THE DESIGN AND INSTALLATION OF FENCES FOR CONTROL OF SNOW DRIFTING

J. R. Hicks and S. J. Bolsenga, U.S. Army Cold Regions Research and Engineering Laboratory, Environmental Research Branch, Hanover, New Hampshire.

ABSTRACT

The continuously drifting and blowing snow in the high polar regions imposes a severe handicap on maintenance and greatly limits the operational life of both surface and subsurface facilities erected in the Arctic. Certain concepts for drift control practices have been tested in a large wind tunnel using a modeled synthetic snow having suitable physical properties to produce a scale-model blowing snow environment. Criteria derived from these model studies were first used in the development and testing of full scale drift fences, and installation patterns, in Northern Michigan and on the Ice Cap in Greenland. Subsequently, a full-scale protective pattern of fences was erected near Camp Century to determine the feasibility of utilizing snow fences to protect atomic-reactor intakes constructed flush with the snow surface.

I - INTRODUCTION

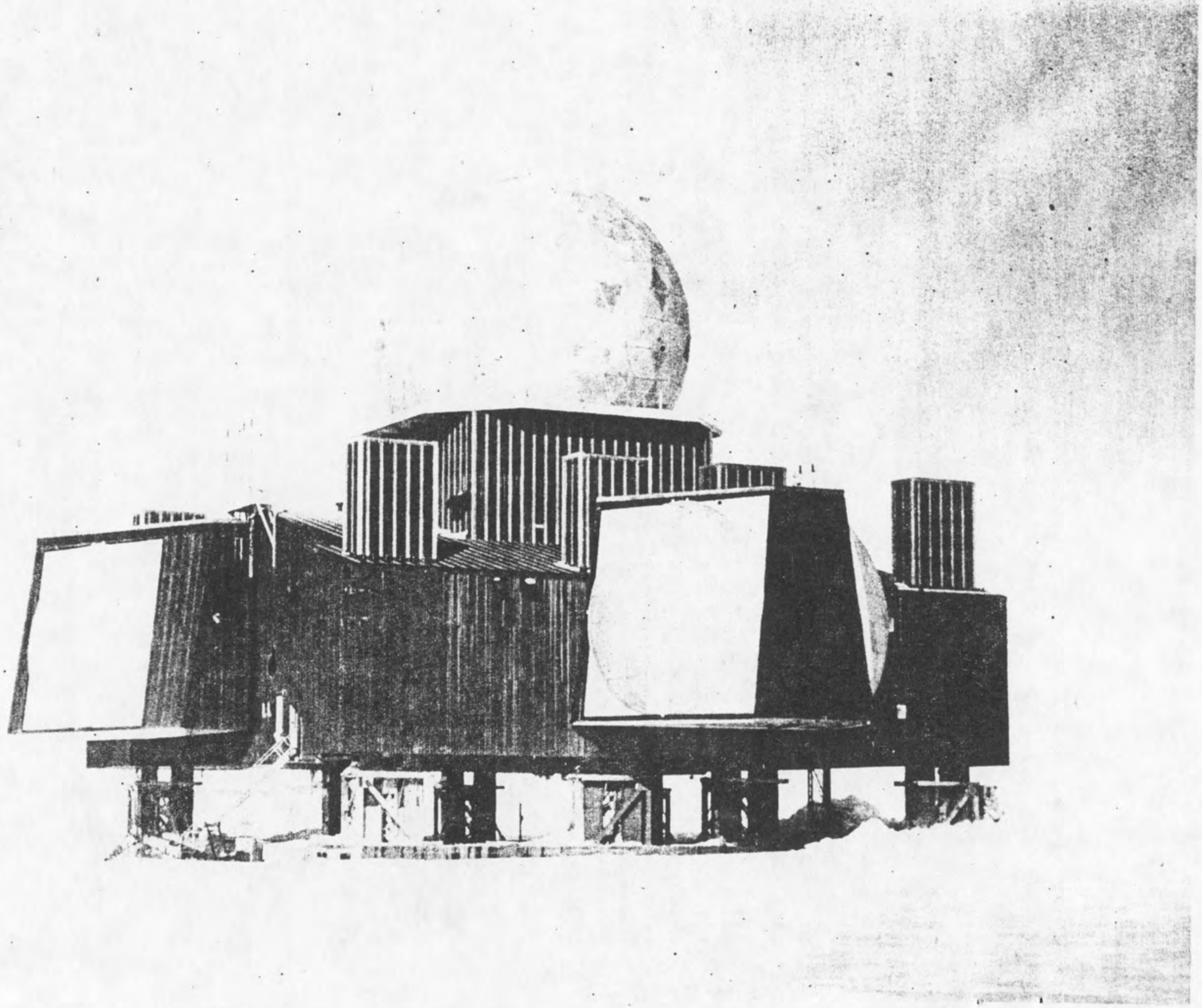
In a paper presented to the Western Snow Conference last year, Dr. R.W. Gerdel (1), Chief of the Environmental Research Branch, USA CRREL, described some of the laboratory and field studies on snow drifting. He discussed the need for scaling the properties of snow-simulating materials and their environment, and he compared the results of model studies with field data and found them to be in close aggreement.

