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Technical Report

PIONEER POLAR STRUCTURES — PORTABLE MAINTENANCE SHELTER

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U. S. NAVAL CIVIL ENGINEERING LABORATORY

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PIONEER POLAR STRUCTURES — PORTABLE MAINTENANCE SHELTER

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Type C Final Report

by

G. E. Sherwood

ABSTRACT

The need for adequate shelter for maintenance and repair of construction and other equipment in pioneer polar camps resulted in the development of a packaged maintenance shelter. The shelter, a canvas-covered, aluminum-frame structure, was developed by NCEL. It is skid-mounted for easy portability around a work area. The 20- by 24-foot shelter is adequate for the repair and maintenance of equipment as large as a Size 2 snow tractor and a Size 4 standard tractor. A standard NCEL portable wanigan was outfitted with shop equipment and tools as a companion piece for the shelter.

A prototype shelter was evaluated on the Ross Ice Shelf in Antarctica. It was concluded from the test that the shelter and its outfitting is well suited for the maintenance and repair of equipment at pioneer polar camps and that it should be included as a facility for such camps.

Specifications and reduced scale drawings for the shelter have been published in Technical Note N-602, "Pioneer Polar Structures — Specifications and Outfitting for the Portable Maintenance Shelter.

Qualified requesters may obtain copies of this report from DDC.
The Laboratory invites comment on this report, particularly on the results obtained by those who have applied the information.

INTRODUCTION

Adequate shelter is essential for efficient maintenance and repair of construction and transportation equipment in pioneer polar camps. Portable shelter is desirable because of the transient nature of many polar work projects and in order that the shelter can be towed to equipment breakdowns in the field.

This report covers the development of a portable maintenance shelter and outfitting of its companion piece, an equipment-repair wanigan. These provide maintenance and repair facilities for equipment as large as a Size 2 snow tractor and a Size 4 standard tractor.

BACKGROUND

Early mechanized expeditions in polar regions required only meager facilities for equipment repair and maintenance. But with the increase in amount and size of equipment used, the repair and maintenance facility requirements also increased. Windbreaks and tents have been used, but this protection was inadequate. The lack of suitable shelter has hampered construction efforts and operations in pioneer polar camps.[1] This lack resulted in development of the portable maintenance shelter.

In 1959, engineering studies were initiated to determine the feasibility of a maintenance shelter which would be easily portable. After several basic approaches were evaluated, a shelter was designed and a prototype fabricated in 1962. The prototype was shipped to McMurdo, Antarctica, with a companion equipment-repair wanigan[2] for in-service test at the NCEL field camp during the FY-63 summer season. Evaluation revealed inadequacies in certain components. These components were redesigned and evaluated in the prototype during the FY-64 antarctic summer season. At the end of the season, custody of the shelter was transferred to Antarctic Support Activities for in-service test in the McMurdo area.

CONCEPT

Canvas-covered arch-rib construction was selected for the shelter. The arch provides the strength required to span the building width, and produces the best shape for stretching the canvas cover tightly over the roof. The canvas was not

insulated as only spot heat was planned. The shelter was to be mounted on skids for portability. The skids were to be wide enough to serve as a track for a traveling gantry, providing both longitudinal and lateral positioning of the hoist.

A shelter size of 20 feet wide by 24 feet long was selected to provide a 4-foot work space around a Size 4 standard tractor. Pallet-type flooring was to be used in the shelter.

An NCEL standard portable wanigan was to be used as a companion piece to provide a comfortable shop in which to work and to store the shop equipment and tools.

CRITERIA

General criteria applicable to all structures for pioneer polar camps[1, 3] were used in the development of the portable maintenance shelter:

1. Satisfactory operation in ambient temperatures to -65 F
2. Structural adequacy for winds up to 100 miles per hour
3. Air shipment by C-130 aircraft
4. Simplicity of design
5. Minimum maintenance requirements
6. Maximun use of Federal standard stock items or readily available commercial items
7. Fast and efficient assembly or erection

Specific criteria for development of the portable maintenance shelter were:

1. Sufficient space to accommodate a Size 4 standard tractor and provide a 4-foot work space around the tractor
2. A skid system suitable for local towing
3. A hoist, with a lifting capacity of 2 tons, which can be positioned both longitudinally and laterally in the shelter
4. Vehicle doors in each end for easy entry and exit of equipment up to and including Size 2 snow tractors and Size 4 standard tractors (10-1/2 feet wide by 9 feet high)

5. A personnel door
6. An electrical harness to provide general lighting and convenience outlets for electrically driven power tools
7. An optional floor for converting the maintenance shelter to a shop
8. An equipment-repair wanigan outfitted with shop equipment, tools, and accessories for general repair of all types of equipment

PACKAGED SHELTER COMPONENTS

Components for the packaged portable maintenance shelter include a shelter, electrical harness, traveling hoist, personnel door, equipment-repair wanigan, shop equipment and tools. The cost, shipping weight, and cube of these components are given in Table I. Based on 1962 prices, the cost of the maintenance shelter and outfitting is $10,848. Packaged for shipment, it weighs 6198 pounds and occupies 538 cubic feet. Based on 1962 prices, the cost of the equipment-repair wanigan and outfitting is $16,000. Packaged for shipment, it weighs 15,130 pounds and occupies 987 cubic feet. The total cost for the packaged shelter is $26,848. Packaged for shipment, it weighs 21,328 pounds and occupies 1525 cubic feet.

