NEW PORTABLE SHELTERS FOR POLAR USE

by Roderick B. Ledingham and Peter L. Keage

Edgeworth-David Summer Base, Bunger Hills, Antarctica, established in February 1986. The base comprises three basic Igloos (radio-meteorology, photographic darkroom, and living quarters) and two extended Igloos (mess and living quarters). Summer operations involve about 25 people. The shelters remain over winter. (Photographs and figures courtesy of AAD; photographs by Rowan Butler.)

THE AUSTRALIAN Antarctic Division has assisted in developing a new free-standing, igloo-shaped portable shelter for polar use. The shelter, known as the "Igloo Satellite Cabin," is of glass-fiber construction, able to be sited on irregular terrain, and to be extended laterally using additional side and floor panels. It is available from Malcom Wallhead and Associates, (Watson's Road, Kettering, Tasmania, Australia, 7155).

Prior to developing the "Igloo," the Australian National Antarctic Research Expeditions (ANARE) used plywood shelters,[1] Parcoll huts,[2] sled-mounted living caravans, and heavy-duty pyramid tents for field shelters. While these shelters have proved reliable and suit a range of uses, all had shortcomings. Most are not readily transported to field sites; pyramid tents cannot be left unattended for long periods; and plywood and Parcoll huts are time consuming to erect and dismantle. Hence the use of traditional shelters was generally restricted to areas accessible to oversnow transport and, once established, the shelters were seldom relocated during summer field operations. Some shelters have never been moved despite having been required only for brief field programs. A number of pyramid tents have been lost by parties leaving them unattended for several days; guy ropes work loose and wind action shreds tent material.

These operational considerations were central in designing an improved portable shelter. The design criteria included that the shelters

- be able to provide comfortable shelter for three people and basic shelter for a large number;
- be able to house scientific instrumentation including magnetically sensitive instruments;
- be able to be erected by two people on snow or irregular terrain;
- be capable of withstanding strong Antarctic winds (up to 140 knots) and snowstorms;
- be capable of being transported fully assembled by a single-engine helicopter, a sledge, or a small boat;
- require minimum maintenance and be repairable in the field by unskilled labor; and
- allow for extension and interlinking of shelters.

The Igloo shelter was developed in 1982 and tested in Antarctica during the 1982-83 austral summer on an offshore island

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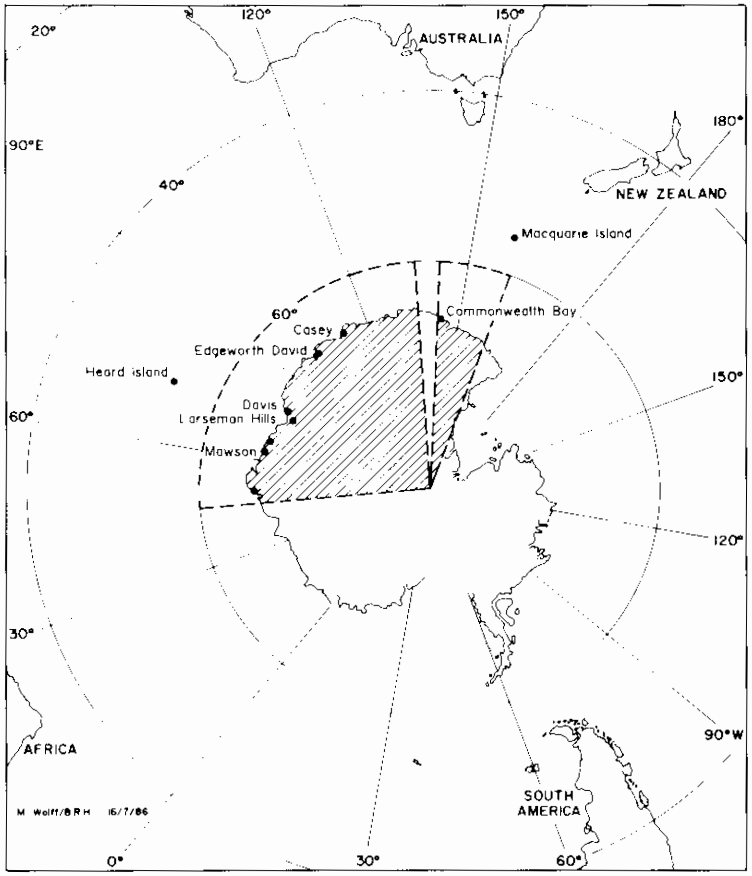