This paper presents the results of further research on the problem of drifting snow and describes some field studies in Greenland and some wind-tunnel studies at New York University.

II - DRIFT PROBLEMS IN THE ARCTIC

Arctic structures are usually designed to minimize the problem of drifting snow; nevertheless, the problem still exists and is very critical in many areas. Two cases in point are the Ice Cap stations of the Eastern Extension of the DEW line across southern Greenland, and the U.S. Army's undersnow research facility, Camp Century, in northern Greenland.

As a product of research and suggestions by USA CRREL, the DEW line composite buildings were constructed on "stilts" so that the area underneath the structures would be wind-swept clear of snow. (See Fig. 1). To compensate for the annual accumulation of snow, the buildings were designed to be elevated periodically; nevertheless, drifted snow is still a major problem as can be seen in Fig. 2. The particular drift shown in this photograph was formed during one 5-day storm in February 1961.



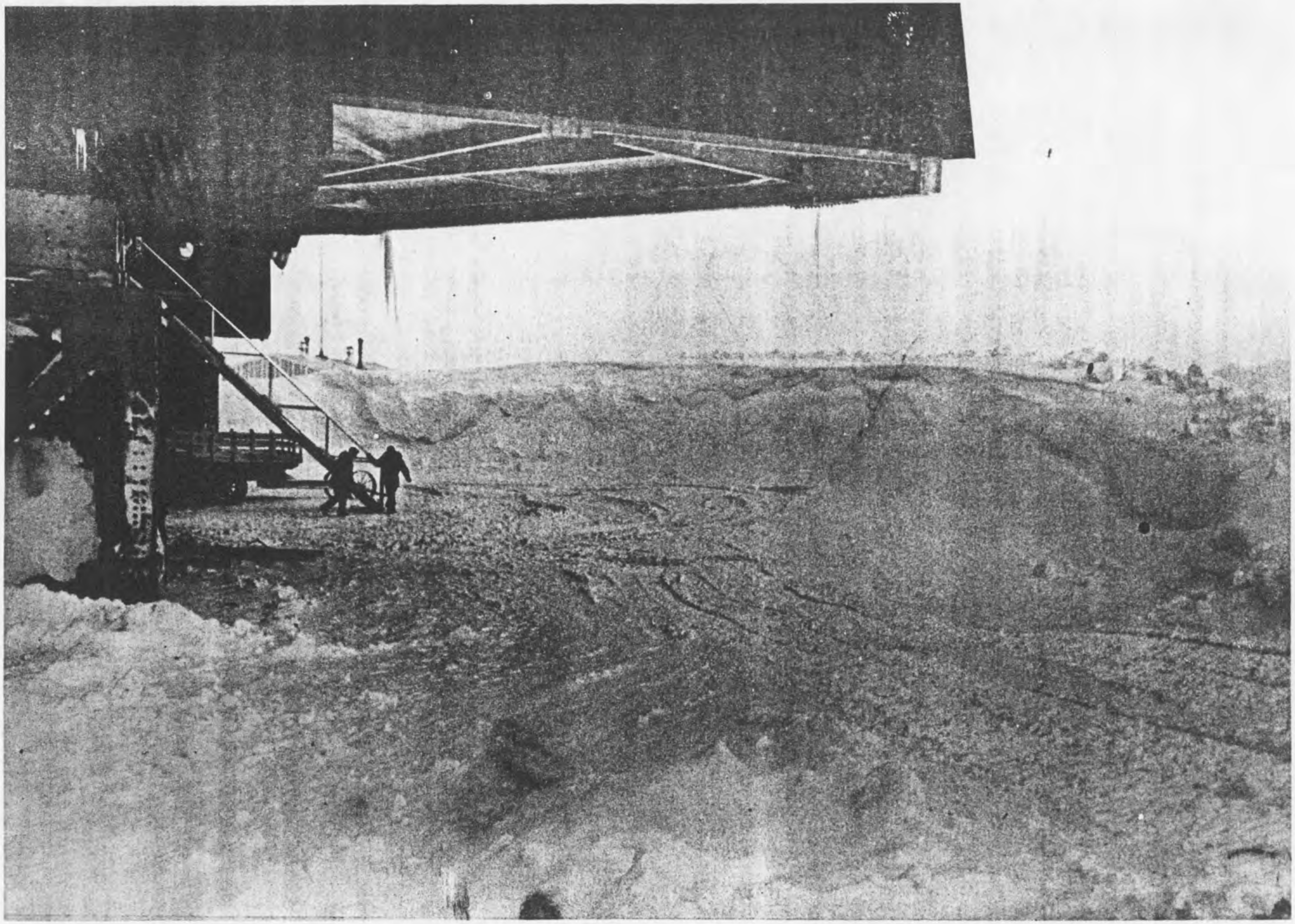


Figure 2. SNOWDRIFT FORMED TO THE WINDWARD OF ONE OF THE GREENLAND DEWline STATIONS. THE AUXILLIARY BUILDING IN THE BACKGROUND IS ABOUT 24 FEET HIGH.

Camp Century, although constructed below the snow surface to eliminate the hazards of snow accumulation, still has its drift problems since many of its structural components: ventilators, escape hatches, antennas, etc., must necessarily protrude above the surface. The ramps to the tunnel entrances are particularly susceptible to the hazards of drifting snow and easily become filled. Also, the main tunnel floor sometimes becomes covered with drifted snow as far as 250 feet from the portal. (See Fig.3) Keeping the portals open is essential to providing proper ventilation and cooling of the reactor power plant at this facility. Not only does this accumulated snow have to be removed, but it also has to be deposited somewhere; and the dump area is difficult to maintain so that it does not interfere with surface operations.

