| SEAL FOR 1-1/4" STRAPPING | 6     | RECD       | NIL     |
| STAPLE, 15/16" X 3/4"     | 96    | RECD       | NIL     |
| PLYWOOD, 1/2"             | 116   | 50 FT RECD | 159 LBS |
| PAPER, KRAFT, 36" WIDE    | 1,680 | RECD       | 69 LBS  |

NOTES:

1. PIECES MARKED (1) AND (2) HAVE BEEN OMITTED FROM BOTH ENDS OF THE LOAD FOR CLARITY.
2. LOADING SHOULD START AT THE 7-WIDE END OF THE CAR. PRIOR TO LOADING, THE FLOOR SHOULD BE MARKED AT A DISTANCE OF 12'-5" FROM THE END WALL. IF AFTER POSITIONING 11 STACKS THE LOAD EXTENDS BEYOND THE MARK ON THE FLOOR, THEN THE OPPOSITE END OF THE CAR SHOULD ALSO BE STARTED WITH A 7-WIDE STACK. ADJUST THE THICKNESS OF THE CENTER FILL. PIECE MARKED (4) TO SUIT. DRUMS MUST BE LOADED IN 6-WIDE STACKS ON EACH SIDE OF THE CENTER FILL. THE LOAD WILL THEN BE 858 DRUMS IN LIEU OF 876.

23 STACKS

22 STACKS

INDICATES A PLUG DOOR.

START 6-WIDE AT THIS END.

START 7-WIDE AT THIS END.

### PLAN VIEW

50'-6" LONG BY 9'-4" WIDE BOXCAR.  
A 3-LAYER LOAD IS SHOWN.

### LOAD AS SHOWN

| ITEM         | QUANTITY | WEIGHT (APPROX)     |
|--------------|----------|---------------------|
| FIBER DRUM   | 876      | 49,932 LBS          |
| DUNNAGE      |          | 331 LBS             |
| TOTAL WEIGHT |          | 50,263 LBS (APPROX) |

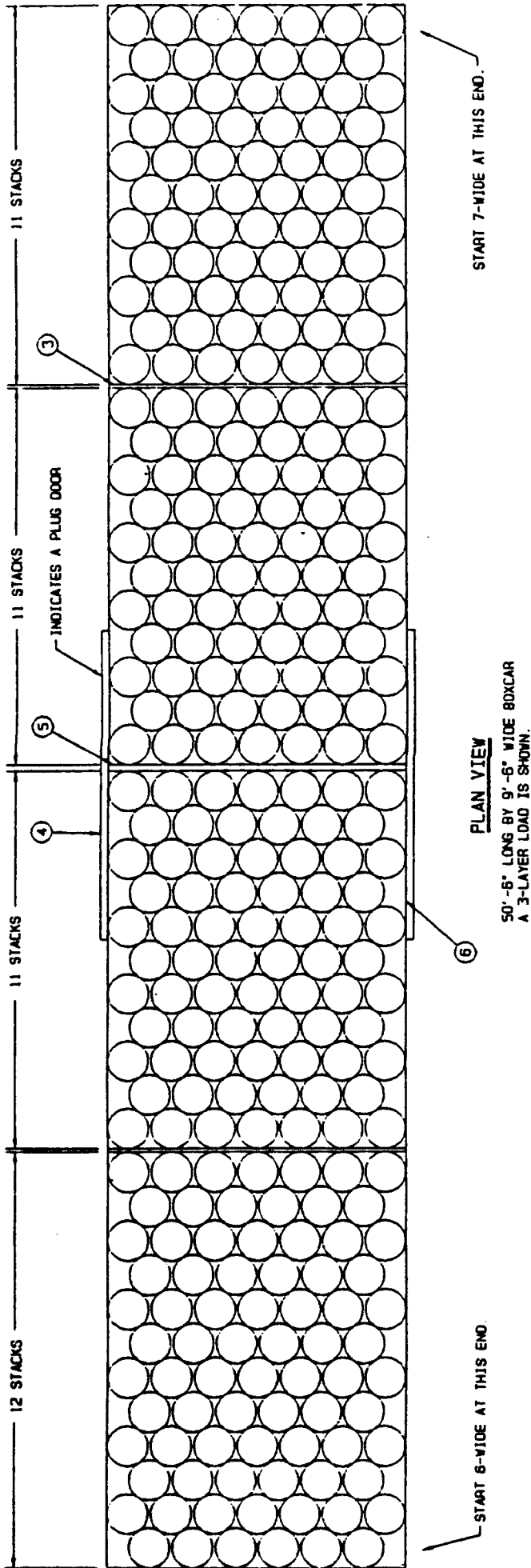
### KEY NUMBERS

- ① KRAFT PAPER END-OF-LOAD PROTECTION FOR THE SECOND LAYER OF DRUMS (REQUIRED AT 2 PLACES). SEE THE "STEP 1" THRU "STEP 4" DETAILS ON PAGE 6 FOR INSTALLATION GUIDANCE.
- ② KRAFT PAPER END-OF-LOAD PROTECTION FOR THE THIRD LAYER OF DRUMS (REQUIRED AT 2 PLACES). SEE THE "STEP 5" THRU "STEP 9" DETAILS ON PAGES 6 AND 7 FOR INSTALLATION GUIDANCE.
- ③ DOORWAY PROTECTION FOR THE SIDE OPPOSITE THE LOADING SIDE OF CAR (1 REQD). SEE THE "DOORWAY PROTECTION A" DETAIL ON PAGE 11. PIECES MARKED ③ AND ⑤ ARE ONLY FOR PLUG DOOR CARS. SEE THE "DOORWAY PROTECTION C", "D", OR "E" DETAILS ON PAGE 12 IF CAR IS EQUIPPED WITH SLIDING DOORS.
- ④ CENTER FILL (1 REQD). SEE THE "CENTER FILL B" DETAIL ON PAGE 8
- ⑤ DOORWAY PROTECTION FOR THE LOADING SIDE OF THE CAR (1 REQD). SEE THE "DOORWAY PROTECTION B" DETAIL ON PAGE 11 FOR INSTALLATION GUIDANCE

### NOTES:

1. PIECES MARKED ① AND ② HAVE BEEN OMITTED FROM BOTH ENDS OF THE LOAD FOR CLARITY.
2. DRUMS MUST BE LOADED IN 6-WIDE STACKS ON EACH SIDE OF THE CENTER FILL. PIECE MARKED ④

| BILL OF MATERIAL                                    |            |             |  |
|-----------------------------------------------------|------------|-------------|--|
| LUMBER                                              | BOARD FEET | LINEAR FEET |  |
| 2" X 6"                                             | 38         | 38          |  |
| NAILS                                               | NO. REQD   | POUNDS      |  |
| 6d (2" )                                            | 153        | 1-1/2       |  |
| STEEL STRAPPING, 1-1/4" - - 153' REQD - - - 22 LBS  |            |             |  |
| SEAL FOR 1-1/4" STRAPPING - 6 REQD - - - NIL        |            |             |  |
| STAPLE, 15/16" X 3/4" - - 96 REQD - - - NIL         |            |             |  |
| PLYWOOD, 1/2" - - - 118 SQ FT REQD - - - 162 LBS    |            |             |  |
| PAPER, KRAFT, 36" WIDE - - 1,680' REQD - - - 69 LBS |            |             |  |