PACKAGED SHELTER DESCRIPTION

The portable maintenance shelter was developed by the Naval Civil Engineering Laboratory, and an NCEL standard portable wanigan[2] was outfitted with shop equipment and tools as a companion piece to the shelter. A schedule of the drawings for the shelter and the equipment wanigan is given in Appendix A. Copies of these drawings are available from the Naval Civil Engineering Laboratory. Specifications and reduced scale drawings for the shelter, and outfitting for the equipment-repair wanigan have been published in TN-602.[4] An erection manual for the shelter and wanigan has been published in TN-587.[5]

Maintenance Shelter

The portable maintenance shelter (Figure 1) is an aluminum, arch-rib structure with a canvas cover. It is 20 feet wide, 24 feet long, and 10 feet high at the haunch of the arch. The frame is erected on skids which provide local portability. Pallet-type flooring is used. The quantity and weight of the building parts are given in Table II. By changing the floor, the equipment-repair wanigan is also suitable for use as a shop; Appendix B presents the optional floor capable of supporting shop equipment.

Table I. Cost, Shipping Weight, and Cube of the Shelter and Wanigan Components

Component	1962 Cost	Shipping Weight (lb)	Shipping Space (cu ft)
Portable Maintenance Shelter			
Shelter	$ 9,126	5,258	426
Traveling hoist	1,312	650	80
Personnel entry	110	90	8
Electrical harness	300	200	24
Total	$10,848	6,198	538
Equipment Wanigan			
Wanigan with standard outfitting	$ 6,600	5,890	350
Shop equipment	5,600	6,200	500
Tools	3,800	3,040	137
Total	$16,000	15,130	987
Total Packaged Shelter	$26,848	21,328	1,525

Table II. Quantity and Weight of Parts for the Shelter

Item	Quantity	Unit Weight (lb)	Total Weight (lb)
Skids	2	280	560
Columns	14	35	490
Arches	7	84	588
Purlins	90	2	180
Turnbuckle rods (10-foot)	8	3	24
Skirt panel	12	12	144
End struts	2	72	144
Cables	8	4	32
Right end covers	2	33	66
Left end covers	2	33	66
Gable covers	2	10	20
Roof blankets	6	44	264
Belly bands	7	12	84
Spreader bars	2	56	112
Turnbuckle rods (31-foot)	2	24	48
Total Shelter Weight			2,822

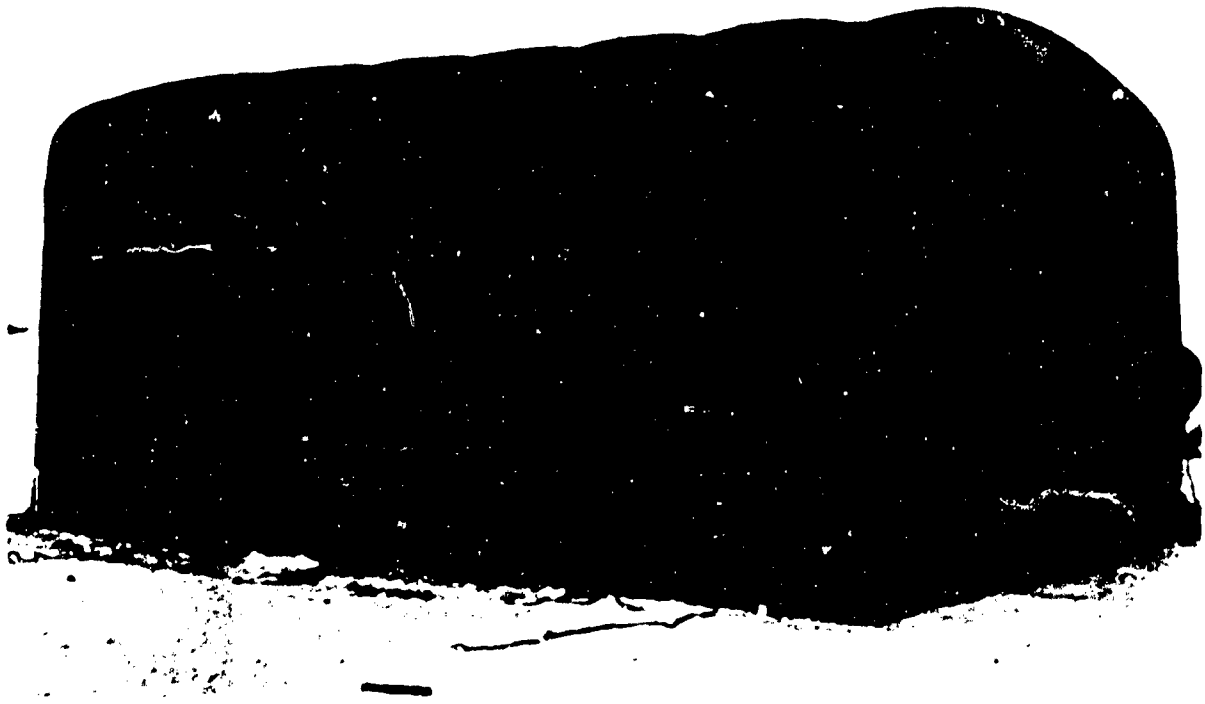

Figure 1. The portable maintenance shelter.

Floor. The floor for the maintenance shelter consists of six pallets, 3 feet wide by 27 feet long. Each pallet is constructed of 2 by 6's, 3 feet long, and 2 by 6 stringers. The pallets are laid side by side across the width of the shelter to form an 18- by 27-foot floor. These pallets are used as crating material for packaging the shelter (Figure 2).

Frame. The 5-inch aluminum I-beam arch ribs are composed of two 10-foot columns and an arch bolted together. The arch is curved to a 23-foot 6-7/8-inch radius. The haunch at each end of the arch for the transition from the arch to the column is curved to a 1-foot 6-inch radius. The ribs are spaced 4 feet apart with the base of the columns bolted to skids. T-section purlins space the ribs and provide support for the roof covers. Aluminum panels, 1 foot 9 inches high by 4 feet long, are bolted to the outer flange at the base of the columns along each side of the shelter; this provides a skirt to which the ends of roof covers can be attached (Figure 3). Turnbuckle rods provide cross bracing between columns in end bays. The ends of the shelter have no framing except a removable aluminum I-beam across the width of the shelter 4 feet above ground level to provide support for the end blankets in high winds.

