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NRL REPORT 3914

A WEATHER HOOD FOR THE AS-45A/APR-6 ANTENNA

NAVAL RESEARCH LABORATORY

WASHINGTON, D.C.

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A WEATHER HOOD FOR THE AS-45A/APR-6 ANTENNA

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ABSTRACT

A new weather hood, constructed of laminated Pittsburgh plate-glass cloth and using Selectron 5003 as the bonding material, has been developed for the AS-45A/APR-6 antenna. The new cover has the required mechanical features, and the materials have desirable electrical characteristics. For comparison, the report includes the electrical characteristics of the original antenna. When equipped with the proposed cover recommended to replace the present Plexiglas model, results indicate that the antenna is suitable as an omnidirectional receiving antenna over the frequency range of 2250 to 4600 Mc.

PROBLEM STATUS

This is a final report on one phase of the problem; work on other phases continues.

AUTHORIZATION

NRL Problem 39R09-17
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A WEATHER HOOD FOR THE AS-45A/APR-6 ANTENNA

INTRODUCTION

The AS-45A/APR-6 (Figure 1), a shipborne, countermeasure, intercept antenna now used with the AN/SPR-2 receiver, is essentially two open-ended waveguides that meet at a common junction and connect to a waveguide transmission line. If the apertures were to remain open-ended, corrosion and moisture would collect in the transmission lines and thereby increase attenuation. The antenna was originally equipped with a Plexiglas hood (Figure 2), but frequent mechanical failures and a relatively high replacement cost accentuated the need for a new housing. The problem, therefore, was to design a less expensive cover that would be mechanically stronger than the original model and yet offer negligible effect on the antenna's electrical characteristics. A comparison of the electrical characteristics of the antenna when equipped with experimental covers was proposed to determine a suitable replacement for the original model.

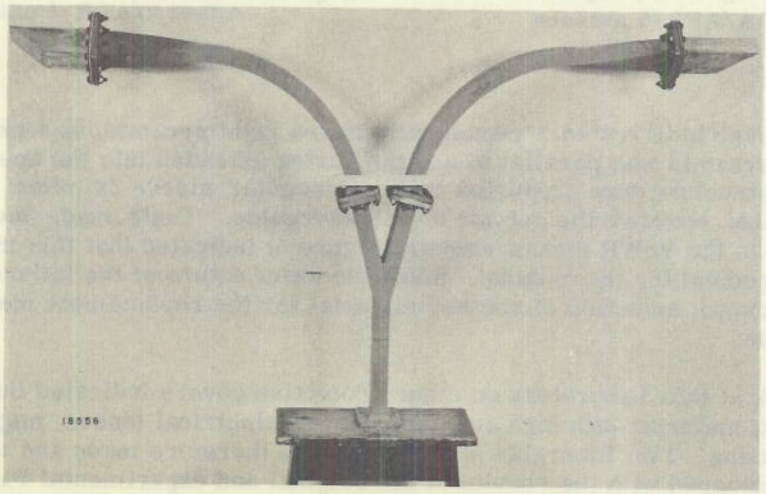


Figure 1 - AS-45A/APR-6 antenna with proposed weather hood

EXPERIMENTAL RESULTS

Since any object in the near field of an antenna alters its electrical characteristics by a reflection of energy, it is desirable to select tapered or oblique structures that reduce this effect as much as possible. For this reason, two of the three experimental models were these types, and the other was a flat plate that covered the open end of the waveguide. Figure 3 shows the proposed model with an oblique face.