# KEY NUMBERS

- ① KRAFT PAPER END-OF-LOAD PROTECTION FOR THE SECOND LAYER OF DRUMS (REQUIRED AT 2 PLACES). SEE THE "STEP 1" THRU "STEP 4" DETAILS ON PAGE 6 FOR INSTALLATION GUIDANCE.
- ② KRAFT PAPER END-OF-LOAD PROTECTION FOR THE THIRD LAYER OF DRUMS (REQUIRED AT 2 PLACES). SEE THE "STEP 5" THRU "STEP 9" DETAILS ON PAGES 6 AND 7 FOR INSTALLATION GUIDANCE.
- ③ DIVISIONAL GATE (2 REQD). SEE THE "PLYWOOD DIVISIONAL GATE" DETAIL OR THE "PLYWOOD/LUMBER DIVISIONAL GATE" DETAIL ON PAGE 9.
- ④ DOORWAY PROTECTION FOR THE SIDE OPPOSITE THE LOADING SIDE OF CAR (1 REQD). SEE THE "DOORWAY PROTECTION A" DETAIL ON PAGE 11. PIECES MARKED ④ AND ⑥ ARE ONLY FOR PLUG DOOR CARS. SEE THE "DOORWAY PROTECTION C", "D", OR "E" DETAILS ON PAGE 12 IF CAR IS EQUIPPED WITH SLIDING DOORS.
- ⑤ CENTER FILL (1 REQD). SEE THE "CENTER FILL C" DETAIL ON PAGE 10.
- ⑥ DOORWAY PROTECTION FOR THE LOADING SIDE OF THE CAR (1 REQD). SEE THE "DOORWAY PROTECTION B" DETAIL ON PAGE 11 FOR INSTALLATION GUIDANCE.

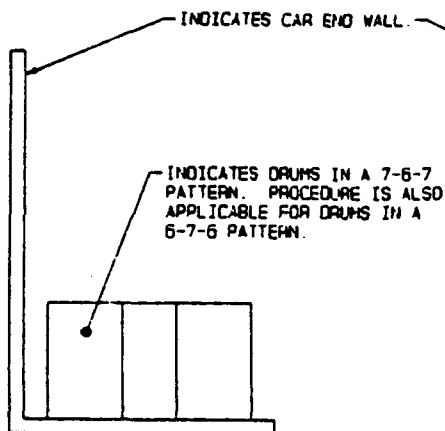
## NOTES

1. PIECES MARKED ① AND ② HAVE BEEN OMITTED FROM BOTH ENDS OF THE LOAD FOR CLARITY.
2. DRUMS MUST BE LOADED IN 7-WIDE STACKS ON EACH SIDE OF EACH DIVISIONAL GATE. PIECE MARKED ③, AND ON EACH SIDE OF THE CENTER FILL. PIECE MARKED ⑤.

## LOAD AS SHOWN

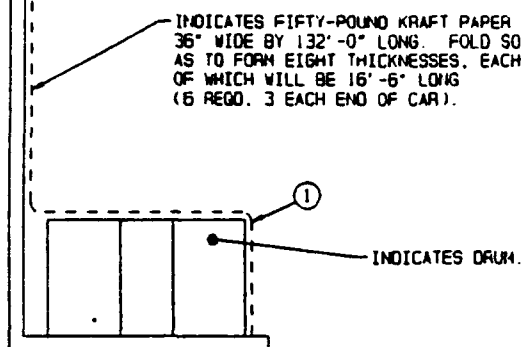
| ITEM         | QUANTITY | WEIGHT (APPROX)     |
|--------------|----------|---------------------|
| FIBER DRUM   | 882      | 50,274 LBS          |
| DAMAGE       |          | 534 LBS             |
| TOTAL WEIGHT |          | 50,808 LBS (APPROX) |

| BILL OF MATERIAL          |            |             |         |
|---------------------------|------------|-------------|---------|
| LUMBER                    | BOARD FEET | LINEAR FEET |         |
| 1" X 6"                   | 75         | 38          |         |
| 2" X 3"                   | 38         | 19          |         |
| NAILS                     | NO. REQD   | POUNDS      |         |
| 6d (2")                   | 352        | 2-1/4       |         |
| STEEL STRAPPING, 1-1/4"   | 153'       | REQD        | 22 LBS  |
| SEAL FOR 1-1/4" STRAPPING | 6          | REQD        | NIL     |
| STAPLE, 15/16" X 3/4"     | 96         | REQD        | NIL     |
| PLYWOOD, 1/2"             | 237 SQ FT  | REQD        | 326 LBS |
| PAPER, KRAFT, 36" WIDE    | 1,680'     | REQD        | 69 LBS  |



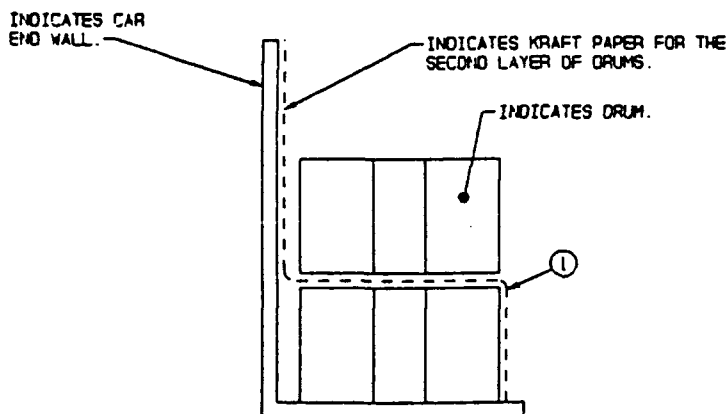
**STEP 1**

POSITION TWENTY DRUMS IN END OF CAR USING A 7-6-7 NESTED PATTERN, OR NINETEEN DRUMS USING 6-7-6 NESTED PATTERN, AS APPLICABLE.



