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Technical Report

POLAR STRUCTURES —
THE NCEL FAMILY OF WANIGANS

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POLAR STRUCTURES — THE NCEL FAMILY OF WANIGANS

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by

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ABSTRACT

The need for portable shelters for trail operations, transient field camps, and remote construction areas in polar regions led to the development and evaluation of a family of wanigans. The basic wanigan in this family is the Standard NCEL Sled Wanigan, which is 8 feet wide and 20 feet long. A 10-foot-wide version of this wanigan is called the Extra-Wide NCEL Sled Wanigan. Both of these wanigans must be mounted on bobsleds for mobility. For limited mobility independent of a sled, a heavy-duty floor and skid system was developed for the wanigans. These skid-mounted units are called the Standard NCEL Portable Camp Wanigan and the Extra-Wide NCEL Portable Camp Wanigan. All are of a prefabricated, panelized construction with interchangeable components. The two standard wanigans are air-transportable in a C-130 aircraft; the two extra-wide wanigans must be disassembled for shipment in this aircraft. A basic heating and ventilating kit, an electrical harness, and a side-mounted fuel storage tank were developed for the wanigans. These are adequate for most general applications.

Prototypes of both sled wanigans and both portable camp wanigans were tested and evaluated at polar field sites. These tests demonstrated that the sled wanigans are well suited for housing the facilities required on sled train operations in polar regions, and that the portable camp wanigans are well suited for housing those facilities required at transient field camps and isolated construction sites.

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INTRODUCTION

Portable structures are required for housing personnel, equipment, utilities, and other facilities at transient work camps away from an established polar station. Also, they are needed for polar tractor trains engaged in overland supply, exploration, and movement of personnel. In the early days of mechanized polar operations, these needs were fulfilled with field-fabricated structures, called wanigans, mounted on cargo sleds. As polar activities increased, so did the requirements for wanigans. Present operations in Antarctica indicate an increasing need for portable structures which are also air-transportable.

Modern polar operations require wanigans for two general categories: sled wanigans for trail use, and camp wanigans for transient work areas. The sled wanigan is needed to berth and feed personnel on the trail. The camp wanigan may be needed to house personnel, but it is also required to house equipment, to provide shop space, and to protect utilities at work areas located away from an established camp or station. The camp wanigan must have limited mobility, but this requirement is far less stringent than the portability required on the trail.

In order to develop a versatile wanigan which could be easily altered to fit this variety of requirements, the Laboratory developed a basic wanigan of modular design with a maximum interchangeability of parts. Following this, it developed a heavy-duty floor and skid system for the basic wanigan. These two developments resulted in a family of four wanigans suitable to a variety of applications on the trail and at isolated work areas.

The basic wanigan, which is designed for use with a cargo sled, is available in two widths. The standard sled wanigan is 8 feet wide, 8 feet high, and 20 feet long. It can be transported by C-130 aircraft without disassembly. The extra-wide sled wanigan is 2 feet wider. It must be disassembled for air shipment, but the extra width permits more versatility in application. Both models of the sled wanigan can be converted to portable camp wanigans by replacing the floor panels with the heavy-duty floor and skids. The portable wanigans are best suited to applications where heavy floor loads are involved or when mobility independent of a cargo sled is desired. The standard 8-foot-wide portable camp wanigan is also air-transportable without disassembly.

BACKGROUND

Tractor trains were used extensively by the Navy in northern Alaska following World War II in support of oil exploration in Naval Petroleum Reserve Number 4. Sled wanigans were used for a variety of purposes on these trains. Their size and shape were dependent upon the particular requirements at the time; their design and fabrication were dependent upon the materials available for construction.

In 1947 the Laboratory undertook the development of a prefabricated, panelized wanigan for sled train operations. This development, which is reviewed in Appendix A, resulted in the standard and extra-wide sled wanigans described in this report. Five of the extra-wide sled wanigans were fabricated by the Laboratory for Deep Freeze I. Three of these units were outfitted as sleeping wanigans and two were outfitted as galleys. These wanigans were used in numerous sled train operations in Antarctica between 1956 and 1958.[1]

To increase the versatility of the wanigan and to provide it some degree of mobility independent of a cargo bobsled, the Laboratory developed a heavy-duty floor and skid system and a double-door end section for its sled wanigans in 1958. These developments are described in Appendix B. Prototypes of the skid-mounted wanigans, called portable camp wanigans, were evaluated by the Laboratory at field sites in Alaska[2] and Antarctica between 1959 and 1963.

Several basic accessories were developed for the NCEL wanigans between 1959 and 1963. These included a heating and ventilating kit, an electrical harness, and an 80-gallon side-mounted fuel tank. These developments and other utility requirements for wanigans are discussed in Appendix C.

DESIGN REQUIREMENTS

The general requirement for developing the NCEL family of wanigans was to provide portable shelters of simple design suitable for diversified usage. Some specific requirements were used in the initial development. Other requirements were brought to light during development and evaluation of prototypes. The four NCEL wanigans were designed to satisfy these requirements:

1. General

   a. Design suitable for fabrication in small shops

   b. All components of a size and weight for easy erection without weight-lifting equipment

c. Components with size and weight restrictions to permit transport by C-130 or similar aircraft

2. Design Loads

a. Snow load, 20 psf

b. Wind load, 70 miles per hour

c. Standard floor load, 40 psf

d. Heavy-duty floor load, 2500-pound spread load in the center section of each bay

3. Configuration

a. A 20-foot length with 8- and 10-foot widths

b. An 8-foot ceiling height

c. Flexibility in placement and size of doors and windows to comply with specific use requirements

4. Construction

a. Insulated and vapor-sealed panels with gasketed joints providing an overall heat-loss from conduction and infiltration no greater than 0.15 Btuh/^{o}F for each square foot of exterior surface

b. Panel-joint gaskets which remain pliable at -65 F

c. Panel fasteners which will not loosen under vibration and racking motion

5. Heavy-Duty Floor and Skid System

a. Interchangeable with the standard floor without adaptors

b. Skids supporting the floor with a ground-bearing pressure of 3 to 4 psi based on a gross wanigan weight of 14,000 pounds

c. A skid system suitable for towing from either end with an approach angle of the skid no greater than 27 degrees

6. Heater

   a. Capable of providing a 70 F interior temperature in an ambient temperature of -65 F

   b. Capable of starting at -65 F without the aid of an auxiliary heat source

   c. Capable of operating under rough trail conditions and without electricity

   d. Operation on arctic-grade diesel fuel

   e. Discontinuance of fuel flow if the fire goes out

   f. Easy maintenance by untrained personnel

7. Ventilation

   a. Can be dependent upon electrical power

   b. Positive fresh-air intake and exhaust independent of wind direction and velocity

   c. Adequate air change to control smoke and odors, commensurate with the need for heat conservation

   d. Simple adjustments of air volume to change ventilation to correspond with requirements

NCEL FAMILY OF WANIGANS

Standard Sled Wanigan

The standard sled wanigan (Figure 1) is 8 feet wide, 8 feet high, and 20 feet long. It is made up of 4-foot-wide floor, wall, and roof panels, which are bolted together to form an integral structure. Personnel entry-door panels are provided at each end of the wanigan, and two window panels are provided for the sidewalls. Based on 1962 prices, the cost of this wanigan complete with a basic electrical harness, a basic heating and ventilating kit, and a side-mounted fuel tank is $4850 (Table I). The net weight of the standard sled wanigan is 2864 pounds. Packaged for shipment it weighs 3410 pounds and occupies 340 cubic feet.

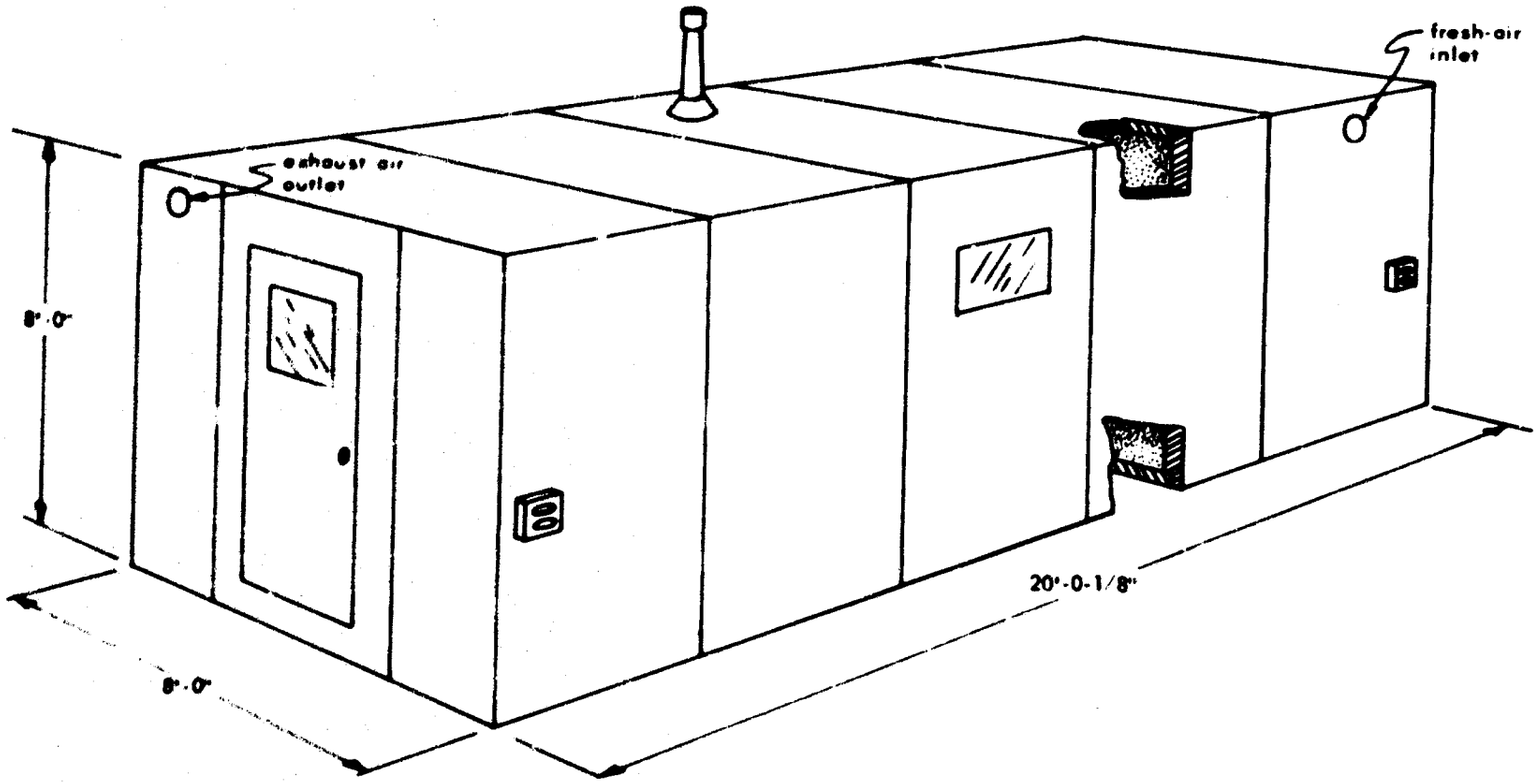

Figure 1. Standard NCEL sled wanigan.