Cover. The canvas cover for the maintenance shelter is a single thickness of coated nylon. Roof covers are wide enough for one 4-foot bay with 9 inches overlap. Belly bands are placed over each rib to further secure the covers. The ends of the belly bands and the roof covers are secured to the skirt panels with hook buckles. Straps are provided on the inner face of all covers for tying them to the frame (Figure 4).

The end covers consist of three parts. Right and left curtains slide horizontally on cables to provide a large opening for equipment. The space above the curtains is closed with a gable cover. The curtains are fastened with harness snaps to cables stretched across the ends of the shelter at the base and at the top of the columns. Right and left curtains slide on separate sets of cables and overlap about 2 feet at the center. The cables are tightened with turnbuckles. These turnbuckles on the lower cables must be loosened for equipment to drive over them.

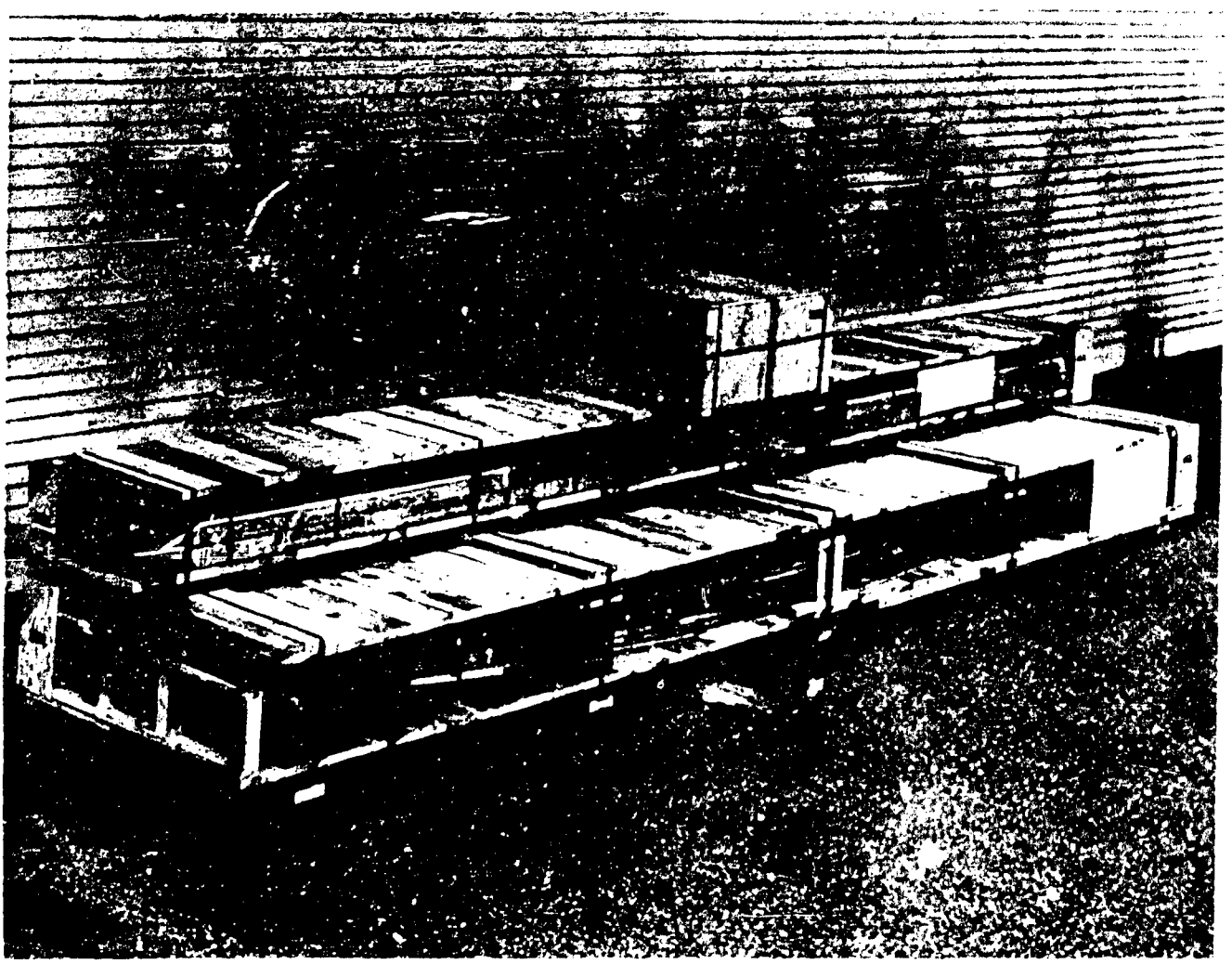

Figure 2. The portable maintenance shelter packaged in pallet-type flooring.