Australia's Antarctic Territory (shaded) showing the locations of permanently occupied stations and other sites where Igloo shelters are used.

near Davis Station. In 1983, a second shelter was deployed in the same area. In 1984, a fully assembled shelter was airlifted and flight tested over a range of air speeds up to 60 knots.[3] As of early 1986, ANARE had deployed 13 Igloo shelters (basic and extended) to support field programs at Commonwealth Bay (1), Ardery Island near Casey Station (1), Casey Station (1), Larseman Hills (1), Bunger Hills (5), Vestfold Hills near Davis Station (3), and Heard Island (1). A larger Igloo with a floor diameter of 6 m is now being developed by the same manufacturer.

CONSTRUCTION

All floor, side, and roof hatches are of glass-fiber construction. Glass-fiber molded construction offers considerable flexibility in the setting up of a particular Igloo as well as allowing panels to be interchanged between Igloos. Glass fiber is also durable and relatively maintenance free over the range of field environments found in Antarctic regions (cold dry Antarctic climate to cold maritime sub-Antarctic conditions). The door and windows may be fitted as required in any order. Non-metallic fittings may also be used to fasten floor, side, and hatch panels to provide a non-magnetic structure for various geophysical observations. A black Igloo was constructed with an extra opaque gelcoat and fitted out as a photographic darkroom for 1985-86 Antarctic summer field operations (summer daylight may be as long as 24 hours). An extended Igloo was sled mounted and used as a diving shelter during the 1985 winter diving program at Davis Station. The diving shelter had a trap door fitted in the floor which was positioned over the dive hole cut through the sea ice.

Floor panels are reinforced, while the curved side panels obtain rigidity from their lipped edges. The lipped edges also act as a gutter to deflect any moisture from melting snow that may trickle through the joint between the panels (Fig. 1).

Insulation is improved by double-glazed polycarbonate for windows fitted with silicon or rubber seals, and by fire-retardant polyurethane spray foam used to insulate wall panels and the undersides of floor panels. A fire-resistant paint is also applied to the foam.

Glass-fiber bunks, desks, and shelves have also been developed. Even with a light helicopter (e.g., Hughes 500 or Bell 206) carrying full fuel tanks, it is possible to sling-carry a fully assembled Igloo with interior fittings.

ASSEMBLY

The Igloo shelter consists of four types of components:

- a floor comprising four clip-together glass-fiber sections;
- eight curved side panels which are joined together by a lipped flange and bolted to each other and to the floor section;
- eight steel wire tie-downs, one attached to each side panel; and