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

Components	Cost ($)			Shipping Weight (lb)	Shipping Space (cu ft)
	Labor	Material	Total		
Walls and Roof	2,350	950	3,300	2,410	240
Standard Floor	650	250	900	600	60
Electrical Harness	50	100	150	80	10
Heating & Ventilating Kit	50	150	200	150	14
Fuel Tank	250	50	300	170	16
Totals	3,250	1,500	4,850	3,410	340

Extra-Wide Sled Wanigan

The extra-wide sled wanigan is 10 feet wide, 8 feet high, and 20 feet long. Except for width, it is identical to the standard sled wanigan. Based on 1962 prices, the cost of this wanigan complete with a basic electrical harness, a basic heating and ventilating kit, and a side-mounted fuel tank is $5150 (Table II). The net weight of the extra-wide sled wanigan is 3228 pounds. Packaged for shipment it weighs 4160 pounds and occupies 420 cubic feet.

Standard Portable Camp Wanigan

The standard portable camp wanigan (Figure 2) is 8 feet wide, 8 feet 9-7/8 inches high, and 21 feet 4-1/4 inches long. It is made up of standard sled wanigan wall and roof panels, and a heavy-duty floor and skid system. Double doors are provided at each end of the wanigan, and two window panels are provided for the sidewalls. Based on 1962 prices, the cost of this wanigan complete with a basic electrical harness, a basic heating and ventilating kit, and a side-mounted fuel tank is $6600 (Table III). The net weight of the standard portable camp wanigan is 4740 pounds. Packaged for shipment it weighs 5890 pounds and occupies 350 cubic feet.

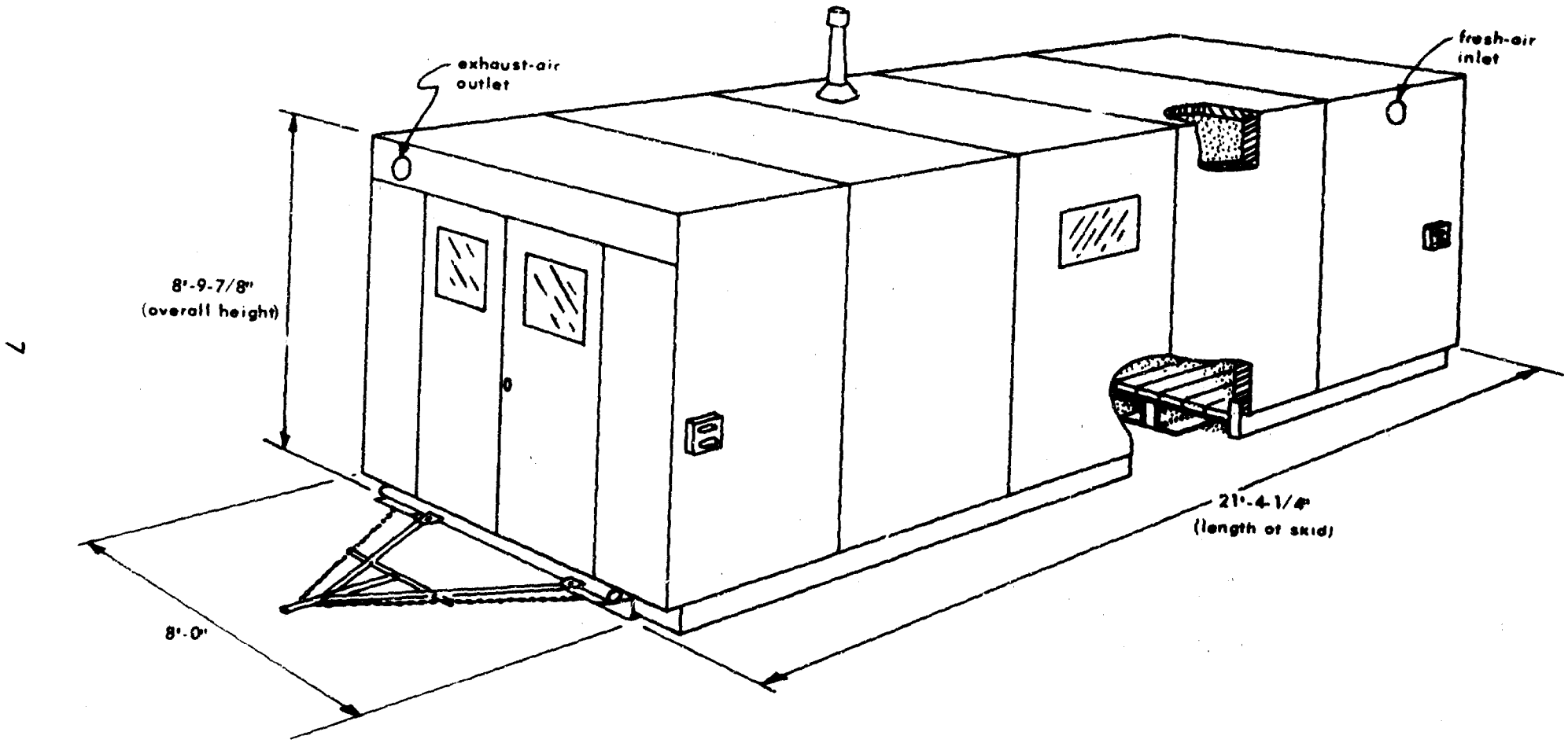

Figure 2. Standard NCEL portable camp wanigan.

Table II. Cost, Shipping Weight, and Cube of the Extra-Wide Sled Wanigan Components

Components	Cost ($)			Shipping Weight (lb)	Shipping Space (cu ft)
	Labor	Material	Total		
Walls and Roof	2,350	1,200	3,550	3,010	300
Standard Floor	650	300	950	750	80
Electrical Harness	50	100	150	80	10
Heating & Ventilating Kit	50	150	200	150	14
Fuel Tank	250	50	300	170	16
Totals	3,350	1,800	5,150	4,160	420

Table III. Cost, Shipping Weight, and Cube of the Standard Portable Camp Wanigan Components

Components	Cost ($)			Shipping Weight (lb)	Shipping Space (cu ft)
	Labor	Material	Total		
Walls and Roof	2,350	950	3,300	2,410	240
Skid-Mounted Floor	1,900	750	2,650	3,080	70
Electrical Harness	50	100	150	80	10
Heating & Ventilating Kit	50	150	200	150	14
Fuel Tank	250	50	300	170	16
Totals	4,600	2,000	6,600	5,890	350

Table IV. Cost, Shipping Weight, and Cube of the Extra-Wide Portable Camp Wanigan Components

Components	Cost ($)			Shipping Weight (lb)	Shipping Space (cu ft)
	Labor	Material	Total		
Walls and Roof	2,350	1,200	3,550	3,010	300
Skid-Mounted Floor	1,900	950	2,850	3,750	90
Electrical Harness	50	100	150	80	10
Heating & Ventilating Kit	50	150	200	150	14
Fuel Tank	250	50	300	170	16
Totals	4,600	2,450	7,050	7,160	430

Extra-Wide Portable Camp Wanigan

The extra-wide portable camp wanigan is 10 feet wide, 8 feet 9-7/8 inches high, and 21 feet 4-1/4 inches long. Except for width, it is identical to the standard portable camp wanigan. Based on 1962 prices, the cost of this wanigan complete with a basic electrical harness, a basic heating and ventilating kit, and a side-mounted fuel tank is $7050 (Table IV). The net weight of the extra-wide portable camp wanigan is 5243 pounds. Packaged for shipment, it weighs 7160 pounds and occupies 430 cubic feet.

DESCRIPTION OF COMPONENTS AND ACCESSORIES

The quantity and weight of the parts required for each of the four NCEL wanigans are listed in Tables V through VIII. Three basic accessories are provided with each NCEL wanigan. These are a heating and ventilating kit, an electrical harness, and a side-mounted fuel tank. In some cases these basic accessories will not be adequate for specific applications. Appendix C should be reviewed for this determination.

All items for the wanigans are of special fabrication except the heater. This item is available from commercial sources. The drawings required for fabrication and construction of the wanigans are listed in Appendix D. All items are suitable for small shop fabrication.