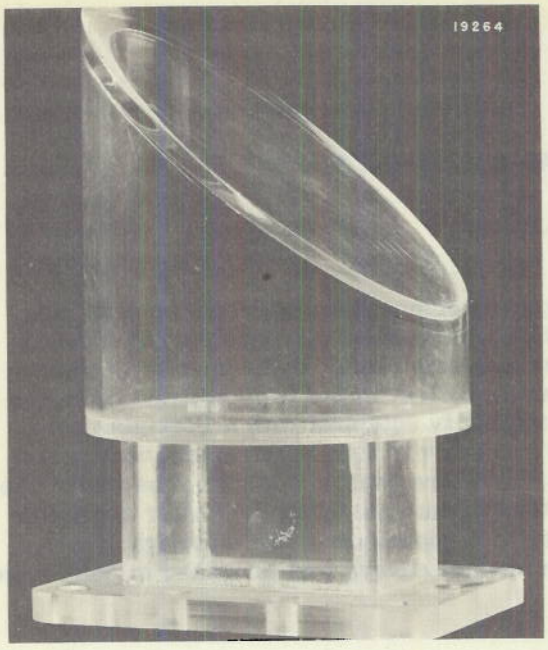


Figure 2 - The original Plexiglas hood for the AS-45A/APR-6 antenna

Figure 3 - Proposed weather hood for the AS-45A/APR-6 antenna

The first cover to be tested, a rectangular-based right pyramid, was made of Plexiglas; the base of the pyramid was parallel to and the vertex extended into the aperture of the antenna. This structure was supported by a rectangular sleeve (similar to that of the original hood) that covered the outside of the waveguide. Tests made incorporating this cover such as the VSWR measurements (Figure 4) indicated that this model could be used as a replacement for the original. Since the exact nature of the failure of the present model was not known, selection of another material for the replacement model was considered desirable.

Recent work at this Laboratory on other protective covers indicated that Fiberglas-cloth laminate, a material with high strength and low electrical losses, might possibly be used for the housing. Two Fiberglas structures were therefore made and tested, and results were compared with the results of the original and experimental Plexiglas models. Although the first models, essentially flat plates that covered the antenna's apertures, did not give results as desirable as the results of the original or experimental Plexiglas models, the suitability of this material for a cover was indicated. The proposed housing has similar construction except that the plates are rotated 45^{0} in the "H" plane. As in the previous models, each plate was supported by a rectangular sleeve and flange. When the antenna was equipped with this cover, tests indicated this model to be a suitable replacement for the original.

Since commercial specifications for the mechanical and chemical characteristics of these materials were considered acceptable, choice of the replacement cover was primarily determined from the standing-wave ratio and radiation-pattern measurements. Although the antenna when equipped with any pair of the experimental models had a VSWR less than 5:1,

the proposed model had, in general, the lowest value over the entire operating range. The VSWR curves for the antenna with the different pairs of hoods are given in Figures 4 and 5. The radiation patterns, representing the free space patterns of the antenna in the $\phi = 0^{0}$, $\phi = 90^{0}$, and $\theta = 90^{0}$ planes (Figure 6) are plotted on a linear, 40-db scale in Figures 7 through 12.