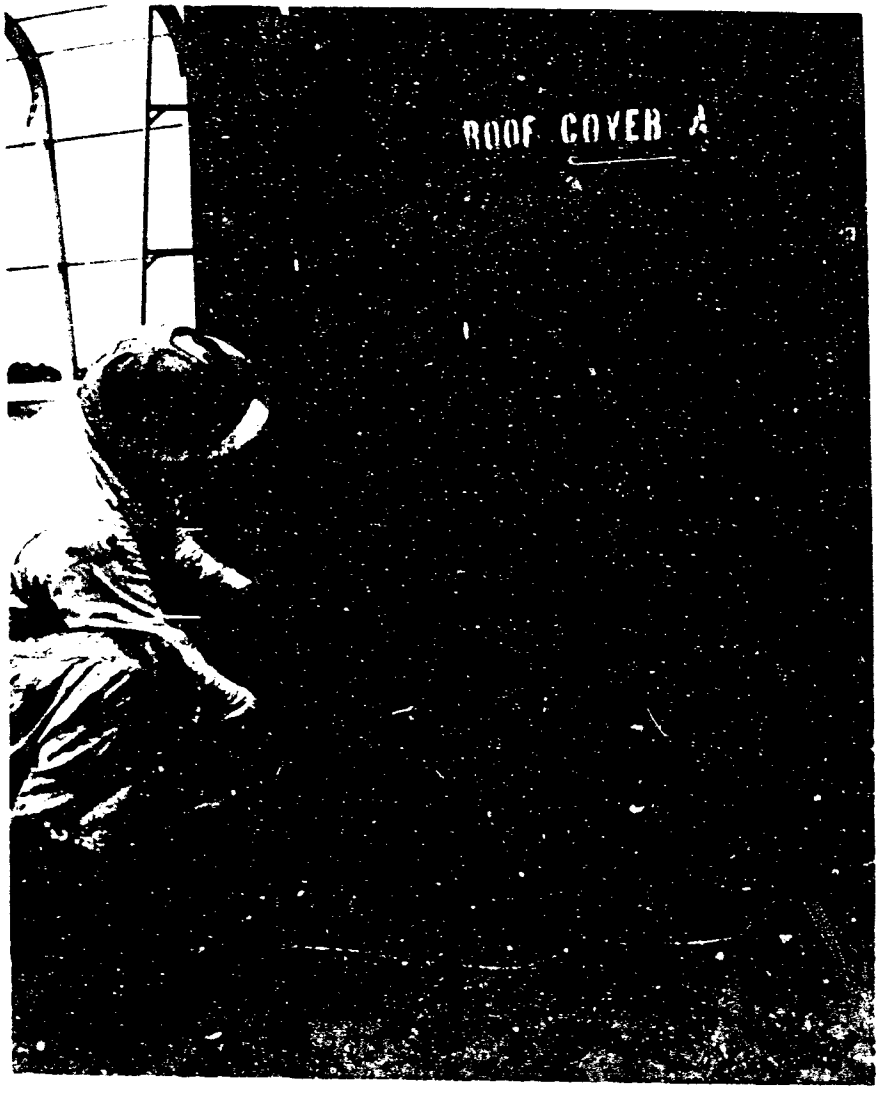

Figure 3. Attaching a roof cover to a skirt panel.

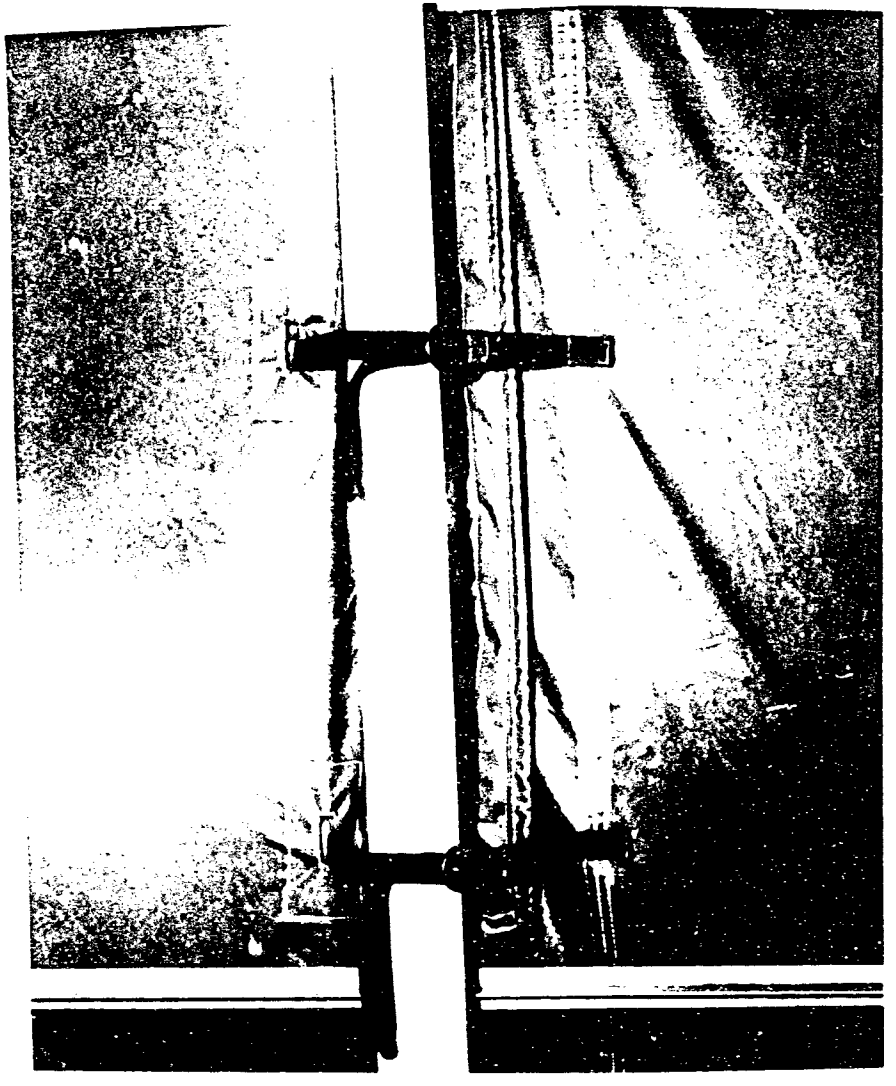

Figure 4. Straps for tying the cover to the frame.