III DESIGN CRITERIA FOR PROTECTIVE BARRIERS

In the two cases just described, and, in fact, all areas in which there is an annual positive accumulation of snow, any protective fence - whether blower, leading, or accumulating type - eventually will become buried. When this occurs, it becomes necessary to construct another barrier, leaving the old one in the snow. This procedure is particularly undesirable because any buried material precludes the use of mechanical snow remover such as the "Peter" snow plows, and the area becomes one in which future construction work becomes very difficult to perform.

It was concluded from several years of field observations that a portable, light-weight, self-cleaning and efficient fence, preferably one which was or could be made commercially available, was required. Hence, model studies in a simulated environment and, later, full-scale field studies on drift fences were initiated.

IV A. TESTS

Model Studies in a Simulated Environment

Previous researchers: e.g., Finney, E.A. (2) had shown that it was feasible to conduct snow-drift studies in a simulated environment using models of structures; however, little consideration was given to the scale factors involved. New York University was given a contract by USA CRREL to investigate the scale-factor problem and to conduct tests based upon the results of these investigations. Initial studies were made using models of proposed Arctic structures and systems for preventing snow damage to them.

Many types of barriers were tested: solid walls, vertical panels of both lightweight metal and plywood construction, horizontally slatted, vertically slatted, paper strips, plastic strips, oil drums and trenches cut in the snow. Of the many fences tested, the 5-slat metal fence shown in Fig. 4 seemed to be the most suitable; and it was the one selected for the field study program. This type of fence has been used successfully by several railroads to control snow drifting along exposed sections of tracks.