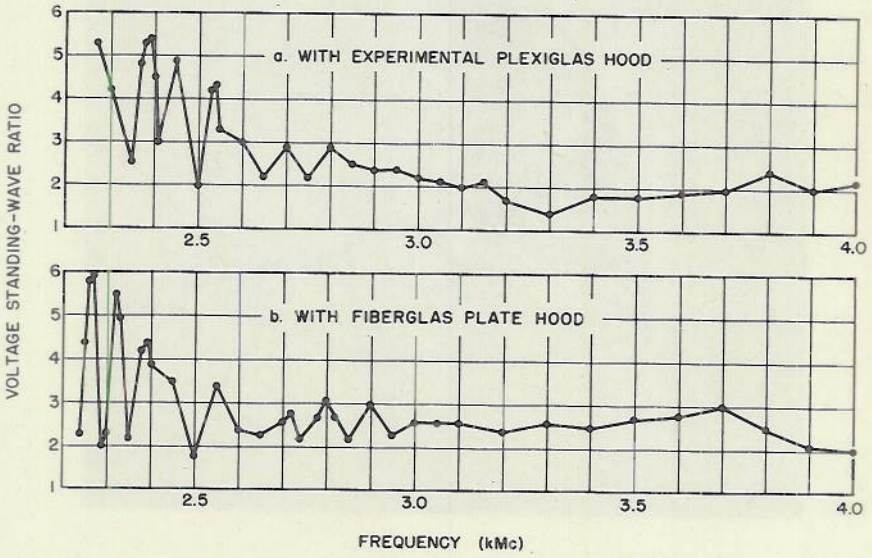


Figure 4 - VSWR of AS-45A/APR-6 antenna with Plexiglas and Fiberglas hoods

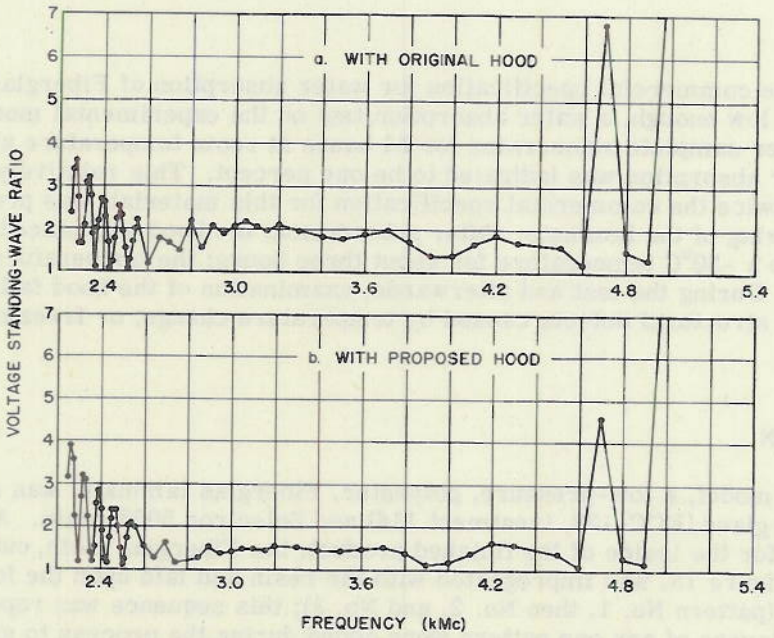


Figure 5 - VSWR of AS-45A/APR-6 with original and proposed hoods

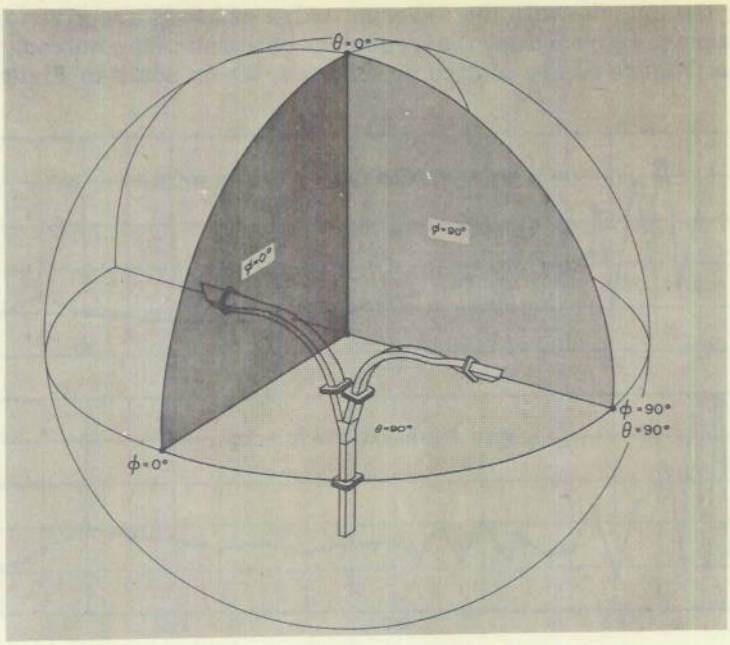


Figure 6 - Spherical coordinate system used in the measurement of the radiation patterns

Although the commercial specification for water absorption of Fiberglas laminates was considered low enough, a water absorption test on the experimental model was deemed necessary. After complete submersion for 24 hours at room temperature and atmospheric pressure, water absorption was indicated to be one percent. This relatively high value, approximately twice the commercial specification for this material, was probably caused by improper curing of the laminate. After submersion, the hood was placed in a chamber and subjected to a -20°C temperature for about three hours; the temperature was then raised to 60°C. During the test and afterwards, examination of the hood failed to reveal any physical or structural defects caused by temperature change, or freezing of the absorbed moisture.

CONSTRUCTION

The tested model, a low-pressure, polyester, Fiberglas laminate, was constructed of Pittsburgh plate glass (ECC-128, treatment 114) and Selectron 5003 resin. After constructing a wooden form for the inside of the finished product, the Fiberglas cloth, cut from patterns illustrated in Figure 13, was impregnated with the resin and laid upon the form in consecutive order (pattern No. 1, then No. 2, and No. 3); this sequence was repeated except that additional layers of any one pattern were added during the process to give the desired wall thickness. When the lay up was completed, it was clamped between wooden blocks which exerted pressure on all surfaces and was then placed in an oven to cure. During the cure, air was excluded by covering the form and blocks with polyvinyl alcohol film.