Traveling Hoist. The skids for the shelter are 2 feet wide, providing a large bearing area to distribute the load and adequate space for a track in which the end supports for a traveling hoist can move longitudinally through the shelter. The 2-ton-capacity hoist travels laterally across the shelter on an aluminum I-beam. The beam is supported on each end by adjustable A frames on wheels which travel in the track provided by the skids.

Personnel Door. A 1-inch plywood door panel is provided for a personnel entry. This panel can be placed in any bay along the side of the shelter by bolting it to the column flanges. The skirt panel is removed and the end of the roof cover is cut off to accommodate the plywood door panel.

Electrical Harness. The electrical harness for the shelter provides general lighting and outlets for the operation of shop equipment and tools. The harness is prefabricated sections of conduit containing the appropriate number of wires. Sections are connected to each other with wire connectors and flexible conduit connectors.

The electrical harness consists of an eight-circuit, 100-ampere, single-phase distribution panel; six ceiling lights with reflectors; six outlet boxes with a duplex 110-volt outlet and a twist-lock, 220-volt outlet in each box. The lights are in two rows located 5 feet from each edge of the building. Convenience outlets are mounted on columns along each side of the shelter about 6 feet above the base. At this height, they do not interfere with the personnel door.

The electrical power requirement for the shelter is 2-1/2 kw. An electrical generator is not supplied with the shelter because the application and consequent availability of electrical power is unknown. The requirement of power and heat for the shelter can be satisfied by using the utility service sled described in TR-276.[6] This sled is equipped with a gasoline-engine-driven 8.75-kw electrical generator, a gasoline-engine-driven 400,000-Btu/hr-output, fresh-air heater, a 180-ampere arc welder, and a portable oxyacetylene cutting outfit.

Towing Braces. For towing, the base of the shelter is braced with a spacer bar at each end and bracing between diagonally opposite corners. The spacer bars are 4-inch-diameter aluminum pipe placed across the ends of the shelter to space the skids 18 feet apart. The bars are secured to the ends of the skids with pinned connections. Diagonal bracing is provided by two 31-foot, steel turnbuckle rods which are secured to diagonally opposite ends of skids with pinned connections. No towing assembly is provided with the shelter; however, steel straps attached through holes in the ends of the skids can be used for this purpose.

Equipment-Repair Wanigan

The NCEL standard portable camp wanigan (Figure 5) is 8 feet wide by 8 feet high by 20 feet long and is built on a skid system for local movement.[2] Standard accessories for the wanigan include a heating and ventilating system, an electrical harness, and a side-mounted fuel tank. To outfit an equipment-repair wanigan, an additional side-mounted fuel tank for gasoline is provided and shop equipment and tools are added. Figure 6 shows the layout. The power requirement for the wanigan is 2-1/2 kw.

ERECTION AND PERFORMANCE

A prototype of the portable maintenance shelter and the equipment-repair wanigan were in-service tested at the NCEL field camp on the Ross Ice Shelf during the FY-63 and 64 antarctic summer seasons.

Figure 5. Standard NCEL portable wanigan.