IV B. FIELD STUDIES

The purpose of this paper is not to present comparisons between the many types of snow-drift fences studied in the field and in the wind tunnel by USA CRREL, but, rather, to show how effective the 5-slat portable fence was in providing drift control where a critical problem exists.

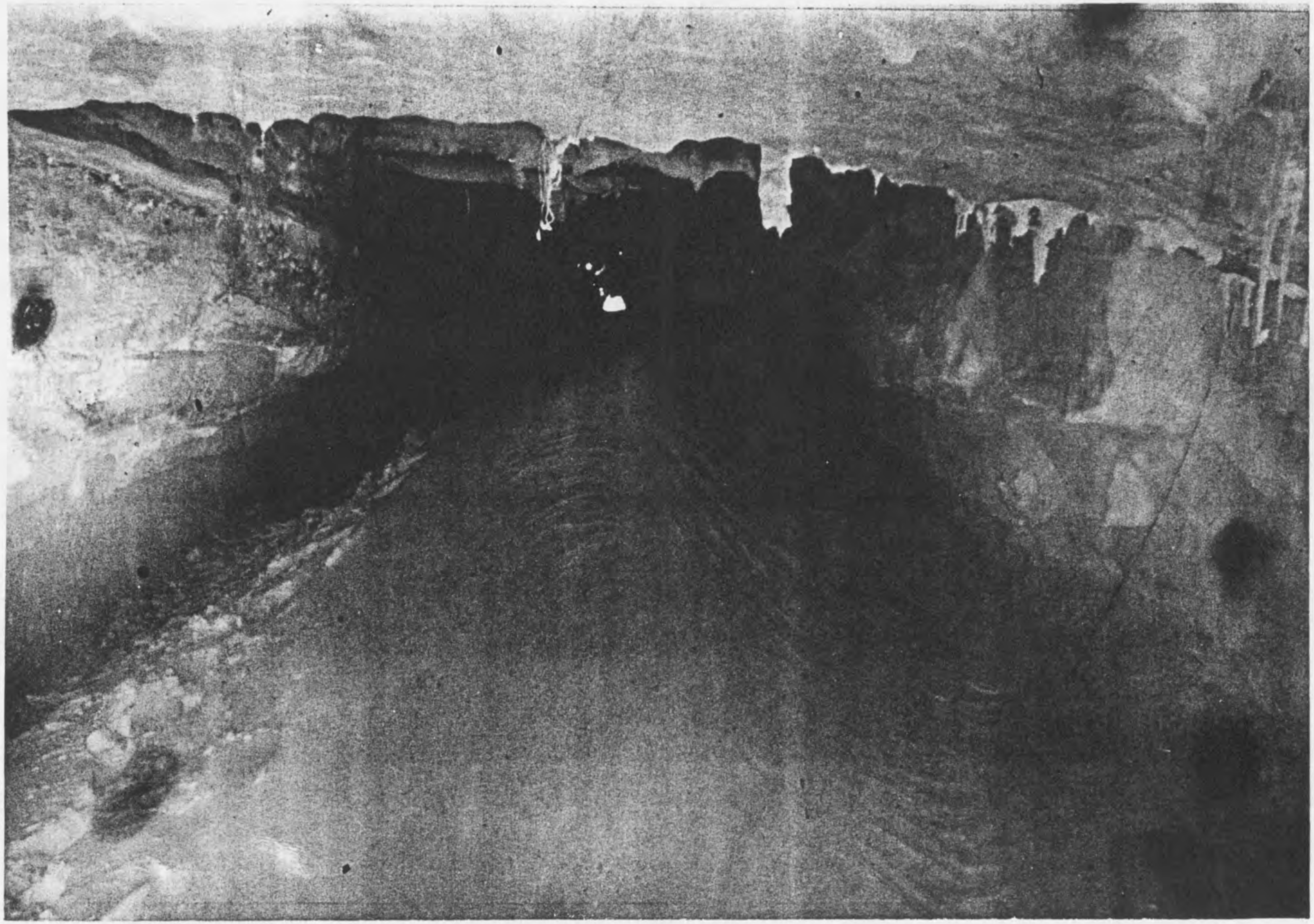
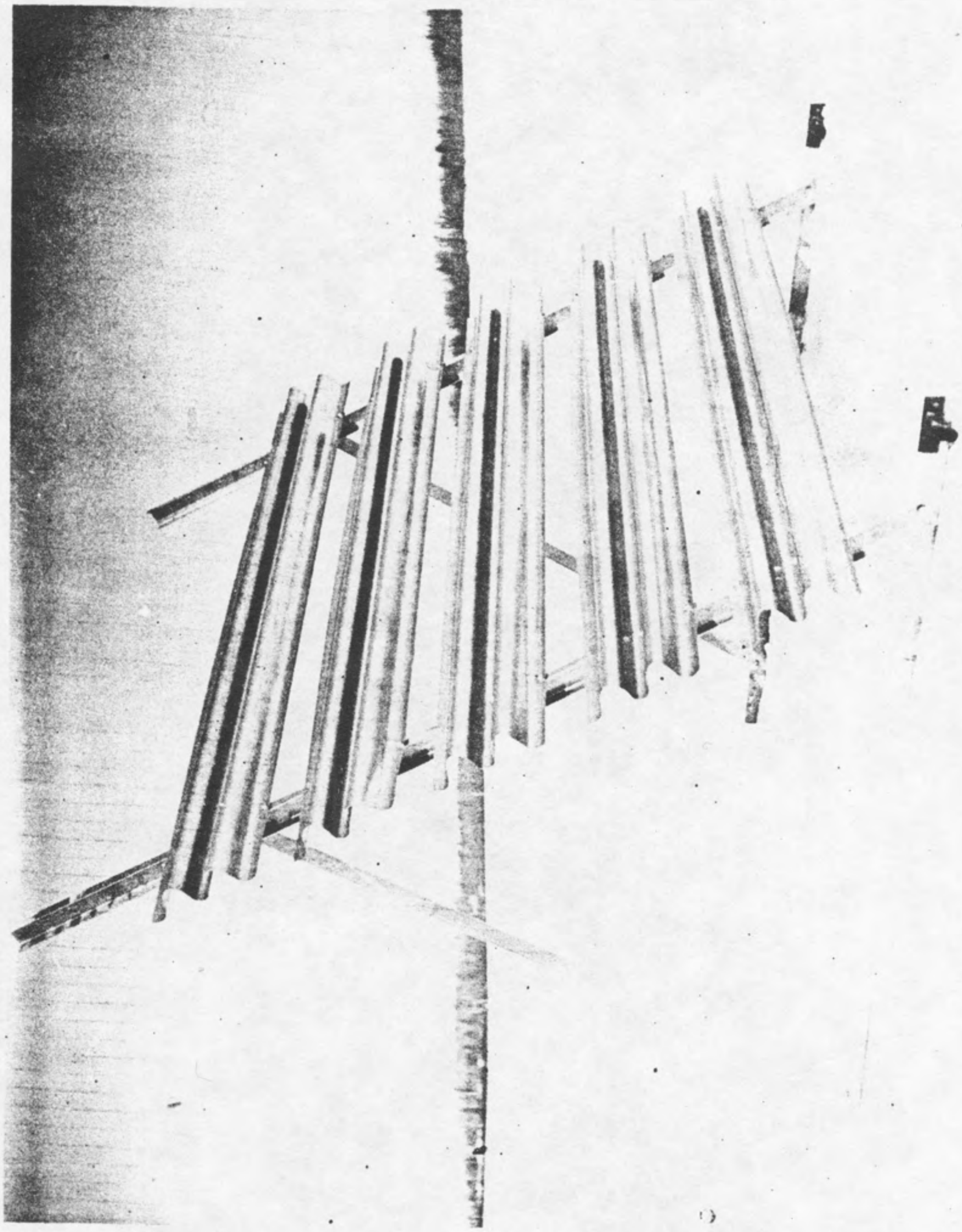


Figure 3. DRIFTED SNOW IN THE RAMP AREA OF THE SOUTH ENTRANCE TO CAMP CENTURY.