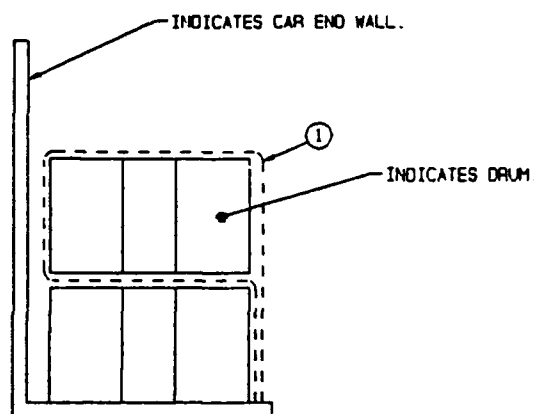
**STEP 2**

AT THREE PLACES, SIDE-BY-SIDE ACROSS THE CAR, POSITION KRAFT PAPER SO AS TO EXTEND FROM FLOOR, UP THE FRONT AND OVER THE TOP OF THE DRUMS. EXTEND PAPER UP THE END WALL. IF DESIRED, PAPER MAY BE TEMPORARILY STAPLED OR TAPED TO END WALL WHILE LOADING NEXT DRUMS.



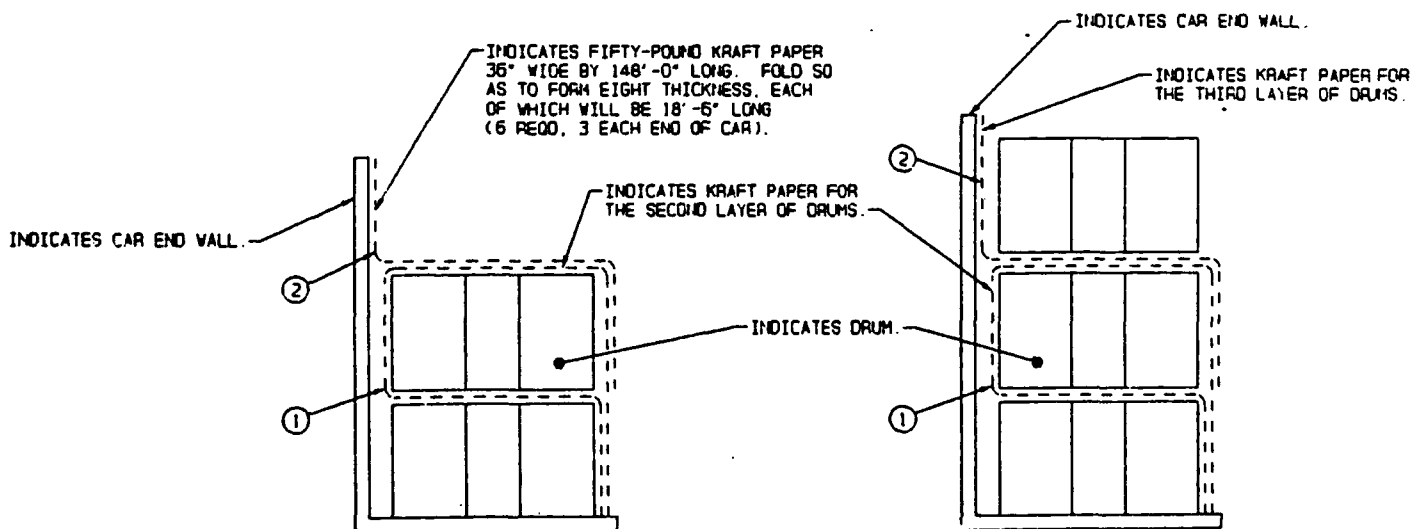
**STEP 3**

POSITION THE NEXT TWENTY OR NINETEEN DRUMS ON THE KRAFT PAPER, DIRECTLY ABOVE THE DRUMS PREVIOUSLY LOADED.



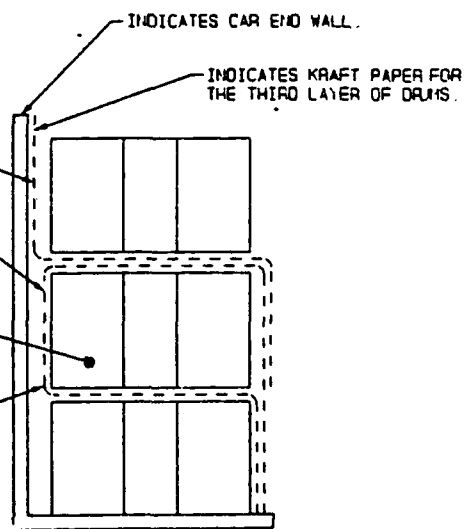
**STEP 4**

LOOSEN PAPER FROM END WALL, IF SECURED, AND BRING OVER THE TOP OF AND DOWN THE FRONT OF THE LOAD AS SHOWN.



**STEP 5**

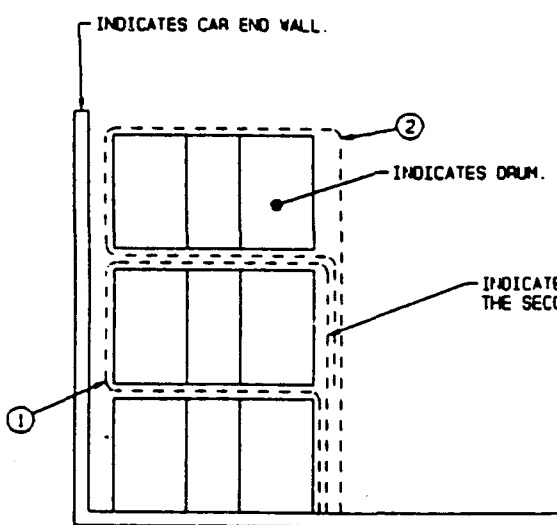
AT THREE PLACES, POSITION KRAFT PAPER SO AS TO EXTEND FROM THE TOP OF THE FIRST LAYER OF DRUMS, UP THE FRONT AND OVER THE TOP OF THE SECOND LAYER OF DRUMS (OVER THE PREVIOUSLY-POSITIONED PAPER). EXTEND PAPER UP THE END WALL. IF DESIRED, PAPER MAY BE TEMPORARILY STAPLED OR TAPED TO END WALL WHILE LOADING NEXT DRUMS.



