PLAINTIFF'S EXHIBIT

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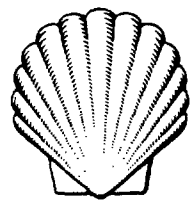
EPON® RESINS FOR CASTING



SHELL CHEMICAL COMPANY
PLASTICS AND RESINS DIVISION
NEW YORK, NEW YORK

Shell Chemical Company is a Division of Shell Oil Company

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INTRODUCTION

The inherent properties of EPON® Resins make these materials outstanding for use in many casting, potting and encapsulation applications.

These resins form polymers that are strong, tough, resistant to chemical attack, and which have excellent electrical properties. It is the purpose of this brochure to indicate the various ways in which EPON Resins can be formulated to produce a compound combining the best of these properties and at the same time, to meet the requirements of a specific application.

The formulator will find in this brochure detailed discussions of curing agents, accelerators, fillers, flexibilizers, and diluents for use with EPON Resins. In addition, extensive data are provided on various EPON Resin curing agent systems, to assist him in the proper formulation of these compounds.

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The effect of fillers on the mechanical properties of resin systems varies. From a use standpoint, however, these properties are largely dependent on the properties of the filler itself. For example, powdered metal oxide fillers, such as aluminum oxide and iron oxide, increase the surface hardness of castings and decrease the ultimate tensile and compressive strengths (see Table II). The compressive yield strength and modulus of cast systems are, however, generally increased (see Figures 2 and 3). A noteworthy exception is atomized aluminum powder which has been found to cause a decrease in yield strength but will impart a definite degree of malleability to the cured product.

TABLE II

EFFECT OF FILLERS ON ULTIMATE STRENGTHS OF EPON RESIN CASTINGS[1]

FILLER	PHR	ULTIMATE COMPRESSIVE STRENGTH (PSI)	ULTIMATE TENSILE STRENGTH (PSI)
None		28,000	12,500
Black Iron Oxide	400	18,000	4,500
Atomized Aluminum	200	15,000	6,500
7TF2 Asbestos Floats[2]	15	17,500	7,000
Water Ground Mica	15	20,000	7,500

[1] *EPON 828-Curing Agent Z*
Cure: 20 hours at 77°F. (25°C.) plus 24 hours at 150°F. (65°C.).

[2] *Johns-Manville Corporation.*

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Undesirable Bolted Construction Avoided in Production of Portable Military Shelters by

Epoxy Bonding Aluminum Components

By NEIL KVASNAK

Craig Systems, Inc.,
Lawrence, Mass.

The recasting of U.S. Army divisions from three regiments into five battle groups brought with it a demand for easily transportable message centers and sub-centers for use in a redesigned system of battle communications. Several years of testing and development have recently led to the perfection of a shelter which basically consists of two high-strength, heat-treated aluminum skins which are epoxy bonded to extruded aluminum framing members.

Called "Helicop-Huts," the air transportable shelters are used for the housing and protection of electronic systems during operation, transit and storage. They were pioneered by Craig Systems, Inc., and provide load-carrying characteristics with as high as a 15 to 1 payload/weight ratio.

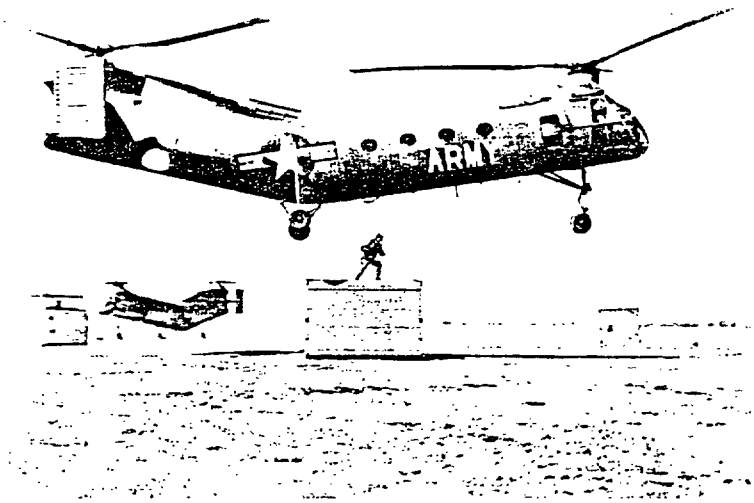
Conventional Construction

Until about ten years ago, most mobile shelters employed conventional construction, *i.e.*, structural framework, an outer metallic skin, usually glass fiber insulation, and an inner skin of plywood or pressed board. In the main, all of these shelters were quite cumbersome and not at all suitable for transport by air.

In addition, before the switch to using structural adhesives, bolted constructions proved undesirable for mobile military use since the bolts always required clearance holes. Under the stress of field use the bolts would work loose and water leaked into the shelter with subsequent damage to installed equipment. Riveted and welded constructions also proved impractical because shelters made in this manner were still too heavy for rapid transportation by air.