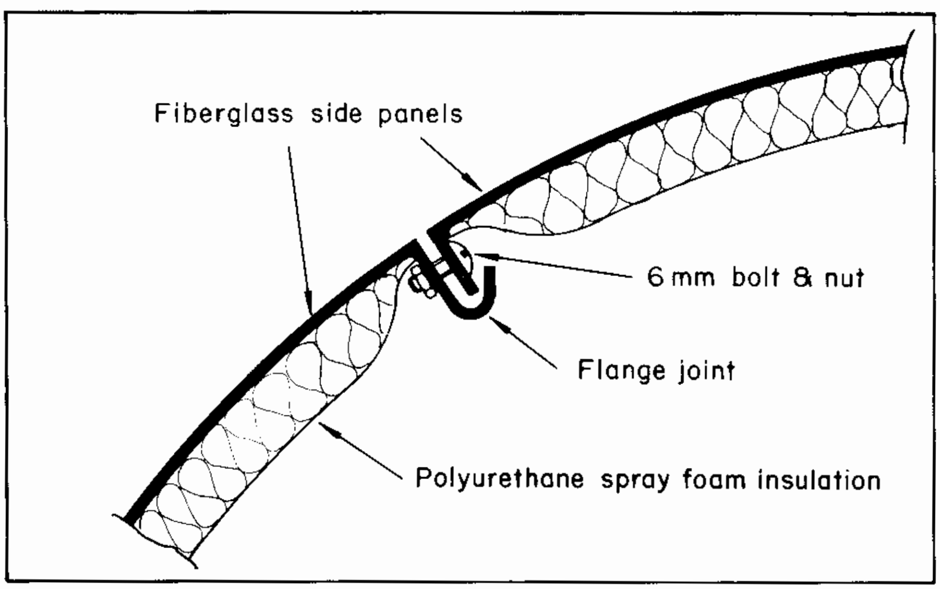
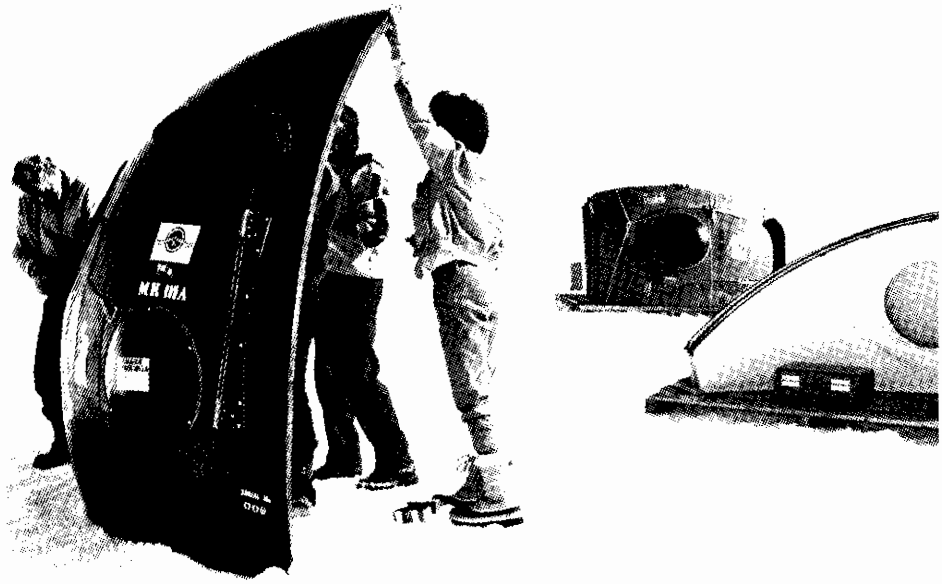


Figure 1. Section through panel joint.



Assembling an Igloo shelter on sea ice for helicopter airlift to an inland location. Note the packing arrangement of side panels.

- a circular ventilation/escape hatch at the structure's apex.

The Igloo may be extended in 0.75-m steps by adding floor panels and arched roof panels to the two hemispheres of the structure. By adding side and floor panels, it is technically feasible to make an Igloo to any length required. Extending the structure also requires the use of two semicircular modified caps to replace the single circular hatch of an Igloo, and the provision of a substitute rectangular escape hatch in one or more of the longitudinal side panels. Each side panel has a folded lip flange (female) on one side, and a straight lip on the other (male). Hence side panels slot together and are fastened by bolts. The fastening bolts do not penetrate the outer wall, thereby reducing heat loss. Floor panels clip together and have a tongue-and-groove edge to prevent draft and moisture penetration through the floor.

Plastic marine ventilation ports are fitted to doors (inflowing air) and to the overhead hatch (exhaust air). Air vents are opened and closed by a screw mechanism and are covered on the outside by a mushroom-shaped outer shield to prevent snow and water ingress. The roof hatches can also be opened to improve ventilation. Two people can erect a basic Igloo and an extended Igloo (two extra side and floor panels) in 30 and 45 minutes respectively, with up to an hour more required for them to tighten bolts. A construction manual and tools are provided and panels are numbered for ease of assembly. Some sealing of wall joints to the floor and around the roof capping may be necessary and can be completed in a few minutes using a silicon compound provided with the shelter.

Most of the Igloos deployed in the field have been anchored to rock using expanding eye bolts (12 mm in diameter). On soft ground and ice, star pickets have been used as tie-down pegs. In soft snow conditions, either aluminum plates or plywood squares buried at a suitable depth would be an ideal "deadman" anchor system.