Initial field studies using the 5-slat metal fence were made at our field station near Houghton, Michigan. The first installation was only 100 feet long, but it demonstrated that this type of fence was efficient, easily installed, self-cleaning and portable; and, thus, would probably be suitable for use on the Greenland Ice Cap or other Arctic areas where the wind is quite persistent.

A full-scale drift fence installation was made at Camp Century, Greenland, in July 1961. Three trenches, each about 50' x 18' x 8', were cut in the snow to provide full-scale models of the usual ramp-type entrance and ventilation system for an undersnow camp. One of the ramps was left unprotected while the two others were used for full-scale studies of the concepts for drift control by snow fences: the first of these two was protected by a V-shaped, vertical, solid wall fence positioned immediately to the windward. In addition, two rows of the 5-slat metal fence were installed farther upwind. The remaining trench was protected by a solid V-shaped fence, modified by flaring the ends to impart a vortex-like motion to the airflow. To add further protection to these two trenches, short sections of the 5-slat metal fence were installed on each of the sides which were parallel to the prevailing wind.

A grid of bamboo poles, marked at 3-inch intervals, was used to measure the volume and distribution of the snow accumulation in the test area.

The entire installation is shown in Figure 5.

V A. RESULTS OF TESTS
Trench Protection

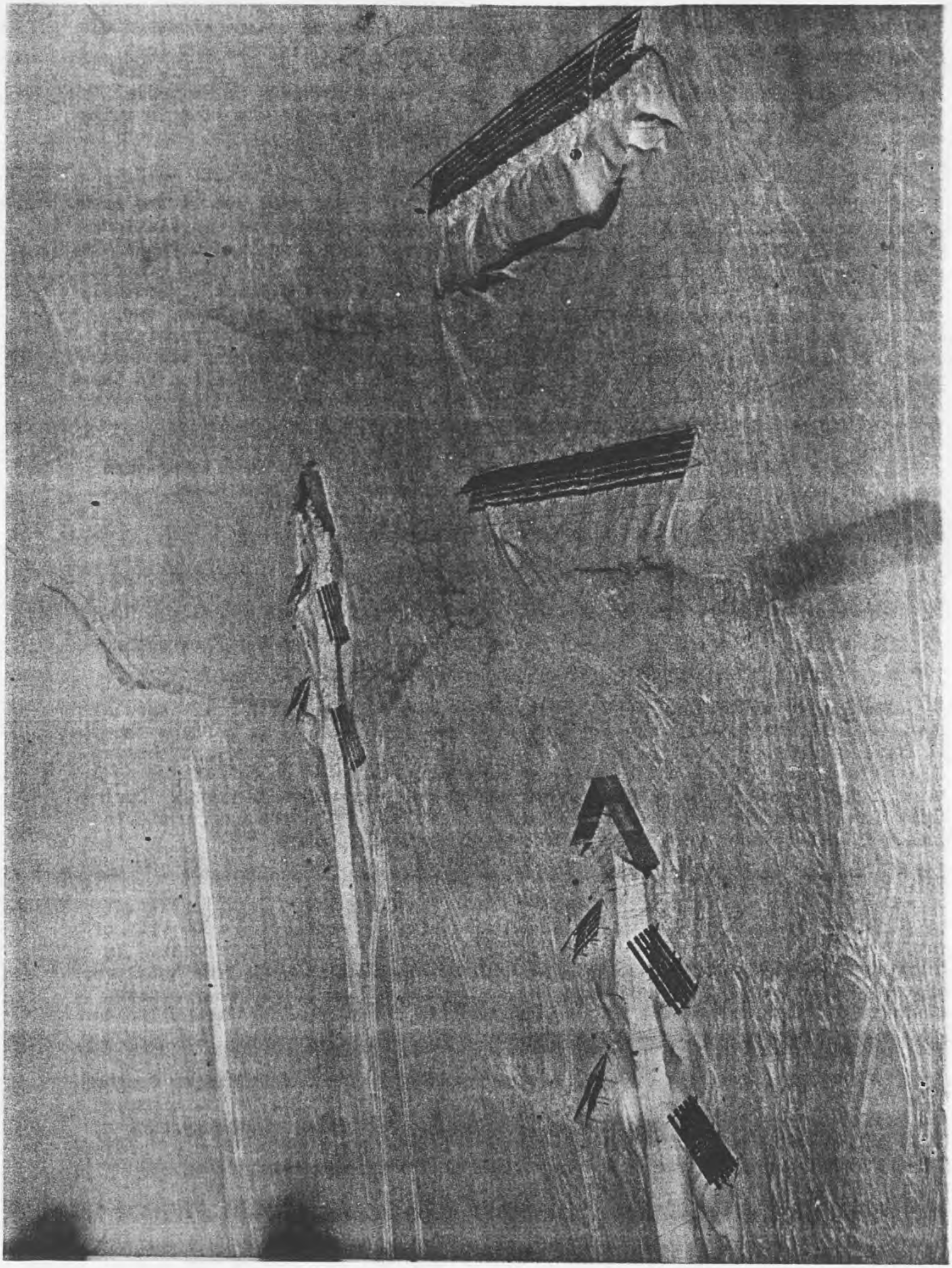
The ability of the snow fences to protect the ramp trenches from accumulating blowing snow is shown by the bar graph of Figure 6.