**STEP 6**

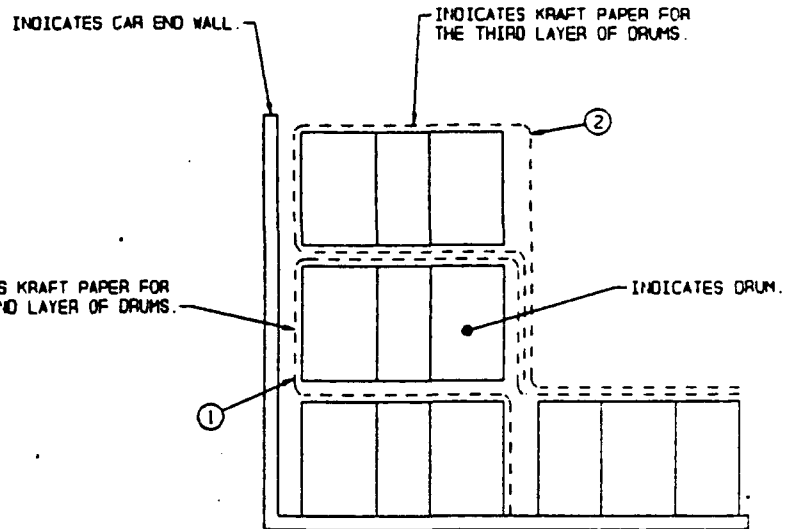
POSITION THE TOP LAYER OF TWENTY OR NINETEEN DRUMS ON THE KRAFT PAPER AND DIRECTLY ABOVE THE DRUMS IN THE SECOND LAYER.

**KRAFT PAPER END-OF-LOAD PROTECTION**



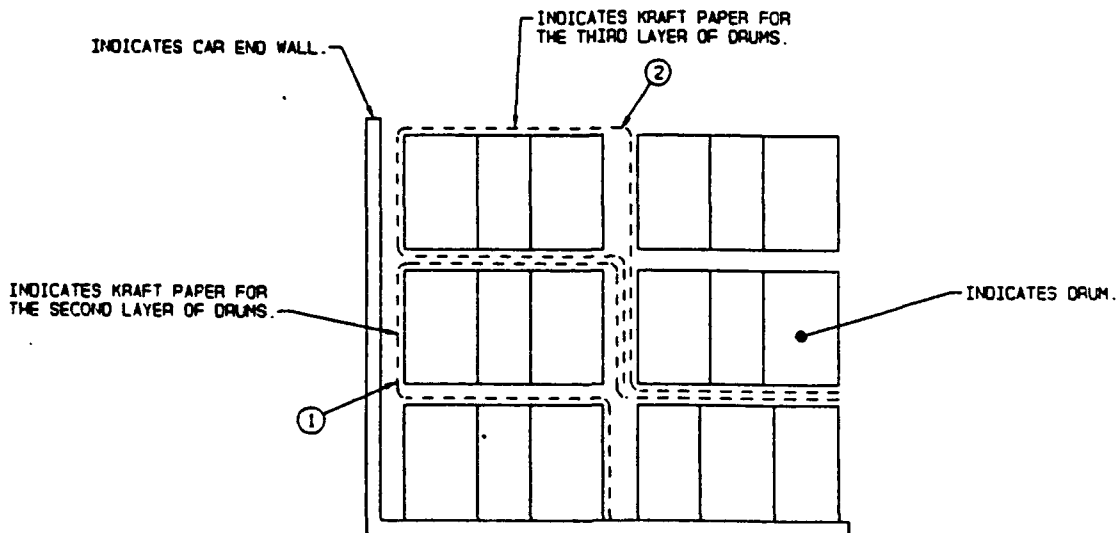
#### STEP 7

LOOSEN PAPER FROM END WALL, IF SECURED, AND BRING OVER THE TOP AND DOWN THE FRONT OF THE LOAD AS SHOWN.



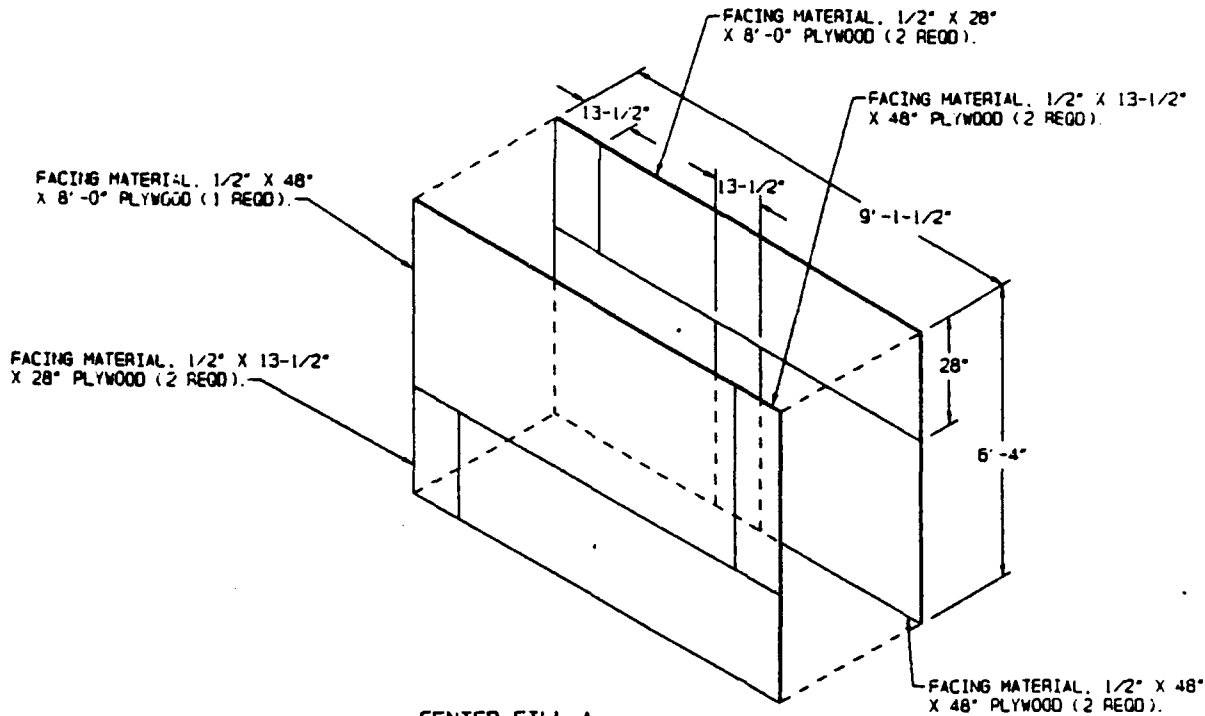
#### STEP 8

LIFT ENDS OF PAPERS WHICH EXTEND OVER THE SECOND AND THIRD LAYERS OF DRUMS. POSITION SEVEN OR SIX DRUMS AGAINST THE FIRST-LAYER GROUP OF 20 OR 19 DRUMS. FORCE DRUMS FIRMLY AGAINST THE KRAFT PAPER TO PROVIDE PROPER NESTING. POSITION THE NEXT THIRTEEN DRUMS AND PLACE KRAFT PAPER ON TOP.