Table V. Quantity and Weight of Parts for the Standard Sled Wanigan

Item	Quantity	Unit Weight (lb)	Total Weight (lb)
Roof Panels	5	128	640
Sidewall Panels	10	82	820
Endwall Panels	4	46	184
Door Panels	2	105	210
Floor Panels	5	112	560
Fasteners & Misc			50
		Total Wanigan Weight	2,464

Table VI. Quantity and Weight of Parts for the Extra-Wide Sled Wanigan

Item	Quantity	Unit Weight (lb)	Total Weight (lb)
Roof Panels	5	158	790
Sidewall Panels	10	82	820
Endwall Panels	4	67	268
Door Panels	2	105	210
Floor Panels	5	138	690
Fasteners & Misc			50
		Total Wanigan Weight	2,828

Table VII. Quantity and Weight of Parts for the Standard Portable Camp Wanigan

Item	Quantity	Unit Weight (lb)	Total Weight (lb)
Walls and Roof			
Roof Panels	5	128	640
Sidewall Panels	10	82	820
Endwall Panels	6	35	210
Doors	4	55	220
Fasteners & Misc			50
		Total Wall and Roof Weight	1,940
Skid-Mounted Floor			
Floor Panels	5	140	700
Frame & Skids			1,700
		Total Skid-Mounted Floor Weight	2,400
		Total Wanigan Weight	4,340

Table VIII. Quantity and Weight of Parts for the Extra-Wide Portable Camp Wanigan

Item	Quantity	Unit Weight (lb)	Total Weight (lb)
Walls and Roof			
Roof Panels	5	158	790
Sidewall Panels	10	82	820
Endwall Panels	6	48	288
Doors	4	55	220
Fasteners & Misc			50
		Total Wall and Roof Weight	2,168
Skid-Mounted Floor			
Floor Panels	5	175	875
Frame & Skids			1,800
		Total Skid-Mounted Floor Weight	2,675
		Total Wanigan Weight	4,843

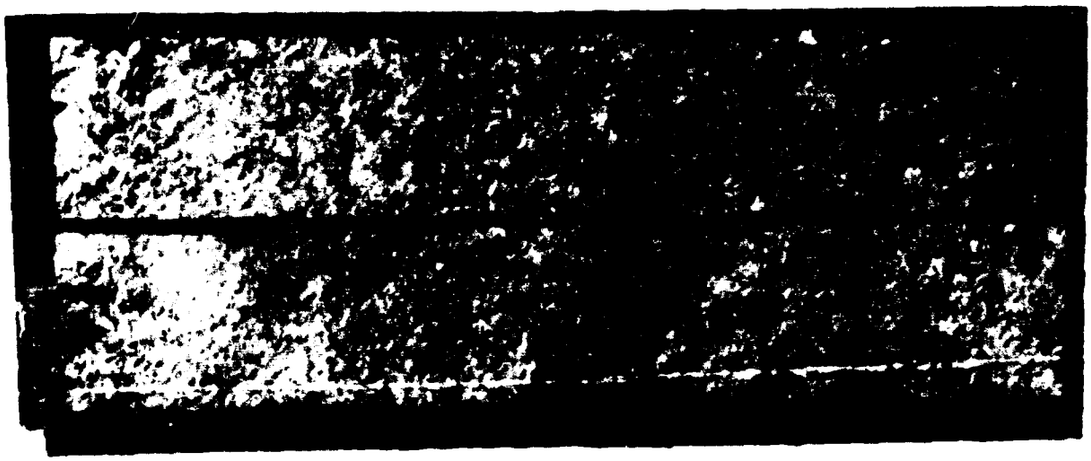

Figure 3. Typical panel construction. Plywood skin removed to show framing and insulation.

Wanigan Panels

The wanigan panels are based on a 4-foot module. Both lap and butt joints are used to join the panels. The lap joints are connected with through bolts; the butt joints are connected with bolts threading into blind nuts.

All of the panels are of stressed-skin hollow-core design. Except for the roof panel, which is crowned on top, all panels are 2 inches thick. The typical panels consist of light wooden frames made of edge-grain Douglas fir faced with 1 4-inch exterior-type B-grade Douglas fir plywood on each side. The top of the roof panels are faced with 3 8-inch-thick plywood, and the traffic side of the floor panels are covered with a 1 4-inch tempered, hard-pressed fiberboard wearing surface. In assembly, all joints in the panels are glued and nailed for unity.

The wanigan panels are insulated with a 3 4-pound-density, 1-1 2-inch-thick fiberglass blanket, which is cut slightly oversize to completely fill the cavities formed by the framing members (Figure 3). Also, a vapor barrier is provided on the warm side of the panels with 0.015-inch-thick aluminum-clad plywood. The aluminum-clad plywood is used instead of aluminum foil bonded to the fiberglass insulation because it is continuous across the face of the panel and has a greater thickness and toughness. In application, the aluminum-clad plywood can be attached with the aluminum face out to provide a metal surface on the panel.

Heavy-Duty Floor and Skid System

The heavy-duty floor consists of five panels constructed of 2 x 6 tongue-and-groove timbers. This floor is not insulated. These panels rest on timbers which are placed transversely across the skids at 4-foot intervals. A predrilled 2 x 8 side rail around the perimeter of the floor is used to bolt the standard wanigan wall panels to the heavy-duty floor.

The skid system consists of two steel skids which are spaced for a tracking gage of 5-3/4 feet. At no penetration, the skids provide a 5-inch clearance under the floor and an 11-inch deck height. A tongue is provided for towing. It can be attached to either end of the skids.

Heating and Ventilating Kit

The basic heating and ventilation kit for the NCEL wanigans consists of a commercial mobile-home-type 25,000-Btuh space heater and 60-cfm wall-mounted intake-air and exhaust-air fixtures. The 25,000-Btuh vaporizing pot-type burner in the heater is suitable for use with all grades of diesel fuel. Gravity fuel flow to the burner is controlled by a float valve. A leakproof sheet-metal drip pan is used under the heater to catch fuel spillage. Standard vent pipe and a counterweighted draft regulator are used to exhaust the heater to the outside. A conventional roof jack is used for the vent pipe. The heater should be located near the center of the wanigan for most satisfactory heat distribution; however, other locations are acceptable.

The 60-cfm intake-air fixture (Figure 4) is mounted high on the sidewall behind the heater. It can be adjusted to discharge air across the ceiling or toward the floor. Also, it can be used to introduce fresh air, blend the inside and outside air, or only circulate the inside air. This is accomplished with the spring-loaded damper on the fixture. The 60-cfm exhaust-air fixture (Figure 5) is similar in design to the intake-air fixture. It is mounted as far as possible from the intake-air fixture to improve the cross flow of air. The spring-loaded damper on this fixture is used to regulate the quantity of air being exhausted from the wanigan.

Electrical Harness

The basic electrical harness for the wanigan consists of a 4-circuit, breaker-type panel box, plastic-jacketed cables, lighting fixtures, and convenience outlets. Three lights with reflectors on the longitudinal center of the ceiling provide general lighting. Four 15-ampere duplex outlets are spaced along each interior sidewall, and two watertight outlets are placed on each exterior sidewall. The circuit-breaker

panel is located at the center of one sidewall. The convenience outlets are mounted 4 feet above the floor so that, in most cases, furnishings will not interfere with their use. The outlets and fixtures are attached with wood screws; the wiring is held in place with clamps.

Side-Mounted Fuel Tank

The fuel supply for the heater is provided by a side-mounted 80-gallon fuel tank connected to the heater with soft-drawn copper tubing. Mounting brackets on the tank are 4 feet apart to match the standard panel bolt holes. This permits mounting the tank on any panel.

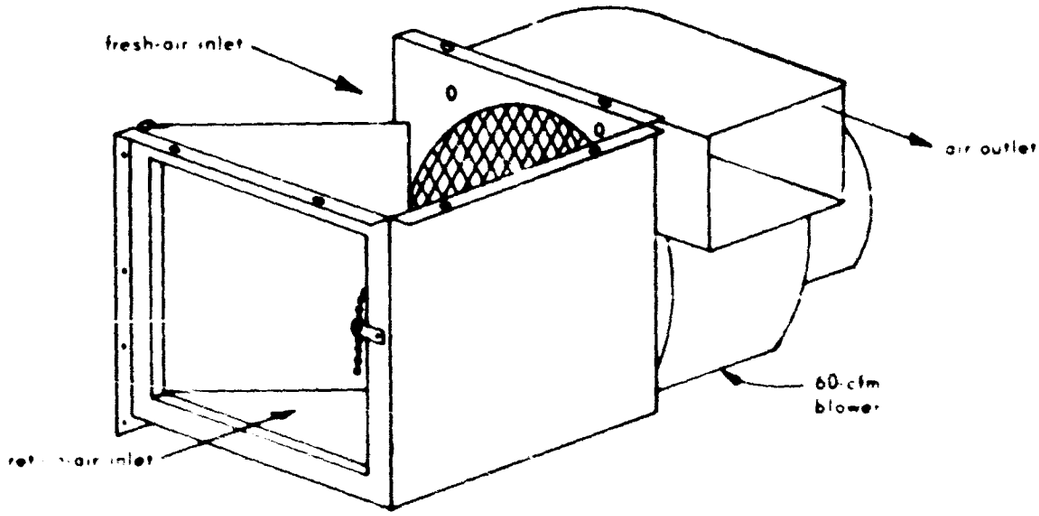

Figure 4. Intake-air fixture for the NCEL wanigans.

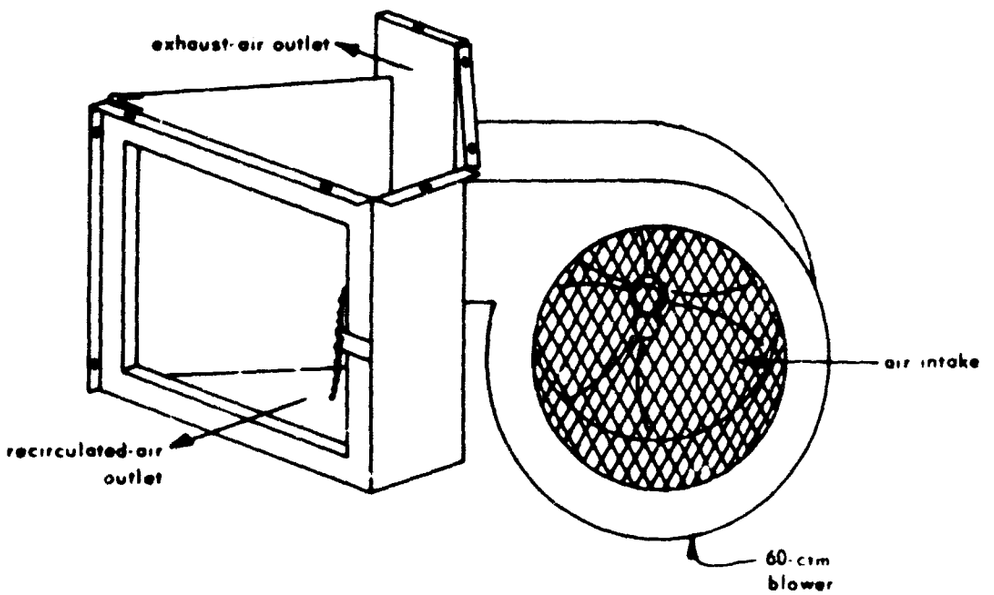

Figure 5. Exhaust air fixture for the NCEL wanigans.