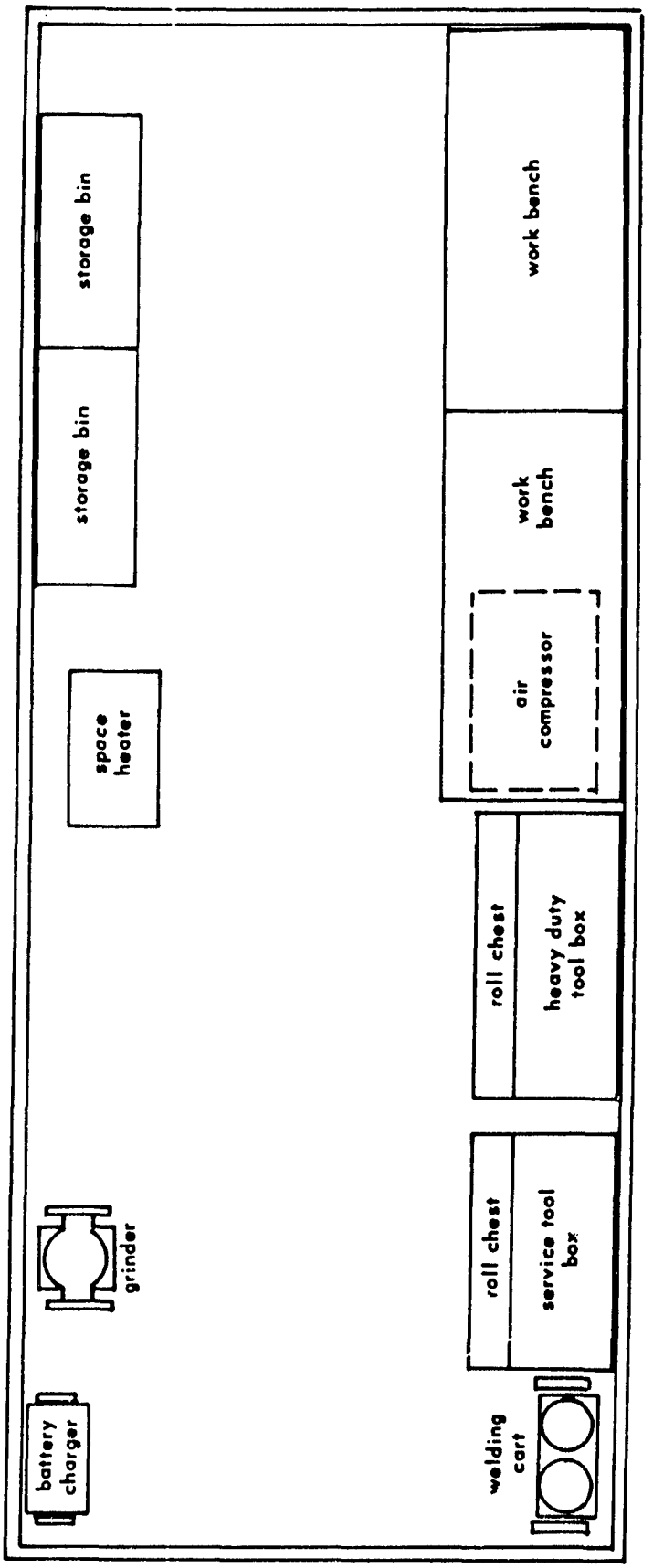

Figure 6. Layout of equipment-repair wanigan.

Maintenance Shelter

The first erection of the frame and cover was accomplished by a 4-man crew in 48 manhours. The floor pallets were installed by a 2-man crew in 8 manhours. After the purlins were installed, they were used for climbing on the structure to secure the cover. There was no difficulty in handling the cover during the first erection which was accomplished at about 20 F; however, when the revised endwall covers were installed, at about 0 F, they were too stiff to handle well. This indicates that the cover should be warmed before the shelter is erected in temperatures below 20 F. Also, one end curtain was made 2 inches wider for easier fastening. A man had to climb over the roof of the shelter to position each belly band exactly over the arch ribs.

The shelter was windtight and quite warm from solar radiation alone. A Herman Nelson heater raised the temperature in the shelter from 18 F to 112 F in one hour and bellowed out the sides.

Wind pushed in the endwall and strained zippers on the roll-up flaps during the first year. In winds of 25 mph, the endwall covers were pushed in about 16 inches, and the end belly bands were flipped off. This was corrected the second year by new endwall covers which operated as curtains, sliding horizontally on cables at top and bottom; this eliminated the need of zippers and provided horizontal support by the use of cables. A removable strut spanning between end columns at their mid-height provided additional horizontal support for the end covers.

The traveling hoist worked very well, but was limited in height of lift due to the low column height in the shelter. In one instance, the hoist was rolled outside the shelter to remove a cab from a Size 2 snow tractor.

During the two seasons of use, the shelter was adequate in size for the repair and maintenance of weasels, Size 1 and Size 2 dual-rail snow tractors, snow mixers, and other miscellaneous construction equipment. The shelter was used only during the summer season; temperatures ranged from 0 F to 41 F and winds to 40 knots.

At the end of the first season, the shelter cover was removed and stored until the following season. Snow drifted in around the frame to a depth of about 4 feet. After the snow was scooped away, the frame was easily moved to another location nearby without installing the towing braces. There was no difficulty in the skids freezing in.

At the end of the second season, the portable maintenance shelter was easily towed from the NCEL camp to the McMurdo sea-ice runway camp, a distance of approximately 5 miles. The terrain was relatively flat, but snowdrifts made

undulations in the surface and there was a 5-foot drop between the shelf ice and the sea ice. The 5-mile move took about 45 minutes with a Size 1 snow tractor. When preparing the shelter for tow, one of the diagonal, aluminum turnbuckle rods broke when it was tightened. The design was changed to provide diagonal, steel turnbuckle rods.

Equipment-Repair Wanigan

The equipment-repair wanigan was erected beside the maintenance shelter. Erection of the wanigan required 3 men working 32 manhours. The wiring harness, heater, work benches, storage cabinets, and shop equipment were uncrated, assembled, and installed by 2 men in 16 manhours.

The wanigan was warm and convenient for small repair jobs. It was also adequate for storage of tools and parts.

FINDINGS

1. The portable maintenance shelter is easily erected in 48 manhours, easily portable on snow, and adequate for maintenance and repair of equipment as large as a Size 2 snow tractor and a Size 4 standard tractor.

2. The maintenance shelter weighs 6198 pounds and occupies 538 cubic feet packaged for shipment. Based on 1962 prices, it costs $10,848.

3. The equipment-repair wanigan provides adequate space, tools, and equipment for the portable maintenance shelter.

4. The equipment-repair wanigan weighs 15,130 pounds and occupies 987 cubic feet packaged for shipment. Based on 1962 prices, it costs $16,000.

CONCLUSION

The portable maintenance shelter and equipment-repair wanigan are well suited for the maintenance and repair of equipment at pioneer polar camps and should be included as a facility for any pioneer camp in the polar regions.

REFERENCES

1. U. S. Naval Civil Engineering Laboratory. Technical Report R-267: A 25-man pioneer polar camp, by G. E. Sherwood. Port Hueneme, Calif., 16 October 1963.

2. U. S. Naval Civil Engineering Laboratory. Technical Report R-309: NCEL Wanigans, by J. E. Dykins, G. E. Sherwood, and C. R. Hoffman. Port Hueneme, Calif., 9 June 1964.

3. U. S. Naval Civil Engineering Laboratory. Technical Report R-241: Pioneer polar structures — Accessories for the Jamesway shelter, by G. E. Sherwood. Port Hueneme, Calif., 28 May 1963.

4. U. S. Naval Civil Engineering Laboratory. Technical Note N-602: Pioneer polar structures — Specifications and outfitting for the portable maintenance shelter, by G. E. Sherwood. Port Hueneme, Calif., 4 June 1964.

5. U. S. Naval Civil Engineering Laboratory. Technical Note N-587: Pioneer polar structures — Erection of the portable maintenance shelter, by R. W. Hansen and G. E. Sherwood. Port Hueneme, Calif., 26 May 1964.