#### STEP 9

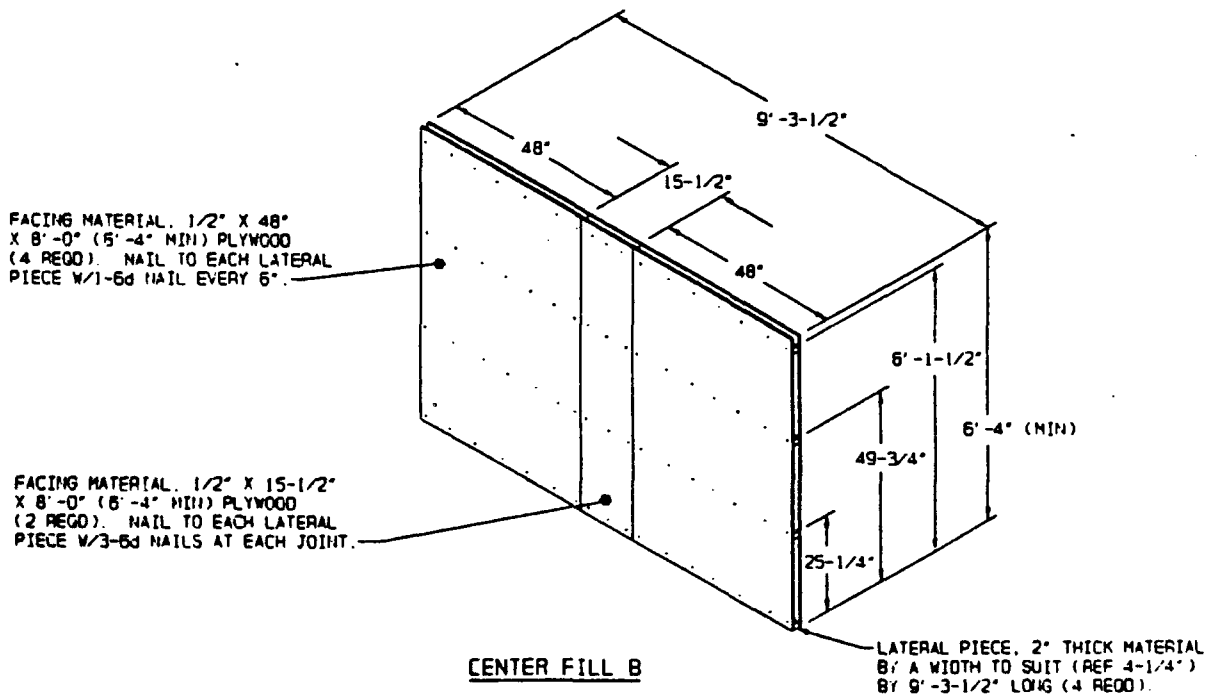
POSITION SEVEN OR SIX DRUMS AGAINST THE SECOND-LAYER GROUP OF 20 OR 19 DRUMS. FORCE DRUMS FIRMLY AGAINST THE KRAFT PAPER TO PROVIDE PROPER NESTING. POSITION THE NEXT THIRTEEN DRUMS OF THE 20 OR 19 DRUM GROUP. POSITION SEVEN OR SIX DRUMS AGAINST THE THIRD-LAYER GROUP OF 20 OR 19 DRUMS. FORCING FIRMLY AGAINST THE KRAFT PAPER TO PROVIDE PROPER NESTING. CONTINUE LOADING THE BALANCE OF THE CAR.



#### CENTER FILL A

FOR A 9'-2" WIDE CAR

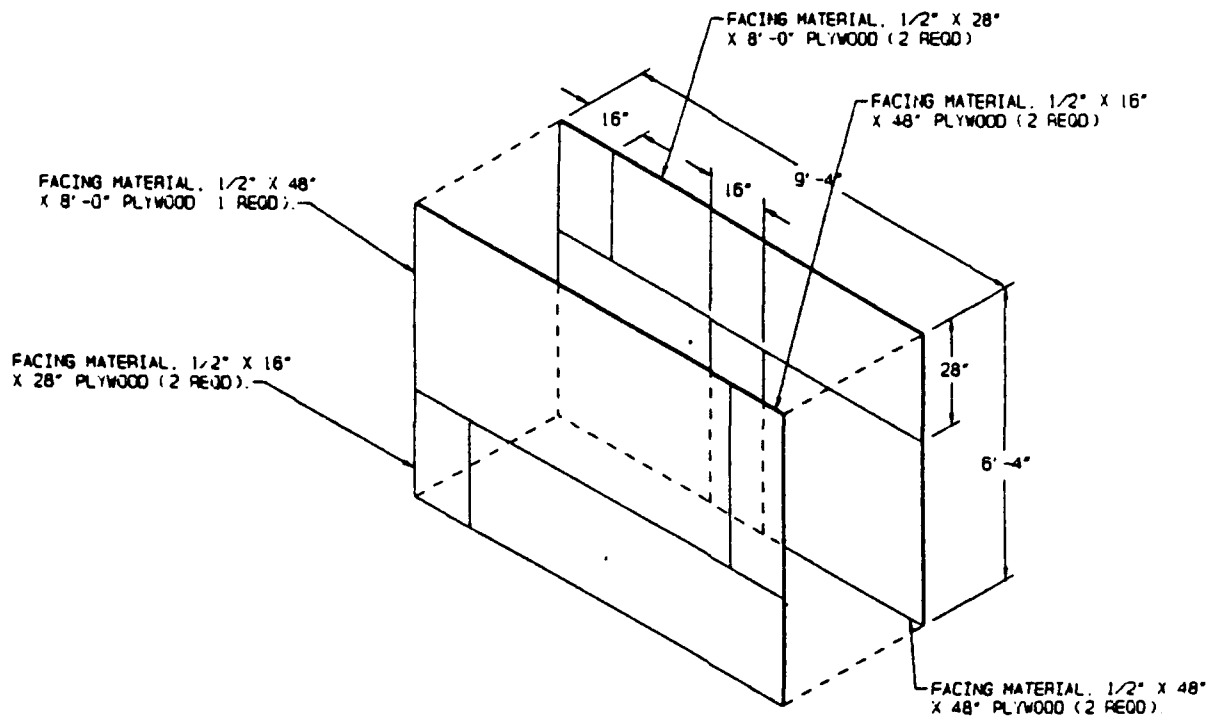
NOTE: ALL PIECES WILL BE LAMINATED  
W/1-4d NAIL EVERY 8" AND CLINCHED.