PERFORMANCE

Five of the extra-wide NCEL sled wanigans were used as messing (Figure 6) and sleeping wanigans in Antarctica from 1956 to 1959. They were used on sled train operations between Little America V and Byrd Station. Field Reports[2] show that they gave good service during this period. Only minor repairs and routine maintenance were required on the wanigans. Some of the mechanical outfitting was overhauled and some was replaced during this period. In Deep Freeze 61, one of the messing wanigans and one of the sleeping wanigans were used on an exploratory sled train treck between Byrd Station and the South Pole. These two wanigans were in good condition at the end of this 800-mile journey. At that time, both of these wanigans had been used in over 5000 miles of sled train operations.

Figure 6. An extra-wide sled wanigan fitted as a messing facility for Operation Deep Freeze.

Prototypes of the extra-wide portable camp wanigan were used at Laboratory field sites in Squaw Valley, California, and near Point Barrow, Alaska, between 1958 and 1960 (Appendix B). During this time these wanigans were used as field offices, a light-duty repair shop, a warm-storage facility, and a pump wanigan. They performed well in each of these applications. At Point Barrow, the pump wanigan loaded with 17,000 pounds of equipment and gear was hauled over a 25-mile trail at the end of the first season. This test demonstrated the practicality of the skid-mounted wanigan for short hauls. Between 1961 and 1964, two portable camp wanigans were used at an NCEL field test site on the Ross Ice Shelf near McMurdo, Antarctica. One was used as an office wanigan and the other was used first as an equipment repair wanigan and then as a generator wanigan. They were readily adaptable to these applications.

Both types and sizes of NCEL wanigans can be easily assembled by two to four men using hand tools. The erection time differs only slightly for the standard and extra-wide sizes of each type. The standard sled wanigan (Figure 7) can be assembled in about 12 manhours. All the parts for this wanigan can be handled by two men. The heaviest pieces are the roof panels, which weigh 158 pounds each. The standard portable camp wanigan (Figure 8) can be assembled in about 31 manhours. The heavy-duty floor and skid system (Figure 9) requires about 20 of these

manhours. All of the parts for this wanigan can be handled by two men except the four half-skid sections, which weigh about 250 pounds each. All four of the NCEL wanigans are easy to assemble. However, because of the variety and types of bolts used in assembly, detailed instructions or prior experience are necessary for erection speed. Assembly instructions for the NCEL portable camp wanigans are given in NCEL Technical Note N-587 (Reference 3).

The basic heating and ventilating kit for the wanigan was evaluated in the office wanigan at the NCEL summer field site in Antarctica. The air temperatures during this evaluation ranged from 40 F to -20 F. Under these conditions, the space heater for the kit was usually operated on low fire; occasional higher settings were required for comfort in high winds and sharp drops in temperature. In two 4-month seasons of use, the heater required only nominal maintenance for satisfactory operation.

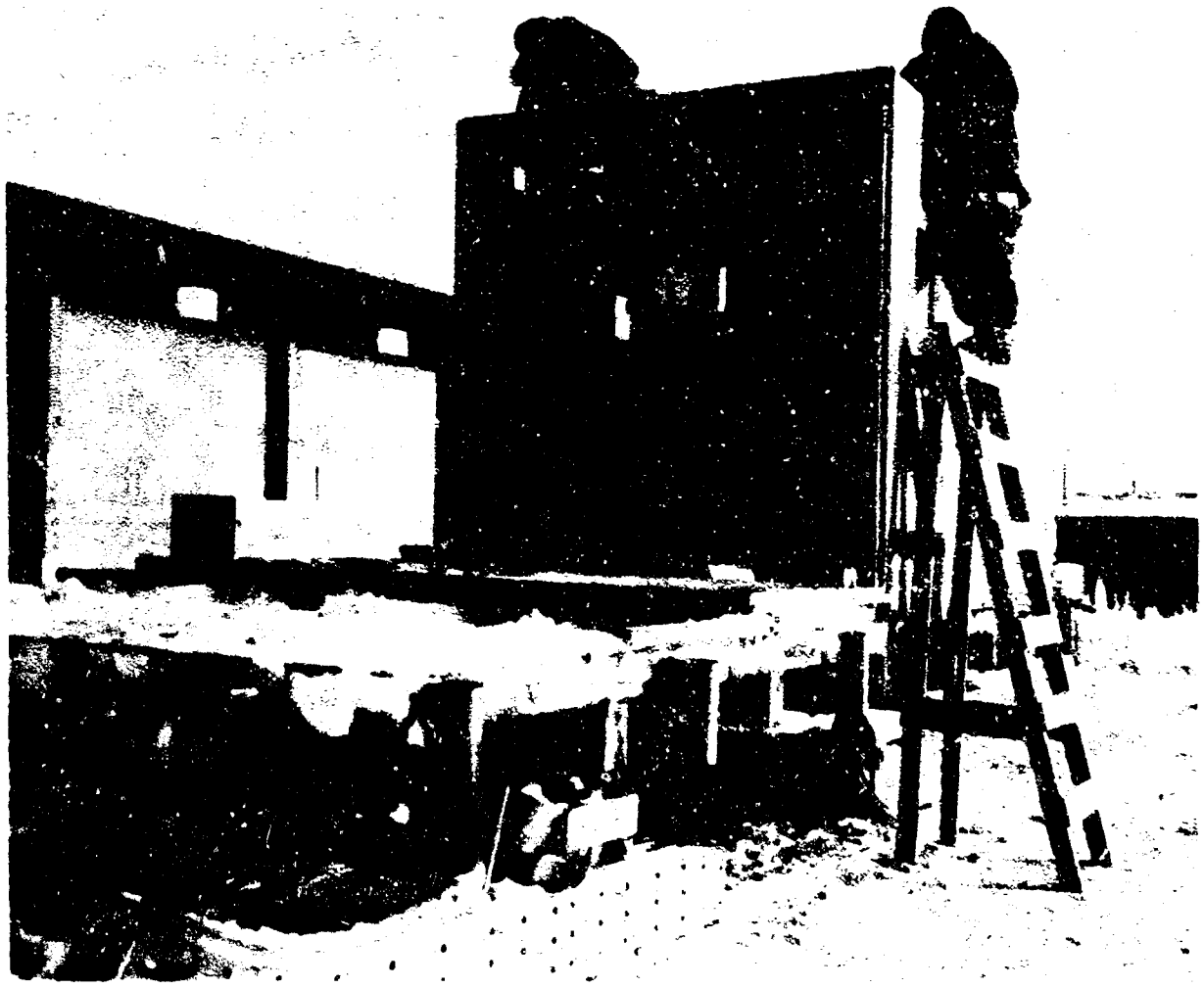

Figure 7. Assembly of the standard sled wanigan.

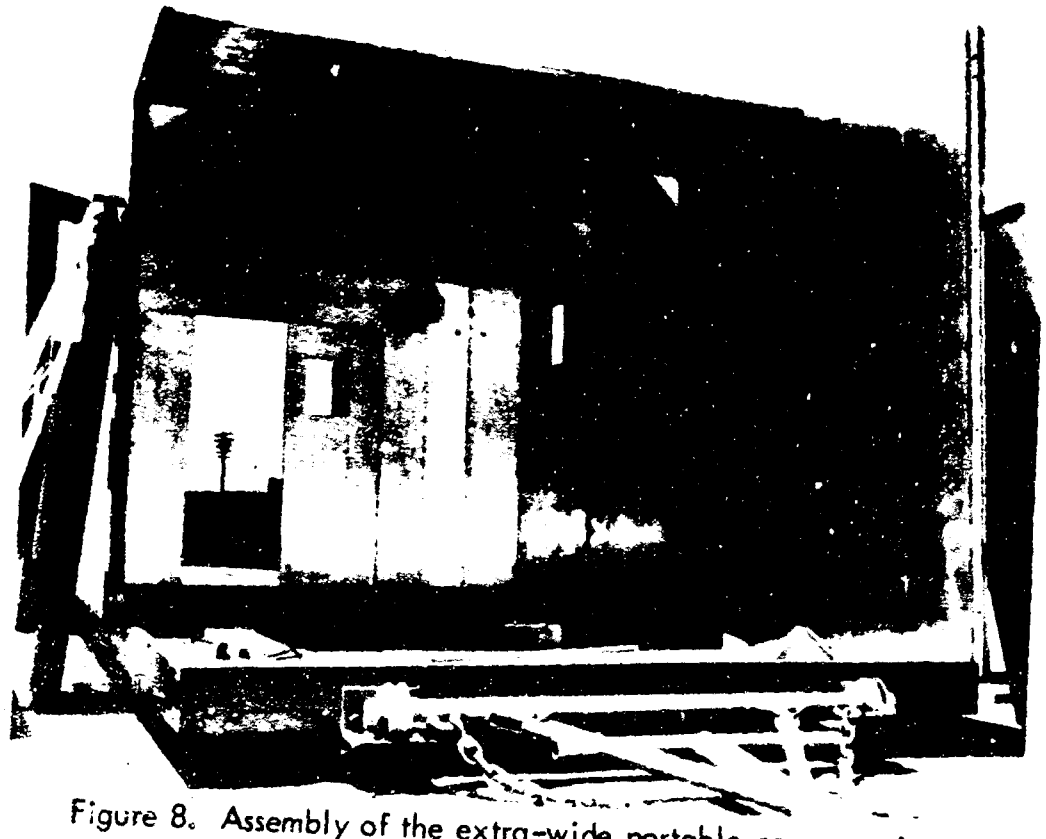

Figure 8. Assembly of the extra-wide portable camp wanigan.