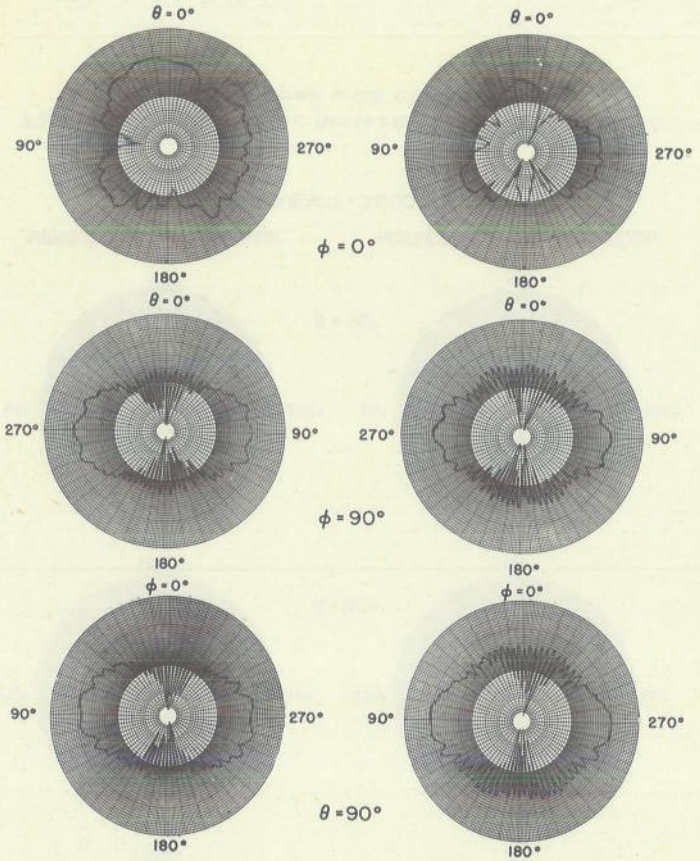


Figure 7 - Free space patterns of AS-45A/APR-6 antenna equipped with original hoods

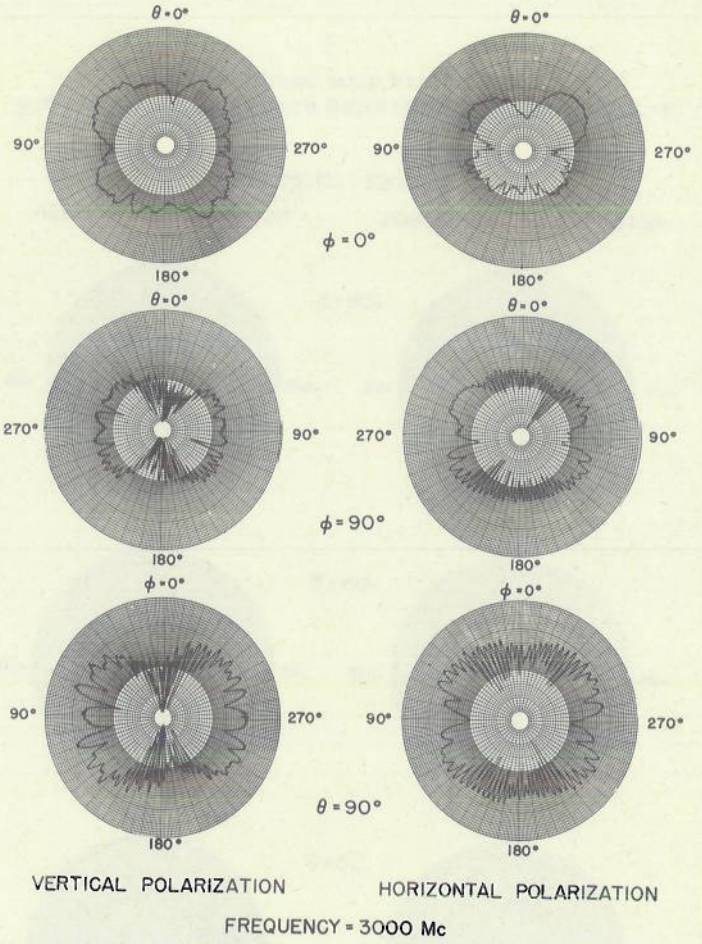


Figure 8 - Free space patterns of AS-45A/APR-6 antenna equipped with original hoods