The rapid rate at which the unprotected trench filled with drift snow as compared with the rate of filling of the protected trenches, is perhaps the most significant feature shown in Figure 6. Of particular interest is the observation made on July 31, 1961, which shows the amount of snow deposited during a minor 2-day storm, during which the windspeed never exceeded 32 knots. During this time, the unprotected trench became 45% filled, while the most protected trench filled to less than 0.5% of the total available volume.

V B. SNOW COLLECTION

During the period 31 July to 4 September 1961, a total of 93,000 ft.^{3} of snow of average density of 0.32 was collected by the two 130-ft. fences. In terms of the water equivalent, this amounts to about 225,000 gallons total, or about 7,500 gal./day. The accumulation has been computed in gallons because, at many installations on the Ice Cap, it is this drift snow that is bulldozed into melters to provide the domestic water supply.

Near-saturation* (see Fig. 7) of the windward fence occurred twice during this period, and each time the fence was moved about ten feet to the windward and positioned on top of the crest of the accumulated drift at that point. Thus, each new position allowed subsequent drifts to form which were of greater depth and areal extent than could be formed if the fence were left in the



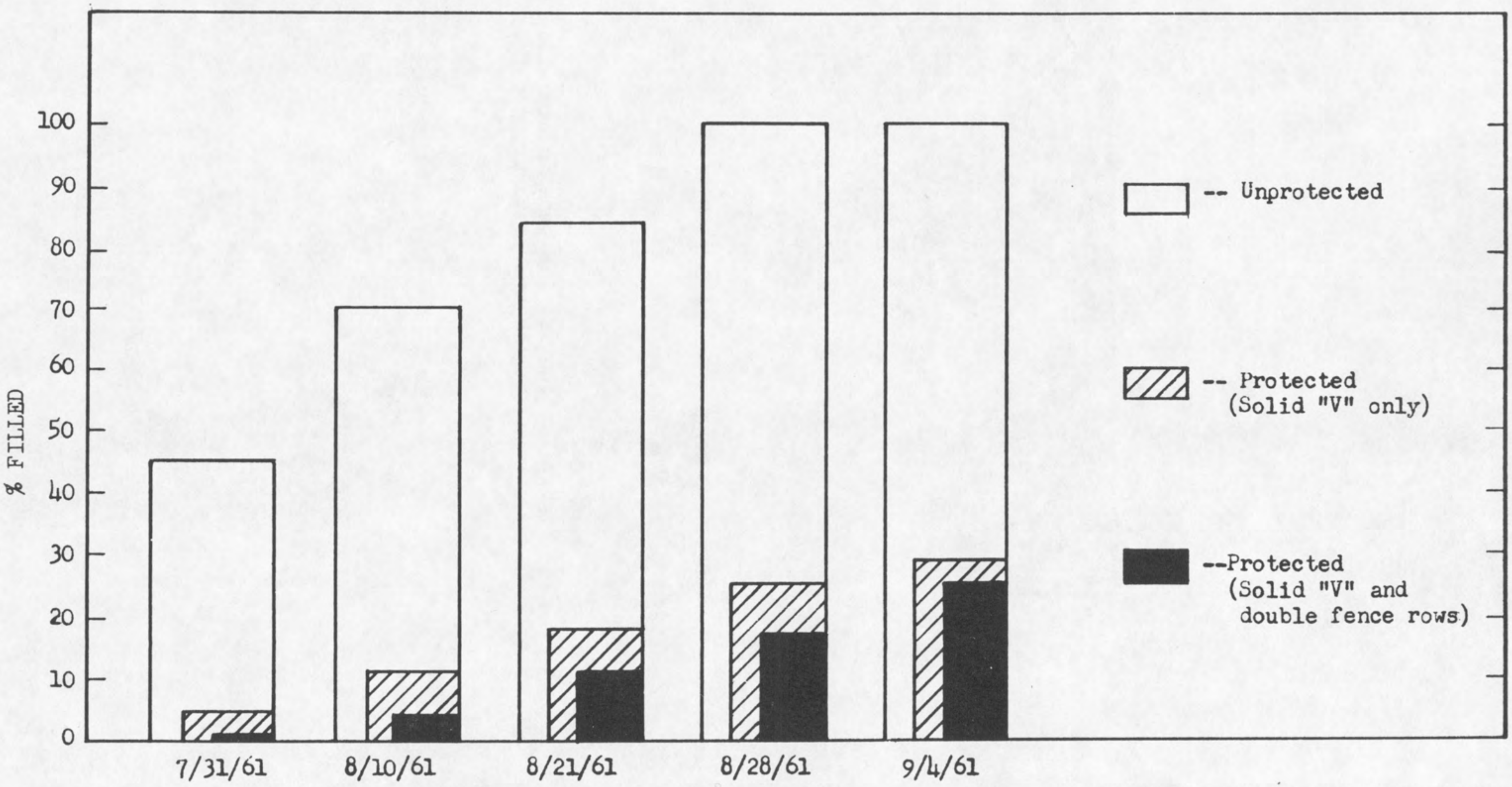


Figure 6. BAR GRAPH SHOWING THE RELATIVE ACCUMULATION RATES IN THREE TEST TRENCHES NEAR CAMP CENTURY, GREENLAND.

Figure 7. Showing the snow accumulation pattern at the near-saturation point.