6. U. S. Naval Civil Engineering Laboratory. Technical Report R-276: Polar construction equipment — Utility service sled, by S. E. Gifford. Port Hueneme, Calif., 8 November 1963.

Appendix A

SCHEDULE OF DRAWINGS FOR THE PORTABLE MAINTENANCE SHELTER AND THE EQUIPMENT-REPAIR WANIGAN

Y&D Drawing No.	Title
	Maintenance Shelter
936918	Portable Shop Structure — Aluminum Fabrication
936948	Portable Shop Structure — Floor, Bracing, Electrical
936949	Portable Shop Structure — Cover Details
936920	Portable Shop Structure — Erection
936951	28- by 44-foot Maintenance Shelter — Floor, Side Entry, Electrical
	Equipment-Repair Wanigan
993670	Standard Portable Wanigan — Fabrication Requirements
993671	Standard Portable Wanigan — Assembly
993678	Standard Portable Wanigan Floor — Assembly
993679	Standard Portable Wanigan Floor — Skids and Cross Members
993680	Standard Portable Wanigan Floor — Frame, Panels, and Connectors
993681	Standard Portable Wanigan Floor — Tongue
993690	Wanigan Sidewall — MK-4 and MK-6 Panels

Y&D Drawing No.	Title
993691	Wanigan Sidewall — MK-5 Panel
993692	Standard Portable Wanigan Endwall — MK-25 and MK-26 Panels
993693	Standard Portable Wanigan Endwall — MK-27 Panel
993699	Portable Wanigan Door — MK-20 Panel
993700	Portable Wanigan Door — MK-21 Panel
993701	Standard Wanigan Roof — MK-22 Panel
993702	Standard Wanigan Roof — MK-23 Panel
993703	Standard Wanigan Roof — MK-24 Panel and MK-7 Gusset Plate
993707	Wanigan Accessories — Heating and Ventilating System
993708	Wanigan Accessories — Electrical Harness
993709	Wanigan Accessories — Side-Mounted Fuel Tank

Appendix B

SHOP FLOOR FOR THE SHELTER

The portable maintenance shelter was designed as a repair and maintenance facility for large equipment; however, there may be situations in which it would be useful as a shop. This use would require a floor suitable for supporting shop equipment. The acceptable strength for shop floors is 150 psf.

Description

The shop floor was designed to support the required 150 psf. It consists of 9-inch aluminum I-beams spanning the width of the shelter and supporting 1-1/8-inch tongue-and-groove plywood (Figure 7). The aluminum I-beams are supported at each end by brackets which bolt to the skids. Beams are spaced 4 feet apart and coincide with the shelter ribs. The 4- by 8-foot plywood sheets have a tongue on one side and one end and a groove on the opposite side and end. These sheets are placed with the 8-foot length spanning across two bays, and are screwed to the top flange of the beams with self-tapping screws. The installed floor is 20 by 24 feet.

Installation

To install the shop floor, insert the brackets attached to each end of the floor I-beam into the free track of the skids at one end of the shelter, and match bolt holes with the inside edge of the skid. Bolt each end with two bolts. Repeat this every 4 feet through the length of the building, installing seven beams.

Place a 4- by 8-foot plywood panel with an 8-foot edge flush with the ends of the floor beams and one end over the center of an end floor beam. Place another panel adjacent to the first one and push matching tongue and groove tightly together. Repeat this installation across the width of the building until five panels are in place. Place a panel at one edge of the building in the two center bays. Install five of these panels across the building as in the first row. Repeat the above operation on the remaining two bays of the building.

When all panels are in place, drill No. 8 holes in each panel at locations shown in Figure 8, and insert a self-tapping screw at each hole.