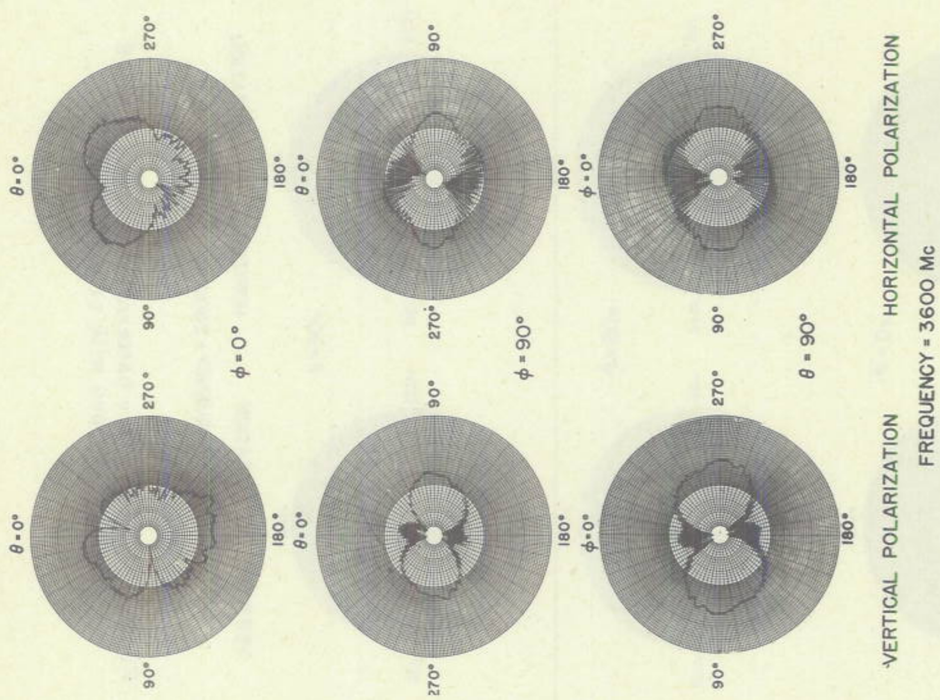


Figure 9 - Free space patterns of AS-45A/APR-6 antenna equipped with original hoods

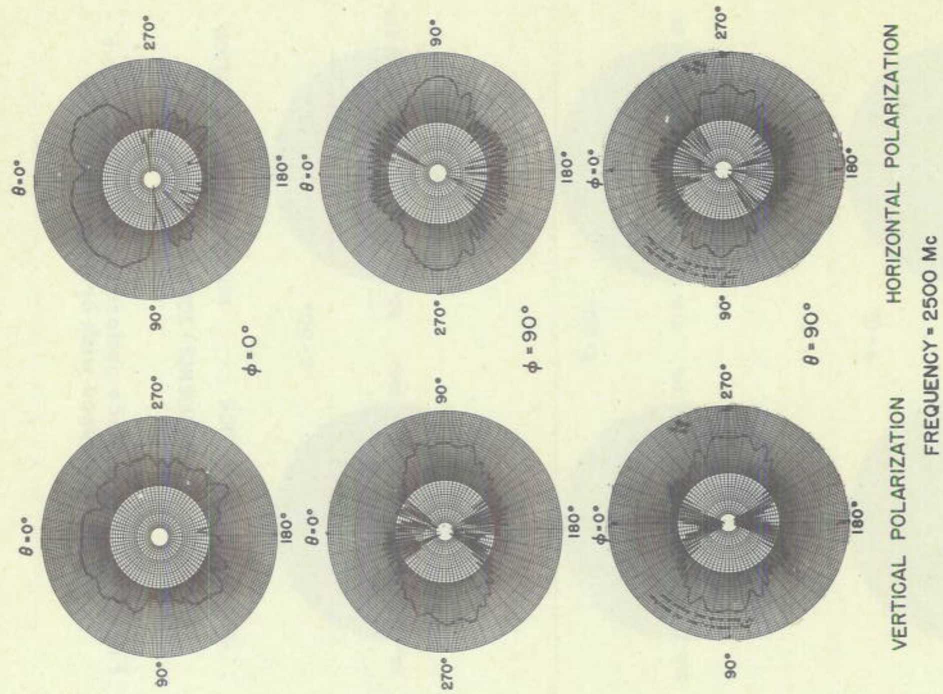


Figure 10 - Free space patterns of AS-45A/APR-6 antenna equipped with proposed hoods