#### CENTER FILL B

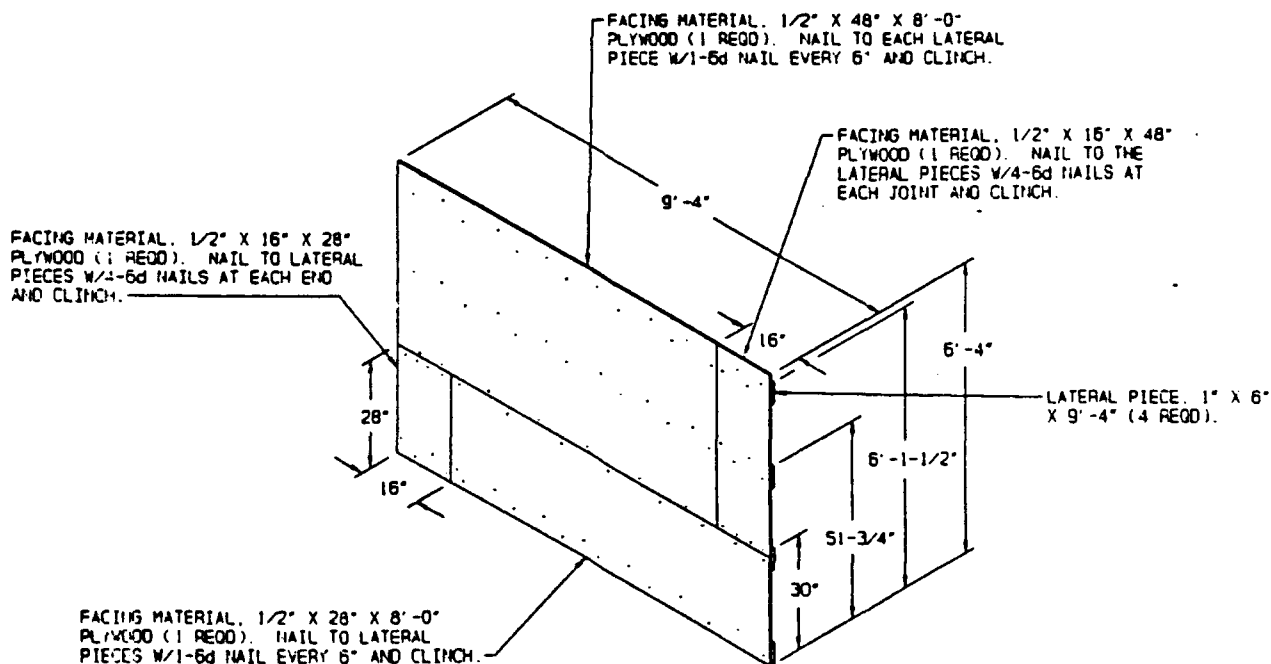
FOR A 9'-4" WIDE CAR.

NOTE: 8'-0" LONG PLYWOOD SHEETS MAY  
BE USED IN LIEU OF CUTTING TO 6'-4".



#### PLYWOOD DIVISIONAL GATE

FOR 9'-6" WIDE CAR AS AN OPTION TO THE PLYWOOD/LUMBER DIVISIONAL GATE.  
NOTE: ALL PIECES WILL BE LAMINATED W/1-4d NAIL EVERY 8" AND CLINCHED.

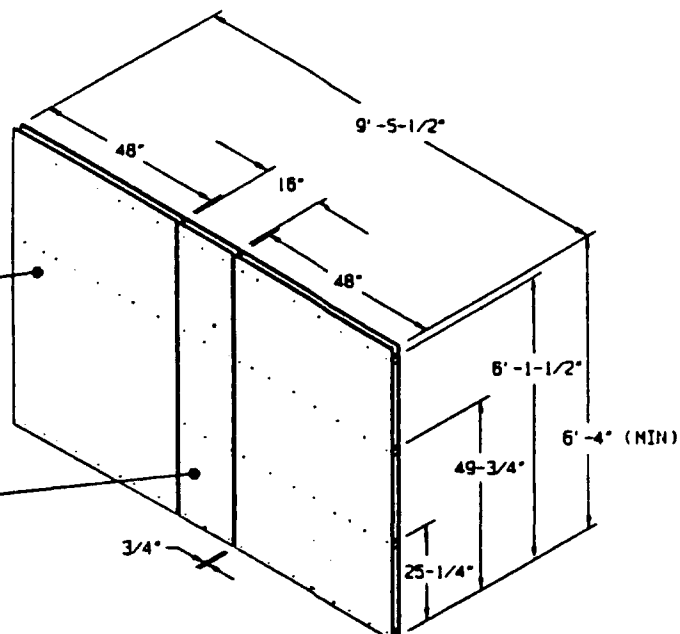


#### PLYWOOD/LUMBER DIVISIONAL GATE

FOR 9'-6" WIDE CAR

FACING MATERIAL, 1/2" X 48"  
X 8'-0" (6'-4" MIN) PLYWOOD  
(4 REQD) NAIL TO EACH LATERAL  
PIECE W/1-6d NAIL EVERY 6"

FACING MATERIAL, 1/2" X 15-1/2"  
X 8'-0" (6'-4" MIN) PLYWOOD  
(2 REQD) NAIL TO EACH LATERAL  
PIECE W/3-6d NAILS AT EACH JOINT.



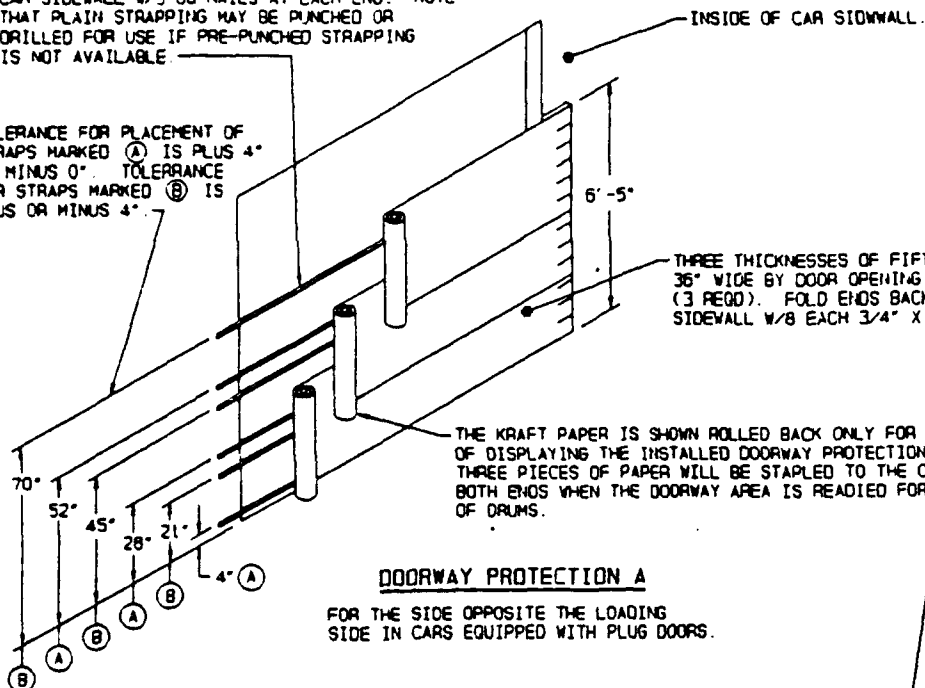
CENTER FILL C

FOR A 9'-6" WIDE CAR.