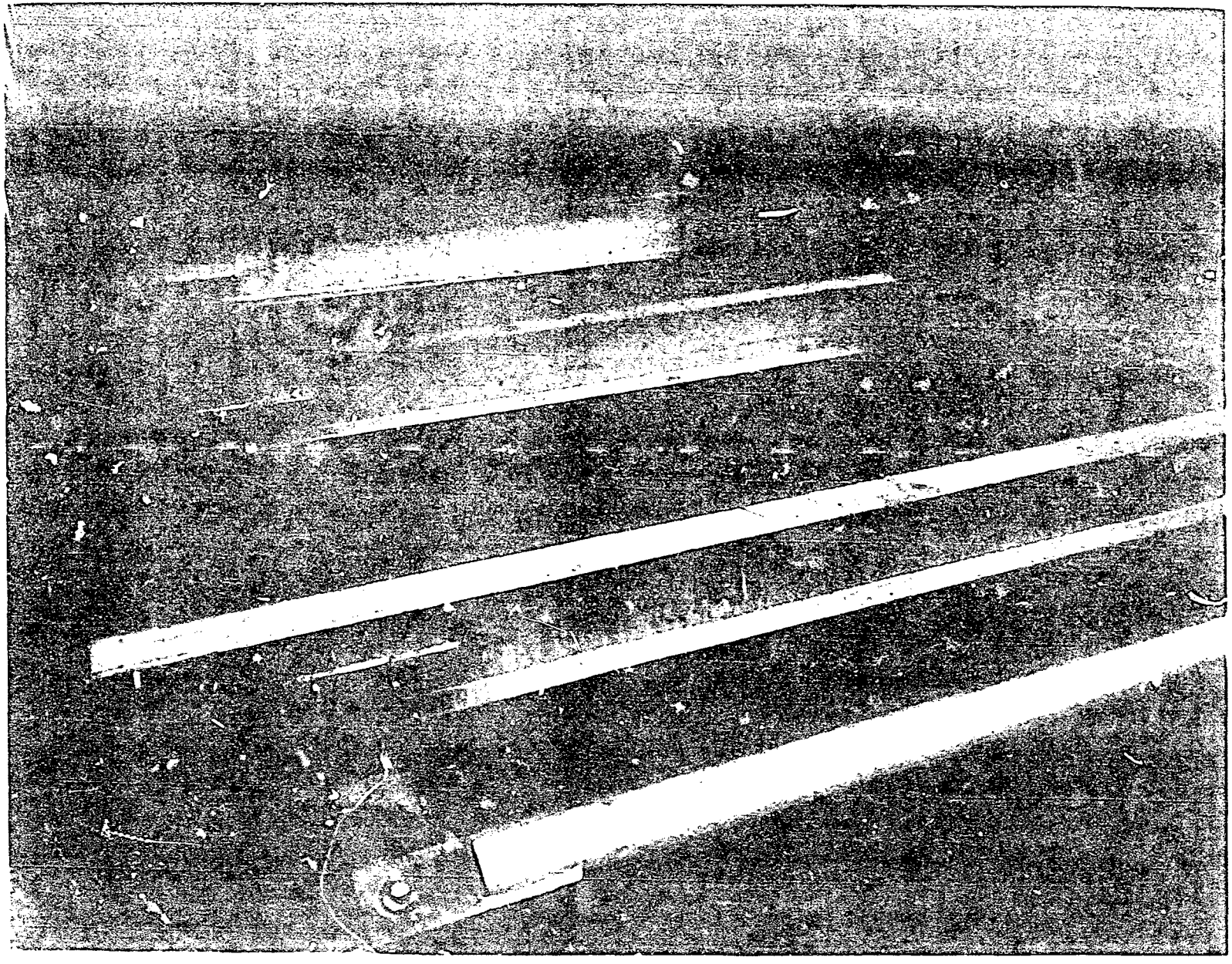

Figure 7. Shop floor with two plywood panels removed to show beams.

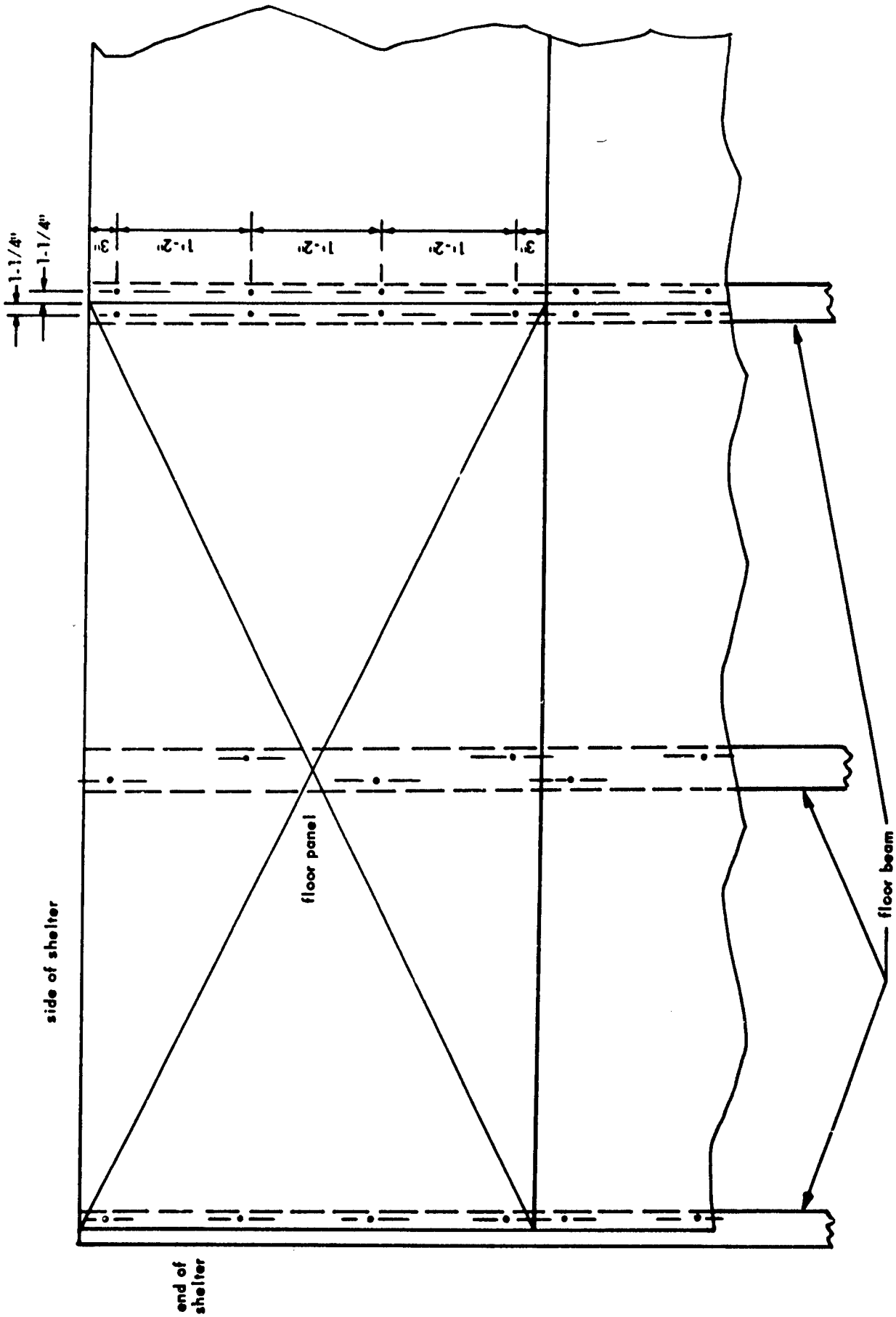

Figure 8. Installation of floor panel.