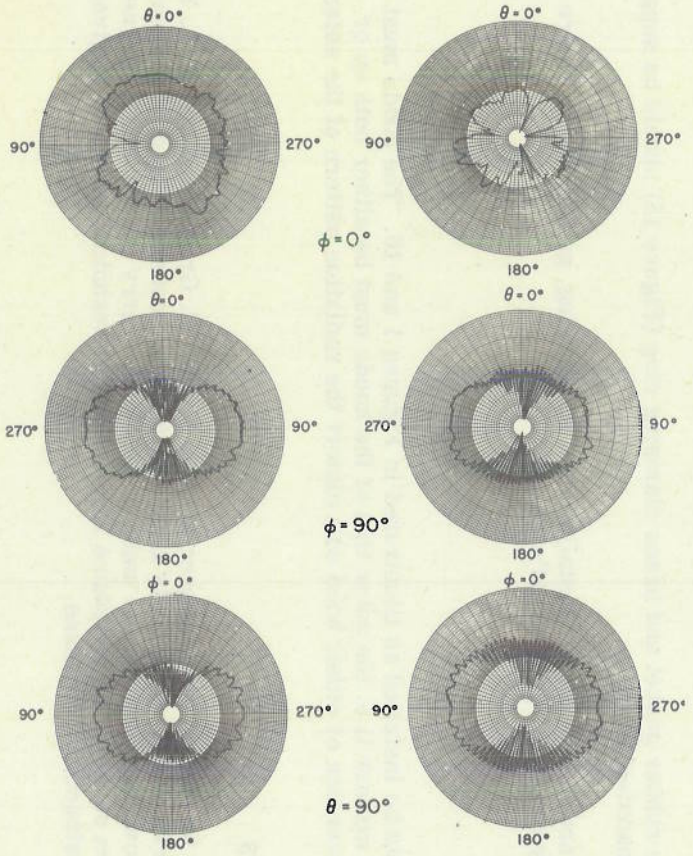


Figure 11 - Free space patterns of AS-45A/APR-6 antenna equipped with proposed hoods

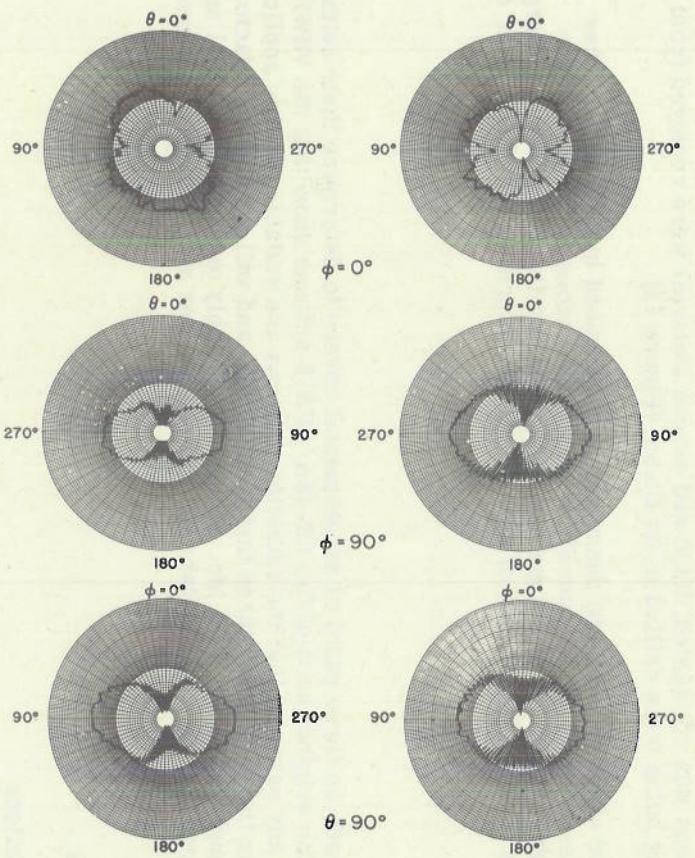


Figure 12 - Free space patterns of AS-45A/APR-6 antenna equipped with proposed hoods

After the curing process was completed, flash and excess material were removed from the hood, and mounting holes were drilled in its flange (Figure 14).

Although a method similar to the one described might be used in production, other construction techniques such as the vacuum diffusion molding process patented by the Marco Chemical Company and high-pressure molding with glass flock in place of Fiberglas deserve consideration. In general, choice of method will be determined by the number of units required.

CONCLUSIONS

Measurements made on three pairs of experimental covers to determine their suitability as replacements for the original hood of the AS-45A/APR-6 antenna show that the VSWR was less than 5:1 for any pair and that the radiation patterns are suitable for this application. The proposed model is the best of the three tested, however, and will operate satisfactorily over the frequency range of 2250 to 4600 Mc. Since results apply only if the material used in the construction have the same or similar characteristics, any substitute material must be carefully chosen.