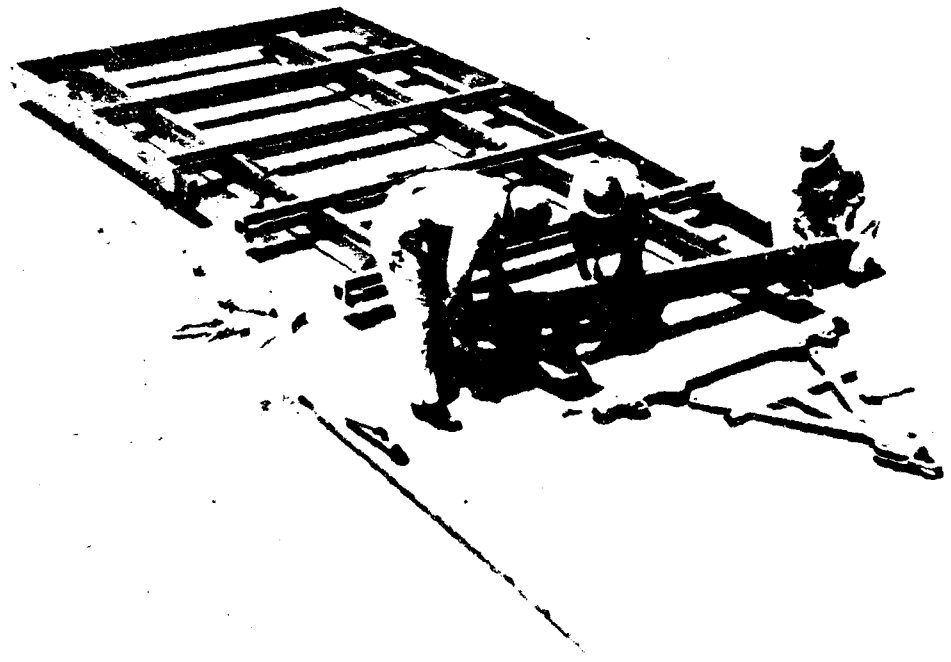

Figure 9. Assembly of heavy-duty floor and skid system.

The effectiveness of the 60-cfm ventilator was first tested at -10 F. Without the ventilator, the interior temperature was 50 F at 30 inches above the floor and 90 F at 66 inches above the floor. With the ventilator set to recirculate only the heated air in the wanigan, these temperatures became 60 F and 80 F. With the system set to introduce only the outside -10 F air, the interior temperatures became 68 F and 72 F. It was found that the 68-72 F interior temperatures could be maintained in outside air temperatures between 25 F and -15 F and winds up to 30 mph by introducing 60 cfm of outside air, provided the heater was adjusted to the prevailing conditions. The blower noise on the intake-air fixture did bother one out of five personnel using the wanigan.

A prototype of the basic electrical harness was also tested in the office wanigan at the NCEL Antarctic test site. Two manhours were required to install the harness. The three overhead lights provided adequate general lighting for the wanigan. The convenience outlets were used to energize desk lamps, office equipment, and the ventilator. They were more than adequate for these requirements.

A side-mounted fuel tank was used to supply fuel to the heater in the office wanigan. It was easy to fuel, but because of the relatively low fuel consumption of the heater, it was refueled at infrequent intervals. The changing level of the fuel in the long, slender tank did not have a noticeable effect on the operation of the heater.

APPLICATIONS

Sled Versus Portable Camp Wanigans

Sled-mounted wanigans can be used for many types of camp and construction applications. But the initial cost of the wanigan and the sled to haul it, the total shipping weight involved, and the 3-foot deck height usually prevent its utilization for such purposes. Based on 1962 prices, the heavy-duty floor and skid system for the extra-wide portable camp wanigan costs $1900 more than the standard floor for this wanigan. To convert a sled wanigan to a portable camp wanigan, using a 10-ton bobsled as the carrier, costs about $6400. This cost, which is based on the estimated price of the 10-ton bobsled in 1962, is $4500 more than the cost of the extra-wide heavy-duty floor and skid system. The shipping weight of the heavy-duty floor and skid system is 3000 pounds more than the shipping weight for the regular floor in the extra-wide sled wanigan. This is 2300 pounds less than the shipping weight for the 10-ton bobsled. It weighs 5300 pounds packaged for shipment. The deck height for the heavy-duty floor and skid system is 11 inches; the deck height for the 10-ton bobsled is about 36 inches. Access to the portable NCEL wanigans is easy and relatively simple for both personnel and equipment. Access to a sled-mounted wanigan is more difficult, especially for heavy equipment.

Sled Wanigans

The NCEL sled wanigans are best suited for tractor train operations in polar regions. They can be used as sleeping and messing facilities for the sled train personnel and passengers. Also, they can be used for housing generators, communication equipment, maintenance and repair equipment, and other such facilities that might be required in trail operations.

The Laboratory provided three 9-man sleeping wanigans for Operation Deep Freeze (Figure 10). It also provided two 12-man messing wanigans (Figure 11). The extra-wide NCEL sled wanigan was used for these applications. A 4-man combination sleeping and messing wanigan (Figure 12) was developed by the Laboratory for sled train operations. The standard sled wanigan was used for this application.

Portable Camp Wanigans

Development of the heavy-duty floor and skid system for the wanigan greatly expanded its potential application. This self-portability concept more closely allied the wanigan with the remote, transient nature of many polar projects. They are often performed at isolated locations, and they are often of limited duration.

The NCEL portable camp wanigans are best suited for transient camps and work areas away from an established camp or station. They can be used for sleeping and messing personnel in the absence of other facilities, but they are more adaptable to housing those facilities, within the size limitations of the wanigans, that require both shelter and limited mobility. Such facilities include, but are not limited to, communication centers, field offices, shops, laboratories, utilities, and fixed construction equipment. Some examples of current applications for the portable camp wanigan are given in the following paragraphs.

A standard portable wanigan was used as a field office at the NCEL test site near McMurdo, Antarctica, during Deep Freeze 63 and 64. It was fitted with hinge-mounted tables to provide work space for four men and with adjustable metal shelving for the storage of forms and records.

A standard portable wanigan was used as an equipment repair shop in conjunction with a portable maintenance shelter at the antarctic test site during Deep Freeze 63. It was fitted with the shop equipment, work benches, tools, and storage bins required for the maintenance and repair of equipment at a construction site.

Figure 10. An extra-wide sled wanigan outfitted as a sleeping facility, 9-man capacity.

Figure 11. An extra-wide sled wanigan outfitted as a messing facility, 12-man seating capacity.

Figure 12. A standard sled wanigan outfitted as a combination sleeping and messing facility, 4-man capacity.

A standard portable wanigan is currently being outfitted as a field test laboratory for ice and snow studies. It will contain cold and warm test spaces and the instruments required for this work.

An extra-wide portable wanigan was used as a utility shelter at an NCEL field site near Point Barrow, Alaska, in 1961 and 1962. It housed a sea-water distillation unit and a fresh-water storage tank.

A standard portable wanigan was used as a generator shed at the antarctic field site in 1964. It housed the 25-kw generator, switch gear, and panel boards used to generate and distribute electricity to the field camp.

An extra-wide portable wanigan was used as a pump wanigan (Figure 13) at an NCEL field site on the sea ice near Point Barrow, Alaska, in 1958 and 1959. It housed a diesel-driven pump and the hose and fittings necessary for flooding sea ice.

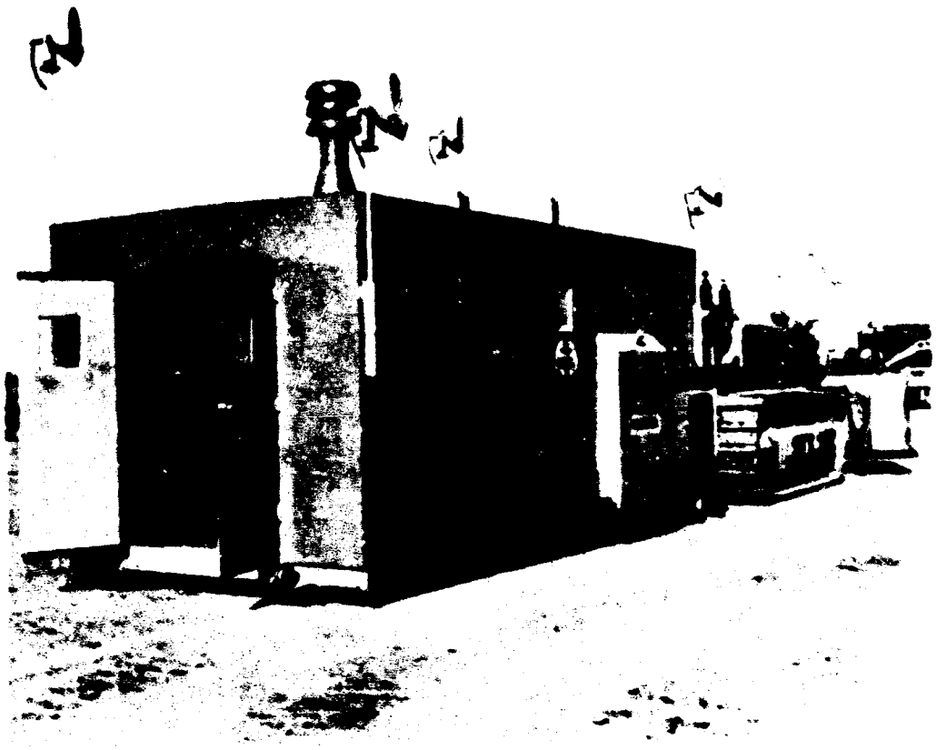

Figure 13. An extra-wide NCEL portable camp wanigan outfitted as a pump wanigan for sea ice flooding. Note side-mounted fuel tank.

FINDINGS

1. The NCEL wanigans are adaptable to a variety of applications, within the space available, on sled train operations, in transient field camps, and at remote construction sites.

2. The two NCEL sled wanigans are best adapted to facilities for sled train operations. They are easy to erect, and the standard 8-foot-wide sled wanigan can be air-transported in a C-130 aircraft without disassembly.

3. The two NCEL portable camp wanigans are best adapted to facilities for transient field camps and remote construction projects. They are also easy to erect, and the standard 8-foot-wide portable camp wanigan can be air-transported in a C-130 aircraft without disassembly.

4. The basic heating and ventilating kit, electrical harness, and side-mounted fuel tank provide adequate comfort and lighting for most wanigan applications.

5. The packaged wanigans complete with the basic accessories weigh from 3410 pounds for the standard sled wanigan to 7160 pounds for the extra-wide portable camp wanigan. Based on 1962 prices, their costs range from $4850 to $7050.