TRANSPORTATION

Because most of the sections of an Igloo (basic and extended forms) are regular in shape and size, they can be packed efficiently into a relatively small container or crate for shipment. A major operational advantage of the basic Igloo, especially where rapid field deployment of people and equipment is required, is that after it is fully assembled it can be airlifted by a single-engine helicopter. Four of the eight steel tie-down lines can be joined and attached to a 5-m sling which is then attached to the helicopter. This length allows the aircraft to pick up the sling from alongside the Igloo and to drop the lifting shackle well clear of the roof when unloading. It also can be transported by motor toboggan sledge, rubber inflatable boat, or even by hand over rough terrain as the heaviest panel (side panel fitted with door) weighs 27 kg. The weight of a fully assembled basic Igloo is 240 kg. The dimensions of the Igloo are given in Table1.

Table 1. Igloo Dimensions in Meters

Maximum diameter	3.10
Floor diameter	2.85
Internal height	2.15
Window diameter	0.60
Door height	1.25
Door width (maximum)	0.62
Escape hatch diameter (basic Igloo)	0.60
Side panels (extended Igloo)	2.40 x 0.75
Packed dimensions (basic Igloo)	2.45 x 1.25 x 1.25

Helicopter (Bell 206) delivering an Igloo shelter to a selected site at Edgeworth-David Base. Four of the Igloo's guy lines form a sling for helicopter transport.

SUMMARY

The Igloo provides an effective shelter for field activities in polar conditions. In addition to the versatility provided by the shelter's design and construction method, it offers the major advantage of the ability to be airlifted by helicopter to remote and climatically extreme localities. The ease of portability allows the shelter to be redeployed a number of times during a summer field season. Because of the Igloo's streamlined shape, little movement in the structure is evident even in strong to gale-force winds, and little drifted snow piles up in its lee. As the shelter is easily deployed and retrieved by helicopter, there is minimal disturbance to fragile polar environments caused by the erection, maintenance, and removal of field shelters and observatories. The Igloo shelter provides its occupants with warmth and a comfortable atmosphere, and it is a great improvement on many alternative shelters.

Extending a basic Igloo shelter by the addition of floor and side panels which had been airlifted inside the Igloo.

REFERENCES

[1]Ballantyne, J., and J. Nisbet. 1962. A lightweight portable hut for field use. *In* Proceedings of the Symposium on Antarctic Logistics, Report of the Working Group on Logistics, Scientific Committee on Antarctic Research, Boulder, CO, August 13-17, 1962, pp. 197-201.

[2]Parcoll Products Ltd. 1962. The "Parcoll" housing unit. *Polar Record* 11(72):294-295.

[3]Ledingham, R. B. 1985. Igloo Satellite Cabins Mk IIIA. Report of flight tests, Antarctic Division Technical Note, p. 3. ♦

Back of the Book

• Noted

Keen-eyed readers may spot an empty space on our back cover where once the phrase **Address Correction Requested** appeared. Be warned: if you move and don't tell us where you've gone, now you'll never see *TNE* again. It's the tight times, sorry to say. We can't pay the postal people to be detectives anymore. Thus, if you want the magazines you've paid for, let us know where you go and when you're going.

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Among the retiring faculty members honored with the title of professor emeritus at the 1986 University of Alaska-Fairbanks commencement ceremonies were two of special interest to *TNE*'s readers. **James B. Tiedemann**, who taught mechanical engineering at UAF since 1969 (and aerospace engineering at the University of Kansas for 15 years before that) is now Professor of Mechanical Engineering Emeritus. **Keith B. Mather**, whose name has graced our editorial board roster these past few years, is now Professor of Physics Emeritus and Director of the Geophysical Institute Emeritus. Among his many accomplishments was preserving this magazine when its then-parent organization closed in 1973—at least, we certainly think it should be listed among his accomplishments.

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Honored also this spring was **William Mendenhall**, UAF professor of civil engineering who was named Engineer of the Year by the Fairbanks chapter of the National Society of Professional Engineers. As many of our readers know, Mendenhall has been teaching civil engineering at the University since 1955, and—as well as being registered in the state as a civil engineer, a mechanical engineer, and a land surveyor—has also maintained a private practice in photogrammetry.

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Last year was a good one for engineers – employed ones, at least – according to the National Society of Professional Engineers. Salary statistics indicate that **U.S. engineers' median annual income was $47,200 as of January 1986.** By field, the highest median was in petroleum and mining ($52,850); by location, New York is