RECOMMENDATIONS

Construction Specifications

(a) Wall thicknesses and resin content of the housing should be given, and Figure 14 can be used as a guide for these values.

(b) Moisture absorption and permeability of the finished product should be specified. It is recommended that each of these be less than 0.5 percent.

(c) The neoprene rubber gasket and brass clamping ring (Figure 15) should be supplied with the hood by the manufacturer.

(d) To facilitate and insure proper installation of the housing, gasket No. 2 (Figure 14) should be permanently cemented to the hood's flange.

Installation

The housing should be installed as illustrated in Figures 1 and 16. The hoods must be installed in a similar manner (i.e. the outer tips of the hoods must be either both up or both down) because inversion of either hood will distort the radiation pattern of the antenna.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to Mr. W. R. Graner and Mr. E. L. Bono of the Engineering Services Division of this Laboratory for the construction of the experimental models. Acknowledgement is also made to Mr. H. A. Perry and Mr. F. R. Barnet of the Chemistry Division of the Naval Ordnance Laboratory for technical information given on glass-laminate construction processes.

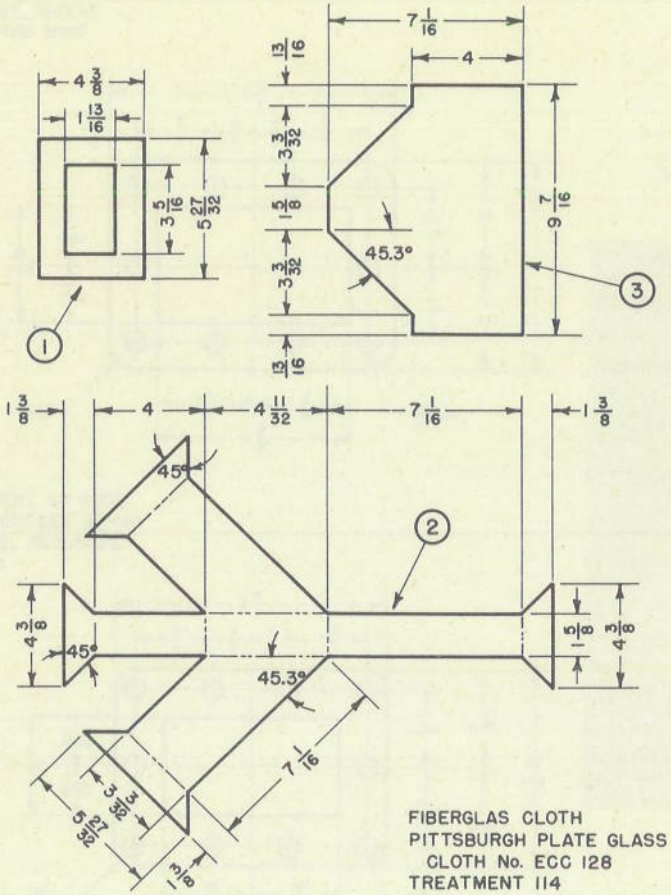


Figure 13 - Layout for weather hood AS-45A/APR-6 antenna

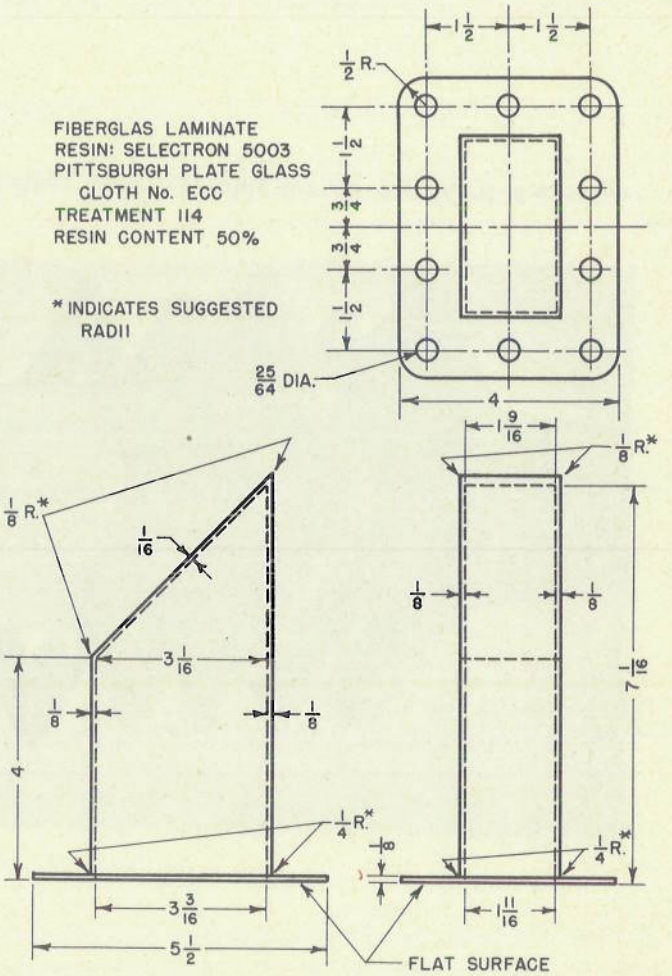
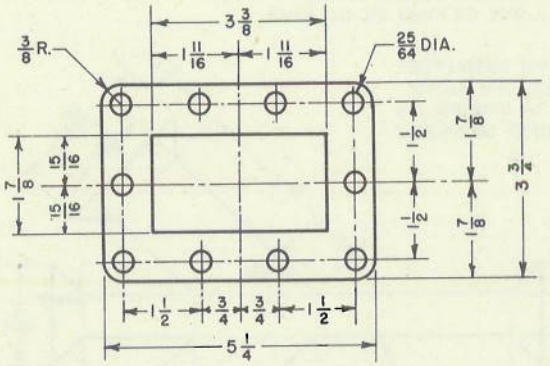
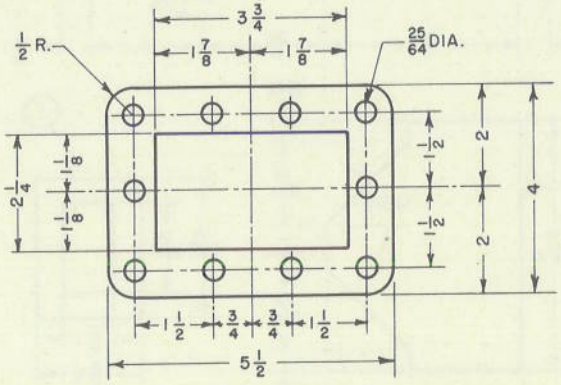


Figure 14 - Weather hood AS-45A/APR-6 antenna



GASKET
0.125" NEOPRENE
DUROMETER 35-40
CEMENT TO HOOD



CLAMPING RING
0.062" BRASS

Figure 15 - Weather hood accessories
AS-45A/APR-6 antenna

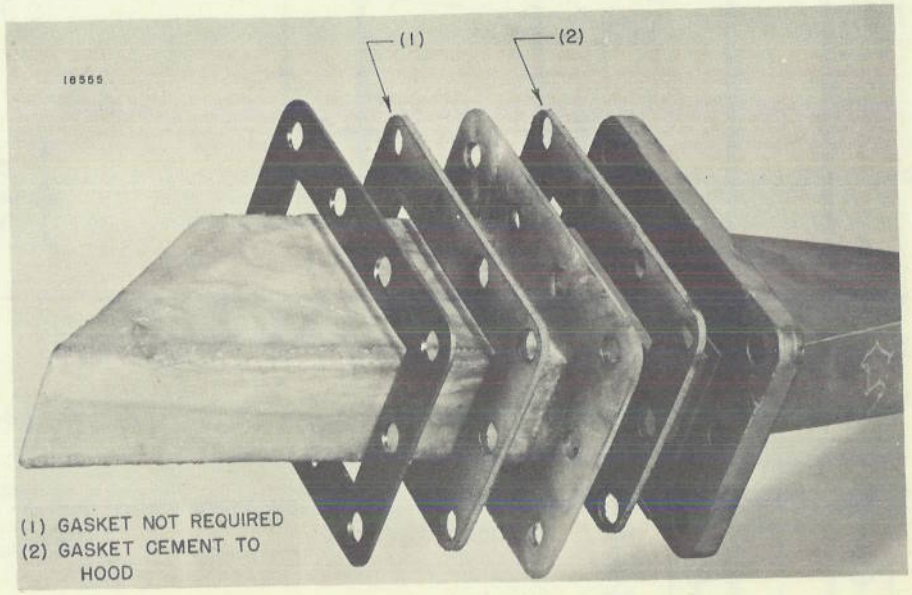


Figure 16 - Weather hood assembly for AS-45A/APR-6 antenna