CONCLUSIONS

1. The NCEL sled wanigans are well suited for housing messing and sleeping facilities on extensive sled train operations in polar regions. They are also adaptable to housing other facilities that might be required on such operations.

2. The NCEL portable camp wanigans are well suited for housing offices, field laboratories, utilities, fixed construction equipment, and other such portable facilities that are required at transient field camps and isolated construction sites in polar regions.

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Appendix A

DEVELOPMENT OF THE BASIC NCEL WANIGAN

Between 1947 and 1955, a series of prefabricated, panelized wanigan designs were developed and tested by the Laboratory. These designs, which were designated Mark I through Modified Mark V respectively, resulted in the basic NCEL wanigan design described in this report.

MARK I WANIGAN

The Mark I Wanigan, which was 8 feet wide and 32 feet long, was designed and fabricated at the Laboratory in 1947. It was made up of plywood-faced, 4- by 8-foot insulated panels which were locked together with a tie-rod harness to form the boxlike structure. In the field tests at Point Barrow in 1947-49, it was found[4] that the tie-rod harness was inadequate and the 32-foot length was too cumbersome for trail use.

MARK II WANIGAN

The Mark II Wanigan, which was 8 feet wide by 24 feet long, was designed by the Bureau of Yards and Docks and fabricated at the Laboratory in 1948. It was also made up of plywood-faced, 4- by 8-foot insulated panels which were locked together with a tie-rod harness. However, in an attempt to simplify erection, each set of roof, floor, and side panels were hinged together to form a collapsible section. Metal knee braces were used in the assembled wanigan to stiffen the upper corners of these sections. In field tests at Port Hueneme, California, and Point Barrow, Alaska, in 1949-50, it was found[5] that the bulk of the collapsed sections was too great for easy handling and that the panel joints leaked.

MARK III WANIGAN

The Mark III Wanigan, which was 10 feet wide by 24 feet long, was designed and fabricated by the Laboratory in 1950. Except for the increased width and a different panel hinge arrangement, it was similar to the Mark II Wanigan. In the Mark III design, one sidewall panel was hinged to the roof panel and the opposite side panel was hinged to the floor panel with fixed-pin hinges. These two parts were assembled into a panel section by inserting pins in the open hinges on the free

ends of the matching panels. Knee braces were used to stiffen the assembled wanigan, and the entire unit was locked together with four binding angles and vertical and horizontal tie rods. In tests at Camp Hale, Colorado, and Point Barrow, Alaska, between 1950 and 1952, it was found[6] that the wanigan was structurally satisfactory, but the weight of its individual parts was too great for easy handling.

MARK IV WANIGAN

The Mark IV Wanigan, which was 10 feet wide by 24 feet long, was designed and fabricated for the Laboratory by a trailer-house manufacturer in 1951. Stressed-skin panels and other lightweight principles used in trailer manufacturing were used in this design. Basically, the design consisted of floor, wall, and roof panels hinged together so that they could be collapsed into a flat package. The primary difference between this hinge arrangement and that used in the Mark II and III Wanigans was the addition of a hinge point in the center of the sidewall panels. This allowed the sidewalls to fold inward to achieve a vertical collapse and form a folded section 4 feet wide, 10 feet long, and about 8 inches high. In assembly, these sections were supported by frames made of 1-1/2-inch extra-strong pipe. The frames consisted of two columns joined to a roof beam by bolts and gussets. The sections were joined to each other with wedge clamps.

This wanigan was not trail-tested, but it was tested for structural adequacy and weather tightness in the NCEL prefabricated-building test facility. For the structural test, simulated loads were: snow, 30 lb/sq ft; wind, 100 mph; and floor, 75 lb/sq ft. For the weather test, a 2-inch-per-hour rainfall was simulated. These tests showed that the major weakness in the design was the wedge-clip fastener and the joint seal problem resulting from the pipe frame. A satisfactory solution to both problems was considered too difficult to justify further development of this design. However, the stressed-skin principle was considered a good approach to achieving a lightweight, knockdown wanigan.

MARK V WANIGAN

The Mark V Wanigan, which was 8 feet wide by 24 feet long, was designed and fabricated by the Laboratory in 1953. The stressed-skin principle of construction was used in this design. The panels for this wanigan, which were only 2 inches thick, were highly interchangeable. The panels were formed with wood and faced with 1/4-inch plywood. They were insulated with fiberglass and vapor-sealed with aluminum foil. Through-bolt fasteners were used to connect the panels to each other. Unicellular sponge-rubber gaskets were used to seal the panel joints.

The Mark V Wanigan was first tested at the U. S. Army Test Center, Fort Churchill, Manitoba, Canada, in the winter of 1954. For this test it was outfitted for sleeping and messing four men on the trail. The wanigan mounted on a 10-ton bobsled was taken on two trail tests of about 30 miles each. It was then returned to the Laboratory and given an additional 40-hour simulated trail test at a test site near Port Hueneme, California. In the Hueneme sled tests, it was towed over a rough trail having maximum longitudinal and transverse slopes of 25 percent and a section of trail with ridges constructed 45 degrees to the course to induce greater racking in the structure. In these tests it was found[7] that the wanigan was structurally adequate for trail use and that frost accumulation on the through-bolt panel fasteners was negligible.

MODIFIED MARK V WANIGAN

Five Modified Mark V Wanigans, which were 10 feet wide by 20 feet long, were fabricated and outfitted by NCEL for Operation Deep Freeze in 1955.[8] In addition to increasing the width of the floor and roof panels, the roof panel design was changed to provide a slight slope to the roof, and the endwall panels were redesigned because of the increased width.

The basic modification consisted of increasing the width of the wanigan from 8 to 10 feet. The roof panel framing was strengthened with heavier members and contoured on the upper surface to produce a 1-inch crown in the roof. The panel was further reinforced by replacing the 1 4-inch-thick plywood skin on the upper panel face with 3 8-inch plywood. Three endwall panels were designed to replace the two endwall panels used in the 8-foot-wide Mark V Wanigan.

Three of the five wanigans fabricated for Deep Freeze were outfitted to berth nine men each, while the other two were outfitted with a galley and messing facilities to accommodate 12 men at one setting.

Appendix B

DEVELOPMENT OF THE NCEL PORTABLE CAMP WANIGANS

In 1958, the Laboratory developed a heavy-duty floor and skid system for its sled wanigan. Increasing use of the wanigan for housing equipment and machinery during pioneer deployment to the polar regions, and construction activities away from an established polar camp or station dictated this need.

The floor and skid system consisted of a panelized floor made of 2 x 6 timbers mounted on steel runners spaced 5-3/4 feet apart. To match the dimensions of the standard and extra-wide NCEL sled wanigans, its deck was 20 feet long and respectively 8 and 10 feet wide. For towing, it was fitted with a tongue which could be attached to either end of the skids. As the deck height of the floor was only 11 inches, it was designed so that it could be separated into two half-section work platforms.

Initial tests on the heavy-duty floor and skid system were performed on a prepared sand test course at Port Hueneme, California. This course was laid out to produce high tensional and racking forces. A half unit, or 10- by 8-foot section, was towed over this course loaded with three different weights, ranging from 1000 to 4500 pounds (Figure 14). The total test time was approximately 3 hours, with 1 hour devoted to each load. A thorough inspection of the unit at the conclusion of the testing revealed no structural weakness.

Following these tests, a 10-foot-wide by 20-foot-long heavy-duty floor and skid system was fabricated and fitted with an extra-wide wanigan shell. This unit, called an extra-wide portable camp wanigan, was used to further test the floor and skid system. During a 12-hour tow test, over the Hueneme sand course, its performance was observed with no load and with deck loads of 1000, 3000, and 5000 pounds. The 5000-pound test load was distributed as follows: a 3000-pound weight was concentrated near one end of the deck on the longitudinal centerline of the wanigan, and 1000-pound weights were located on either side of the deck at the opposite end. The maximum racking observed in the wall panels was 0.3 inch. This measurement was made at a point 6 feet about the floor. The maximum flecture observed was about 0.4 inch. The maximum variation observed between the test performed with the 1000-pound test load and the 5000-pound load was 0.1 inch. The sand test course provided a good bridging and torsional test for the wanigan (Figures 15 and 16); however, it did not simulate the impact stresses which would be produced by a natural arctic environment.

Between 1958 and 1960, the prototype camp wanigan was used successively as a headquarters building, a light-duty repair shop, and as a warm-storage facility for the Navy's compacted-snow parking project at Squaw Valley, California, for the VIII Olympic Winter Games. It performed very satisfactorily for these functions.

In 1958, two additional portable camp wanigans were fabricated for use in the Laboratory's sea-ice flooding trials at Point Barrow, Alaska. The endwalls in these two wanigans were fitted with 5-foot-wide double doors for easy entry and exit of large equipment. These wanigans were used for two winter seasons at Point Barrow — one as a field office at the test site and the other as a pump wanigan.

The pump wanigan housed a 5000-pound diesel-engine-driven pump and collateral equipment weighing approximately 7500 pounds. After 2 months of pumping operations, during the first test season, this wanigan was subjected to a 25-mile trail test over bare ice, snow-covered ice, and snow-covered tundra. It was found[2] that the wanigan was structurally adequate for this type of travel, but because of its low ground clearance, it was not considered suitable for extensive trail use.