The new shelters are basically sandwich-type constructions and weigh about two-thirds less than comparable previous units. In them, the space between the inner and outer aluminum skins is filled with a light-weight, foamed-in-place isocyanate core.

In addition to its inherent toughness and resistance to chemicals and weathering, adhesive bonding was selected for joining the skins and framing members because it made possible shelters of high temper aluminum alloy, 6061-T6. This thin, high-strength aluminum could not be used on previous shelters because welding heat inevitably annealed the metal.



The completely contained communications center can be easily transported to new positions. Flat helicopter drops up to two feet can be made without damage to the shelter or equipment. New units weigh two-thirds less than previous ones.

Curing Epoxy Adhesives

Epoxy adhesives can be cured at room temperature or low heat and therefore do not affect the temper of the aluminum. During the course of research and development studies, tensile shear tests (in accordance with MIL-A-5090A) showed that the bond strength available with epoxy adhesives was 80 per cent greater than the minimum specified by the government.

The adhesive used is based on Shell Chemical Corp.'s Epon® resins

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and is produced by Lawrence Adhesive and Chemical Co., Lawrence, Mass. It is a thixotropic (non-sagging) metal-to-metal bonding agent supplied as a two-component system involving a resin and a curing agent.

As has been pointed out, framing members for the floor, roof and wall of the shelters are angular aluminum extrusions. Where specified, vertical mounting ribs and other extruded members are inserted between the wall skins to serve as anchoring mediums for the fastening of electronic and other equipment. All of the individual frames and ribs are bonded together with the epoxy. The aluminum skins are then also bonded to the extrusions; once the adhesive has cured, the bond between extrusions and panels is virtually indestructible.

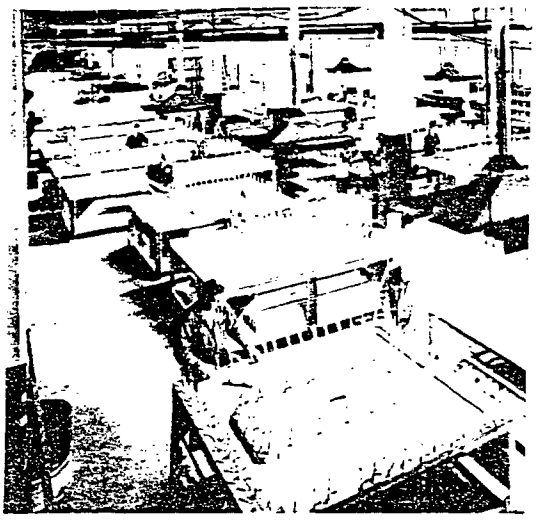
Assembled panels are filled with the isocyanate foam which is capable of transferring some shear between the inner and outer skins by distribution of shear loading. The foam also imparts tensile, shear and compression loading to the vertical members embedded within the core material. Finally, the fire-resistant foam also serves as an excellent insulation medium.

Completed floor, roof and wall panels are bonded together to form the enclosed shelter. For additional weather protection, all exterior seams and joints are filleted with the adhesive.

Enclosures are built in sizes from 4¾′ x 5′ x 6′ up to 6⅛′ x 6⅛′ x 14′, and have an assured service life of five years. Recently, the ruggedness of the foamed-in-place panels and bonded aluminum constructions was graphically illustrated when the shelters passed a grueling battery of tests.

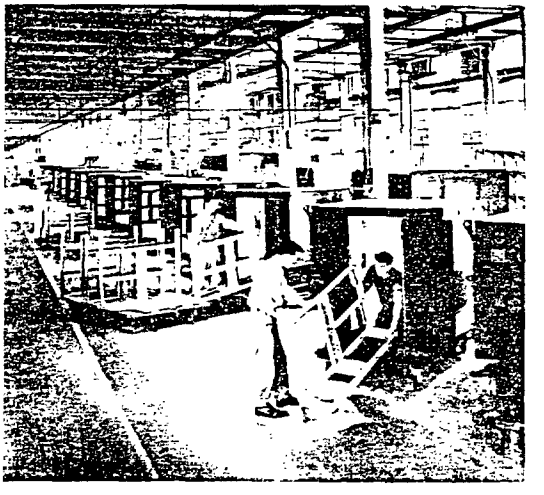
The S-144 shelter, weighing only 350 pounds, was loaded with 1500 pounds of simulated electronic equipment and dropped ten times from one to ten-foot heights without damage. In actual helicopter transport, flat drops up to two feet were made without deforming the shelter or damaging the equipment.

Equally successful were Helicop-Hut tests for insulation, air tightness, snow load, temperature range, humidity, salt spray, and fording. In the latter test, a shelter loaded with 7000 pounds of simulated equipment, was successfully floated free in water.



At the panel assembly division of the Craig plant, floor and roof panels are formed and wall panels are laid up and bonded with epoxy adhesive.

View of the shelter assembly area where finished panels and extrusions are combined to form the completed aluminum communications shelter.



Finished shelters on the Craig assembly line are ready for the installation of racks which will support the communications equipment.

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50 West 50th Street, New York 20, New York

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