initial position and only additional sections added to increase the height as needed; a common procedure along highways.

---

* Near-saturation is a condition that occurs when the present volume of snow collected by a fence has nearly reached the total volume which the fence is able to collect. For the 5-slat fence described here, the point is reached when the lee drift reaches almost to the height of the fence itself.

VI FUTURE PLANS

Theoretical studies of the scaling parameters for the wind tunnel simulated blowing-snow environment are still being made (3). Emphasis is being placed on a study of the saltation phenomenon, angle of repose, added mass phenomenon, and other parameters which are needed to reduce the model scale factors to as little as 1/500 or even 1/1000.

It is planned that the present field installation at Camp Century will be kept in operation for at least another year. In addition, protective snow barriers will be installed near the main tunnel entrances of the camp. The first installation will consist of two rows of the 5-slat fence placed to the windward of the south ramp entrance. If this proves effective, similar devices will be erected at other strategic positions in the camp area.

References:

(1) Gerdel, R. W. 1961. The "Simulation of a Blowing Snow Environment in a Wind Tunnel". Proceedings, 29th Annual Meeting, Western Snow Conference, Spokane, Washington; April 1961.

(2) Finney, E. A. 1939. "Snow Drift Control by Highway Design". East Lansing, Mich. Michigan Engineering Experimental Station, Vol. 15, Bulletin No. 86, 56 pages.

(3) Odar, F. 1961. "Scale Factors Applicable to the Simulation of Snow in a Wind Tunnel". Paper presented to the ASCE, New York, October 1961.