LATERAL PIECE, 2" THICK MATERIAL  
BY A WIDTH TO SUIT BY 9'-5-1/2"  
LONG (4 REQD).

DOORWAY PROTECTION STRAP, 1-1/4" X .035" OR .031" STEEL STRAPPING. DOOR OPENING WIDTH PLUS 18" IN LENGTH (6 REQD). NAIL TO THE CAR SIDEWALL W/3-6d NAILS AT EACH END. NOTE THAT PLAIN STRAPPING MAY BE PUNCHED OR DRILLED FOR USE IF PRE-PUNCHED STRAPPING IS NOT AVAILABLE.

TOLERANCE FOR PLACEMENT OF STRAPS MARKED (A) IS PLUS 4" OR MINUS 0". TOLERANCE FOR STRAPS MARKED (B) IS PLUS OR MINUS 4".



THREE THICKNESSES OF FIFTY-POUND KRAFT PAPER 36" WIDE BY DOOR OPENING WIDTH PLUS 48" IN LENGTH (3 REQD). FOLD ENDS BACK 12" AND SECURE TO CAR SIDEWALL W/8 EACH 3/4" X 1/2" OR 1" X 5/8" STAPLES.

THE KRAFT PAPER IS SHOWN ROLLED BACK ONLY FOR THE PURPOSE OF DISPLAYING THE INSTALLED DOORWAY PROTECTION STRAPS. ALL THREE PIECES OF PAPER WILL BE STAPLED TO THE CAR SIDEWALLS AT BOTH ENDS WHEN THE DOORWAY AREA IS READY FOR THE LOADING OF DRUMS.

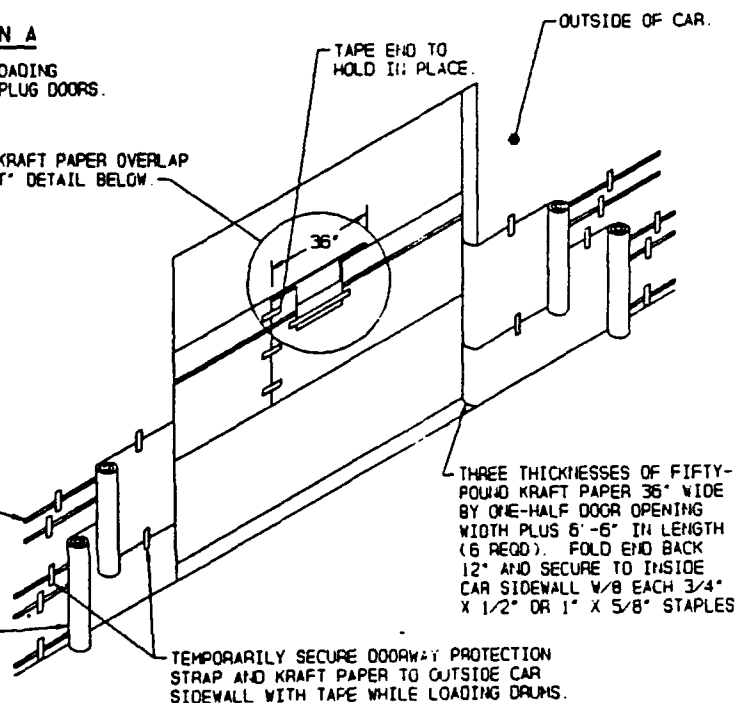
#### DOORWAY PROTECTION A

FOR THE SIDE OPPOSITE THE LOADING SIDE IN CARS EQUIPPED WITH PLUG DOORS.

SEE THE "KRAFT PAPER OVERLAP SECUREMENT" DETAIL BELOW.

DOORWAY PROTECTION STRAP, 1-1/4" X .035" OR .031" STEEL STRAPPING. ONE-HALF DOOR OPENING WIDTH PLUS 24" IN LENGTH (12 REQD). NAIL TO INSIDE CAR SIDEWALL W/3-6d NAILS. SEE THE "DOORWAY PROTECTION A" DETAIL ABOVE FOR HEIGHT LOCATIONS. TENSION AND SEAL WITH ONE SEAL. NOTE THAT PLAIN STRAPPING MAY BE PUNCHED OR DRILLED FOR USE IF PRE-PUNCHED STRAPPING IS NOT AVAILABLE.

THE KRAFT PAPER IS SHOWN ROLLED BACK ONLY FOR THE PURPOSE OF DEPICTING THE METHOD OF SECURING TO THE OUTSIDE CAR WALL/DOOR; ALL THREE PIECES WILL BE EXTENDED ACROSS THE DOORWAY OPENING, TAPED, AND SECURED AS SHOWN BY THE "KRAFT PAPER OVERLAP SECUREMENT" DETAIL BELOW.



THREE THICKNESSES OF FIFTY-POUND KRAFT PAPER 36" WIDE BY ONE-HALF DOOR OPENING WIDTH PLUS 6'-6" IN LENGTH (6 REQD). FOLD END BACK 12" AND SECURE TO INSIDE CAR SIDEWALL W/8 EACH 3/4" X 1/2" OR 1" X 5/8" STAPLES

TEMPORARILY SECURE DOORWAY PROTECTION STRAP AND KRAFT PAPER TO OUTSIDE CAR SIDEWALL WITH TAPE WHILE LOADING DRUMS.

#### DOORWAY PROTECTION B

FOR THE SIDE OPPOSITE THE LOADING SIDE IN CARS EQUIPPED WITH PLUG DOORS.

INDICATES KRAFT PAPER. FORM 36" LONG FLAPS BY FOLDING THE INNER THREE THICKNESSES OUTWARD AND THE OUTER THREE THICKNESSES INWARD. INTERLOCK THE TWO FLAPS AS SHOWN.

INDICATES TAPE.

INDICATES TAPE.