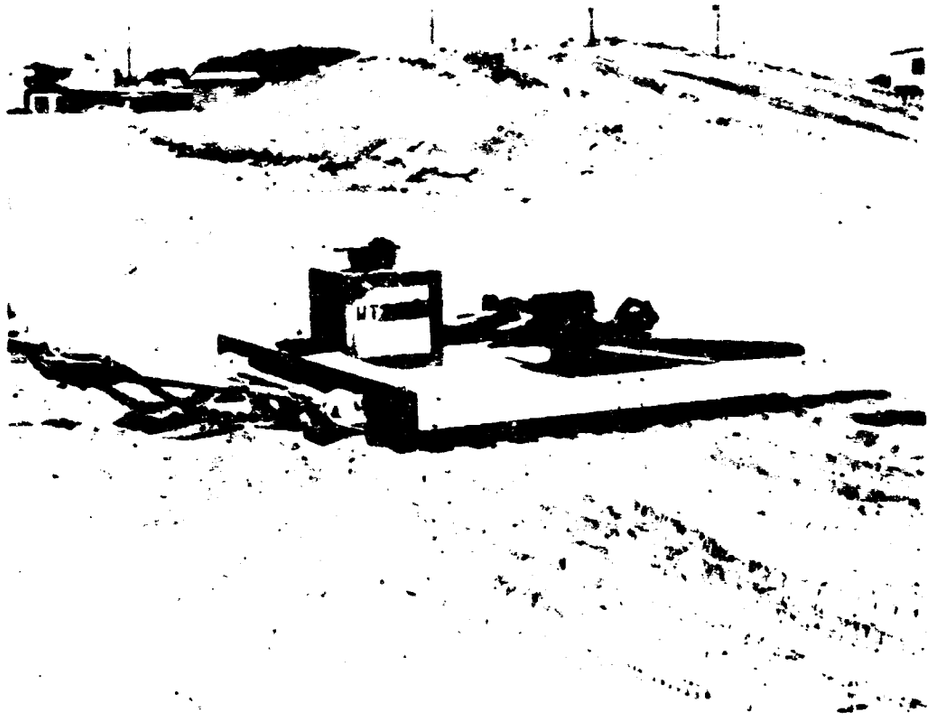

Figure 14. Test of half-section of heavy-duty floor and skid system. Test load 3000 pounds.

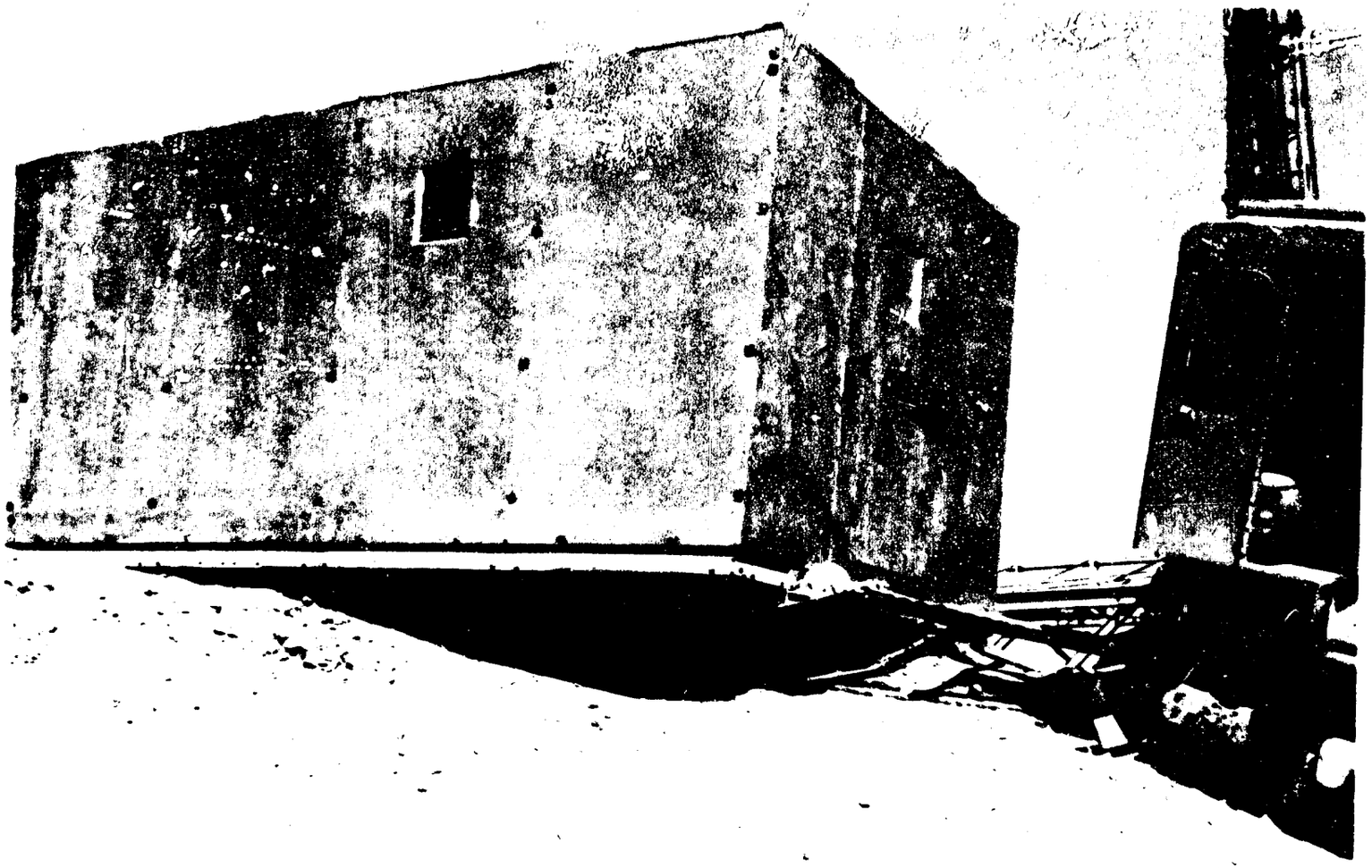

Figure 15. Prototype of extra-wide portable camp wanigan under test on sand course. Test load 5000 pounds.

Figure 16. Corner lift of prototype portable wanigan supporting 5000-pound deck load.

Appendix C

UTILITIES FOR THE NCEL WANIGANS

Utility requirements for wanigans vary with specific applications. The applications shown in Table IX indicate that heating and ventilating requirements for a specific wanigan can range from 500 cfm of ventilation air and 45,000 Btuh of heat for a messing wanigan down to 45 cfm of air and 24,600 Btuh of heat for a maintenance and repair wanigan. The table also shows that the electrical, water, sanitation, and fuel requirements also vary with application. Table IX was developed to determine and select basic utilities for the NCEL family of wanigans; however, it can be used as a general guide for wanigan utility requirements.

HEAT

In 1956, heating studies were conducted in the Laboratory's cold chamber on a prototype of the extra-wide sled wanigan. Electrical heating was used for these tests. In test temperatures of 10 F, -15 F, -40 F, and -65 F, the interior temperature of the wanigan was stabilized as close as possible to an overall average temperature of 70 F. At 10 F, the heat loss was 11,500 Btuh; at -65 F, this loss increased to 19,000 Btuh (Figure 17). These tests indicated that the heat loss from conduction and natural infiltration in the NCEL wanigan is 0.16 Btuh/sq ft/°F. As wanigans are used in temperatures to -65 F, the total heating requirements shown in Table IX are based on 19,000 Btuh of conduction and natural infiltration.

Both forced-draft furnaces and pot-type space heaters were considered for wanigan heating. Neither is entirely suitable. The forced-draft furnace is reliable and efficient, but requires electrical power for operation. Also, it is not available in the small sizes normally required for wanigan heating. The pot-type space heater does not require electrical power for operation, but its efficiency, reliability, and ease of regulation leaves much to be desired. Maintenance requirements are often high when it operates at much less than three-fourths of its rated capacity, as soot formation at low fire settings clog the small combustion air inlet openings in the burner. During the wanigan development, consideration was given to combining the two burner types into a single combustion chamber. Such a combination would have permitted use of the gun-type burner when electrical power was available and of the pot-type burner when such power was not available. Unfortunately, the combustion chambers for the two types of burners are not compatible.

Table IX. Utility Requirements for Various Wanigan Applications

Wanigan Type	Estimated Occupant Load[1]	Ventilation Requirement (cfm)	Ventilation Heat Load (Btuh)	Total Heating Load[2] (Btuh)	Electrical Power Load (watts)	Water Requirement (24-hr supply)	Sanitation Requirement	Fuel Requirement 7 Day Supply (gal)	
								Heating	Power Generation
Messing	13	200 - 500	26,000 max	45,000	3,300	2.2 gal per man	head, sink, and lavatory	70	100
Sleeping	9	45 - 135	17,500	36,500	1,400	3.4 gal per man	head and lavatory	60	50
Office	4	60	7,800	26,800	1,250	2 gal	none	45	50
Scientific	4	60	7,800	26,800	1,250 plus special equipment requirement	dependent on scientific program	sink(?)	45	50 min
Maintenance & Repair	3	45	5,800	24,800	2,250	2 gal	none	45	85
Equipment Shelter	2	dependent on equipment size and type	dependent on equipment size and type	dependent on equipment type and operation	1,250 plus special equipment requirement	as required by equipment	none	dependent on heating requirement	50 min

1/ Occupant load based on maximum simultaneous occupancy and/or estimated functional requirement.

2/ At an ambient temperature of -65 F.

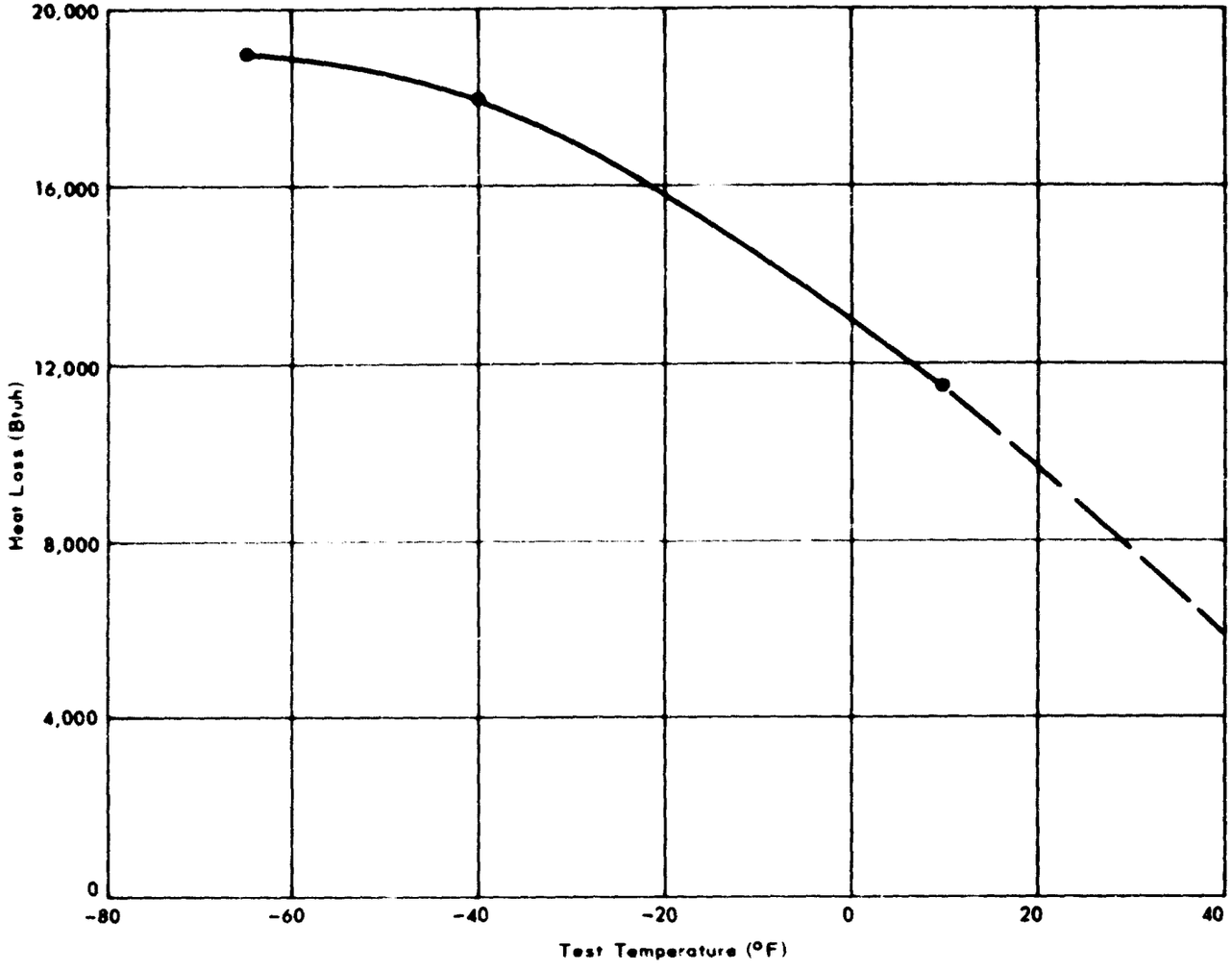

Figure 17. Conduction and natural infiltration in controlled temperature tests in an extra-wide NCEL sled wanigan.

Some effort was devoted toward improving the heating system for wanigans. Tests were made on three types of space heaters with special heated-air distribution systems to reduce stratification and improve comfort in the wanigan, and an experimental thermosiphon hot-water heating system was tested for the same purpose. None were sufficiently satisfactory to warrant development.

After careful survey of the pot-type space heaters available, a 25,000-Btuh space heater similar to those used in mobile homes was selected as the basic heater for the NCEL wanigans. A review of the heating requirements for the various wanigan applications given in Table IX shows that this size of heater is adequate for most applications.

In some applications, this size of heater may be inadequate. For example, Table IX shows that a 36,500-Btuh heater is required for a sleeping wanigan at -65 F. Here a larger heater should be substituted for the basic wanigan heater. In other applications, other heat sources may produce adequate heat for the wanigan. An example of this is the galley range in a messing wanigan. Here, it may be practical to eliminate the heater and use the range for heating as well as cooking. Under certain conditions, cooling rather than heating may be required to maintain comfortable temperatures. This can be accomplished with adequate ventilation.

VENTILATION

In the early stages of development, numerous types and sizes of manual ventilators were used to provide fresh air for the wanigan. None were satisfactory.

In 1960, a positive ventilation system was developed for the NCEL wanigans. This system was based on 15 cfm per man. While this quantity was not based on precise requirements, it appeared to be a practical minimum for most wanigan applications. For rest conditions, such as sleeping, 5 or 6 cfm per man is adequate, but this would not satisfy daytime occupancy. For smoke or odor conditions, 30 cfm per man is required. The ventilation requirements for the various wanigan applications shown in Table IX are based on these rates.

Simple intake-air and exhaust-air fixtures (Figures 4 and 5) are used to ventilate the wanigan. The capacity of these units is 60 cfm. As shown in Table IX, this size fits most general applications.

To control the ventilation, the intake-air fixture can be adjusted to direct the incoming air across the ceiling or toward the floor. It is also fitted with a spring-loaded damper which can be adjusted to control the quantity of intake air.

The exhaust-air fixture is fitted with a similar damper. In those applications requiring more ventilation, such as a messing wanigan, the proper fixture size should be substituted for the basic units.

ELECTRICITY

Electrical power requirements for wanigans vary widely with application (Table IX). Lighting and convenience power outlets, however, can be standard for all applications. Accordingly, a basic electrical harness was developed for the NCEL wanigan. It provides three overhead lights and eight 15-amphere duplex outlets on the interior of the wanigan and four weatherproof outlets on the outside. Depending on the load, between 1000 and 2000 watts are required to energize this harness. This basic electrical harness can be supplemented or replaced as required to provide adequate wiring for specific applications.

Because of the varying electrical requirements for individual wanigans, an electrical generator is not included as standard outfitting for the NCEL wanigans. If a separate generator is required for a specific wanigan application, it should be selected to match the power requirements for that wanigan.

FUEL

Numerous types and sizes of fuel tanks were used initially for the NCEL wanigans. In 1959, an 80-gallon side-mounted fuel tank was developed for the wanigan (Figure 13). Tests on these long, slender tanks at Point Barrow, Alaska, showed them to be generally satisfactory for servicing the wanigan heater with fuel even though the static head changed continually as the fuel was consumed by the heater. Advantages of these tanks were easy refueling, low center of gravity, and easy attachment to the wanigan. One of these tanks is included as a basic item of equipment for the NCEL wanigans. Soft-drawn copper tubing and the necessary fittings are provided to attach the tank to the space heater.

This fuel tank can also be used to service gasoline and diesel equipment housed in the wanigan. It has been used for this at Laboratory field sites in Alaska and Antarctica.

WATER

Water in most polar areas is obtained by melting snow. Most wanigan applications require some water, but as shown in Table IX, this requirement is usually so small that it can be provided by melting snow in a bucket on top of the heater. In

those applications requiring several gallons of water per man per day, such as for sleeping and messing wanigans, other methods should be provided for melting snow. The specific method selected — electrical heat, fuel heat, waste heat, etc. — should be matched to the quantity of water required per day and the personnel available for melting snow. From a fuel standpoint, waste heat when available is the most economical method to melt snow; however, other factors such as the production rate and manpower requirements may outweigh this economy.

Snow-melting equipment, water storage tanks, and distribution lines are not included as standard outfitting for the NCEL wanigans. Where such equipment is required, it should be selected to match specific requirements.

SANITATION

Most wanigan applications do not require sanitary facilities; consequently, none are included as standard outfitting for the NCEL wanigans. In those applications where such facilities are required, such as for messing and sleeping wanigans, simplicity should be the key to their selection. Lavatories, sinks, and urinals can be drained with automotive radiator hose. It is simple and easy to install because of its flexibility. Camp-type portable toilets with disposal-bag receptacles have been used with fair success in trail wanigans.

Appendix D

DRAWINGS FOR THE NCEL WANIGANS

Fabrication and assembly drawings for the NCEL sled and portable camp wanigans in both standard and extra-wide widths are listed below. Table X lists the drawing required for fabricating each type of wanigan. The last three drawings in the following list contain the details for fabricating the basic heating and ventilating kit, the electrical harness, and the side-mounted fuel tank for these wanigans. Specifications for the NCEL wanigans are contained in Reference 9.

Y&D DWG NO.	TITLE
993670	Standard Portable Wanigan — Fabrication Requirements
993671	Standard Portable Wanigan — Assembly
993672	Extra-Wide Portable Wanigan — Fabrication Requirements
993673	Extra-Wide Portable Wanigan — Assembly
993674	Standard Sled Wanigan — Fabrication Requirements
993675	Standard Sled Wanigan — Assembly
993676	Extra-Wide Sled Wanigan — Fabrication Requirements
993677	Extra-Wide Sled 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
993682	Extra-Wide Portable Wanigan Floor — Assembly
993683	Extra-Wide Portable Wanigan Floor — Skids and Cross Members
993684	Extra-Wide Portable Wanigan Floor — Frame, Panels, and Connectors
993685	Extra-Wide Portable Wanigan Floor — Tongue

Y&D DWG NO.	TITLE
993686	Standard Sled Wanigan Floor — MK-28 and MK-30 Panels
993687	Standard Sled Wanigan Floor — MK-29 Panel
993688	Extra-Wide Sled Wanigan Floor — MK-1 and MK-3 Panels
993689	Extra-Wide Sled Wanigan Floor — MK-2 Panel
993690	Wanigan Sidewall — MK-4 and MK-6 Panels
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
993694	Extra-Wide Portable Wanigan Endwall — MK-14 and MK-17 Panels
993695	Extra-Wide Portable Wanigan Endwall — MK-18 Panel
993696	Standard Sled Wanigan Endwall — MK-31 and MK-32 Panels
993697	Extra-Wide Sled Wanigan Endwall — MK-8 and MK-10 Panels
993698	Sled Wanigan Door — MK-9 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
993704	Extra-Wide Wanigan Roof — MK-11 Panel
993705	Extra-Wide Wanigan Roof — MK-12 Panel
993706	Extra-Wide Wanigan Roof — MK-13 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

Table X. Fabrication and Assembly Drawings Required for Each Type of NCEL Wanigan

Y&D Dwg No.	Sled Wanigan		Portable Camp Wanigan	
	Standard	Extra-Wide	Standard	Extra-Wide
993670			X	
993671			X	
993672				X
993673				X
993674	X			
993675	X			
993676		X		
993677		X		
993678			X	
993679			X	
993680			X	
993681			X	
993682				X
993683				X
993684				X
993685				X
993686	X			
993687	X			
993688		X		
993689		X		
993690		X	X	X
993691	X	X	X	X
993692			X	
993693			X	
993694				X
993695				X
993696	X			
993697		X		
993698	X	X		
993699			X	X
993700			X	X
993701	X		X	
993702	X		X	
993703	X		X	
993704		X		X
993705		X		X
993706		X		X

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F81	2	2	Amphibious Bases
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