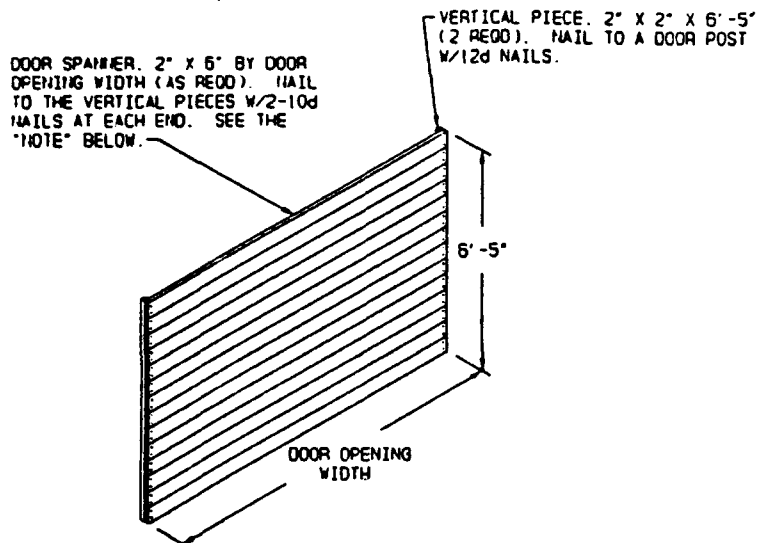
CUT/TEAR THROUGH THE OUTER SIX THICKNESSES OF THE KRAFT PAPER, FROM THE TOP EDGE DOWN TO THE DOORWAY PROTECTION STRAP (TO THE TOP STRAP OF A SET OF TWO DOORWAY PROTECTION STRAPS). FOLD THE SIX THICKNESSES OUTWARD OVER THE STRAP AND SECURE THE FLAP WITH TAPE AS SHOWN. THIS MUST BE ACCOMPLISHED ON ALL THREE LEVELS OF KRAFT PAPER SPANNING THE DOORWAY OPENING.

APPLY TAPE AT THIS AREA TO REINFORCE THE CUT PORTIONS OF THE KRAFT PAPER.

16" MIN  
20" MAX

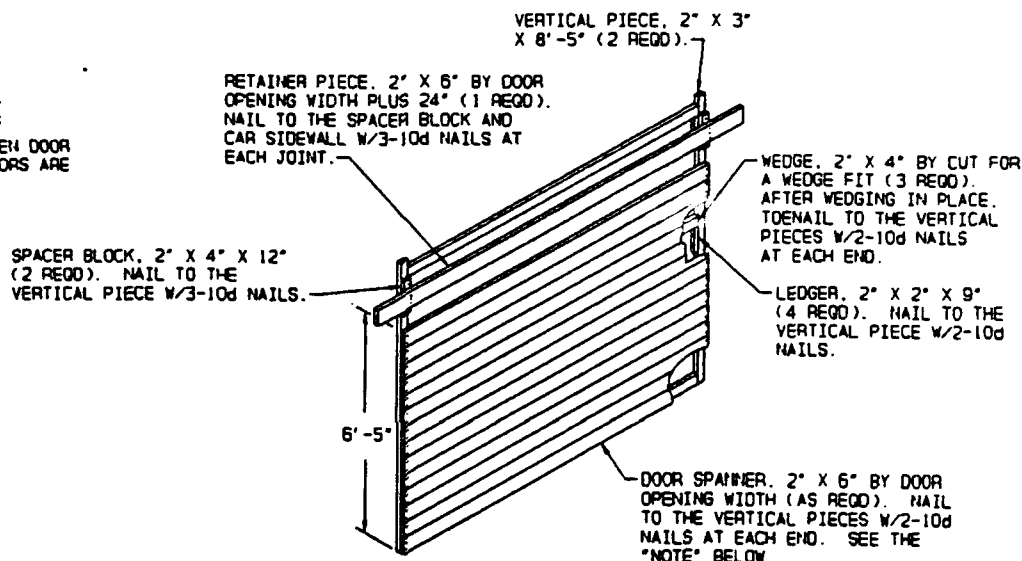
#### KRAFT PAPER OVERLAP SECUREMENT

#### PLUG DOOR DOORWAY PROTECTION DETAILS



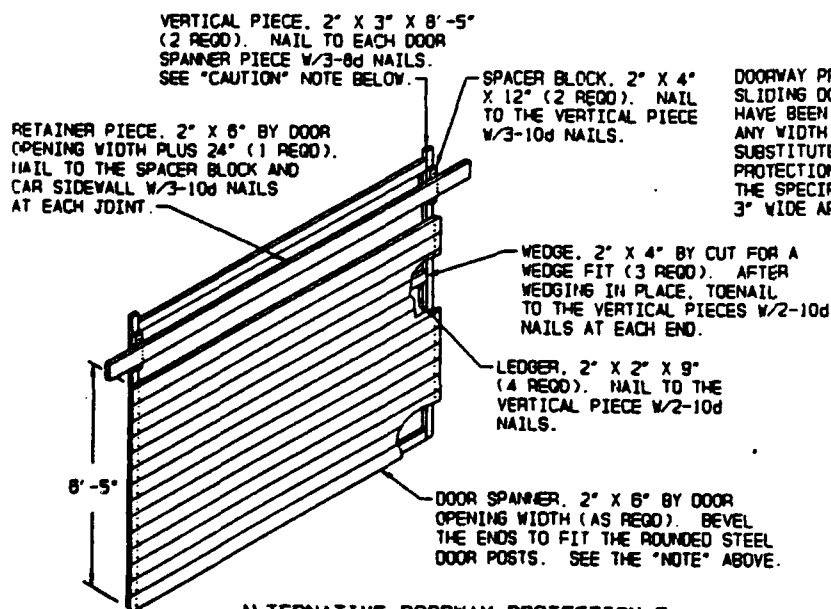
### DOORWAY PROTECTION C

DOORWAY PROTECTION TO BE USED WHEN DOOR POSTS OF CONVENTIONAL SLIDING DOORS ARE WOOD OR NAILABLE METAL.



### DOORWAY PROTECTION D

DOORWAY PROTECTION TO BE USED WHEN DOOR POSTS OF CONVENTIONAL SLIDING DOORS ARE NOT NAILABLE. NOTE: ALTHOUGH 6" WIDE PIECES HAVE BEEN SPECIFIED FOR THE "DOOR SPANNER" PIECES, PIECES OF ANY WIDTH AND COMBINATIONS OF DIFFERENT WIDTHS CAN BE SUBSTITUTED, IF DESIRED, WHEN FABRICATING A "DOORWAY PROTECTION" GATE ASSEMBLY, PROVIDING THE PIECES USED ARE OF THE SPECIFIED THICKNESS (2") AND PROVIDING PIECES LESS THAN 3" WIDE ARE NOT USED.



### ALTERNATIVE DOORWAY PROTECTION E

DOORWAY PROTECTION TO BE USED WHEN DOOR POSTS OF CONVENTIONAL SLIDING DOORS ARE ROUNDED STEEL, WITHOUT NAIL HOLES. CAUTION: WHEN DRIVING THE NAILS THROUGH THE VERTICAL PIECE INTO THE DOOR SPANNERS, EXERCISE CARE SO AS TO NOT DRIVE A NAIL INTO THE LADING.

### SLIDING DOOR DOORWAY PROTECTION DETAILS