(*Reprinted from Activities Report, Vol. 11, No. 4. Published by The Research and Development Associates, Food and Container Institute, Inc.*)

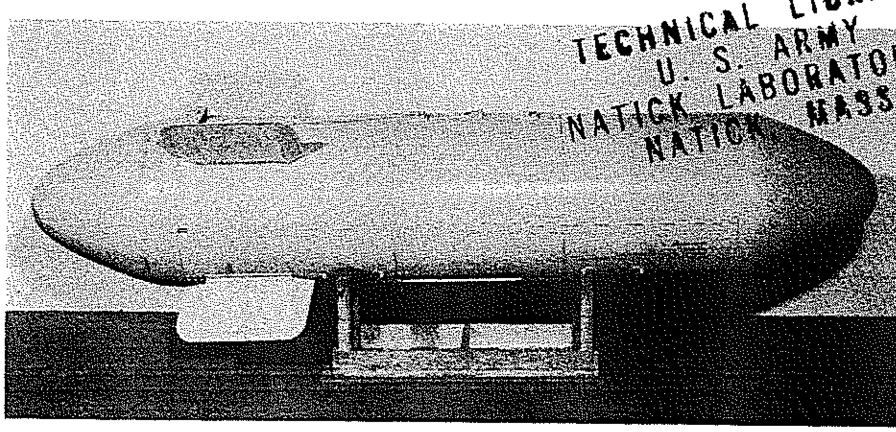
Design of Load Configurations for the M-4A High Speed Aerial Delivery Container

Matthew A. Venetos
Container Division

Modern concepts of warfare stress the importance of troop dispersion as a means of protecting against the blast effects of nuclear weapons. With this type of strategy, it is not difficult to imagine the development of situations where resupply by land routes will be difficult if not impossible. Therefore, the only remaining avenue of supply will be by air. However, the use of cargo type aircraft for this purpose will be dangerous unless our forces have overwhelming air superiority. On the other hand, high speed fighter and tactical bomber aircraft could do the job and still protect themselves against enemy aircraft.

The need for a method of delivering supplies by means of high speed aircraft was well emphasized in 1954 in the battle of Dien Bien Phu in Indo-China. The French troops at Dien Bien Phu were encircled by the Viet Minh forces in an area no larger than one-half mile square. In this situation, low altitude air drops were required in order to obtain the accuracy necessary for hitting the small target area. However, because of the concentrated ground fire from the Viet Minh troops surrounding the perimeter of the drop zone, air drops from C-119 Flying Box Cars had to be made from altitudes of approximately 10,000 feet. As a consequence, more than half the supplies and equipment dropped were captured by the Viet Minh.[1] High speed aircraft could have dropped supplies from lower altitudes with much greater accuracy. Their high speeds would have made them difficult targets to hit.

[1] Werth, Alexander. France 1940-1955, Henry Holt & Co., New York, 1956.



The Marine Corps' M-4A high speed aerial delivery container is being tested for use in supply of dispersed forces anticipated in nuclear and missile warfare. The container is made from aluminum and weighs 104 pounds.

Test M-4A Container

The U. S. Marine Corps, which has been active for some time in the testing of aerial delivery containers for use with high speed tactical aircraft, has found the M-4A high speed aerial delivery container to be suitable for this purpose. The Quartermaster Food and Container Institute for the Armed Forces has been assigned the project of developing load configurations for the M-4A container. The load configurations are arrangements of supplies oriented in such a fashion as to obtain the best possible balance between space utilization, resistance to damage, and ease of loading.

The M-4A container is shaped like a bomb, and consists of a cylindrical cargo compartment, 61 inches long and 21 inches in diameter. The cargo compartment is divided lengthwise into two sections which are connected with a piano hinge and rod. This makes it possible to readily open the container after recovery without the use of special tools. A nose cone, tail cone, and guide fins are attached to the cargo compartment. The entire assembly is fabricated from aluminum and weighs 104 pounds. The container is constructed so that it will fit standard bomb shackles.

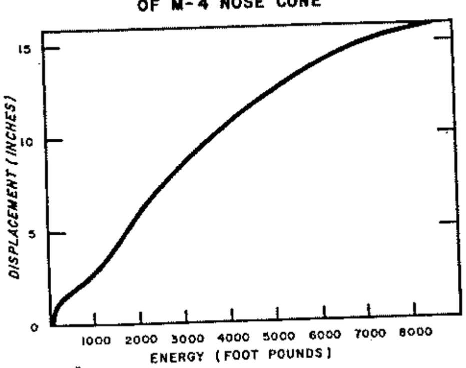
The M-4A container is mechanically, structurally, and aerodynamically suitable for flights at speeds of 600 mph and can be released from a plane traveling at speeds of nearly 500 mph.

Parachute Lowers Container

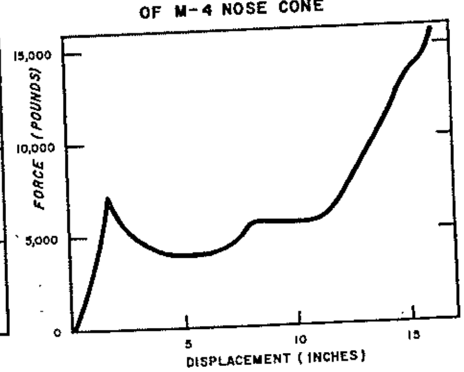
A 34 foot ringslot parachute is packed into a recessed area adjacent to the tail cone. When the M-4A container is dropped from the wing of a plane, a release mechanism causes the tail cone to flip off, releasing the parachute, which lowers the container to the ground at an impact velocity of 35 feet per second. The energy of impact is absorbed by the crushing of the aluminum nose cone. It is capable of absorbing up to 12,000 foot-pounds of energy.

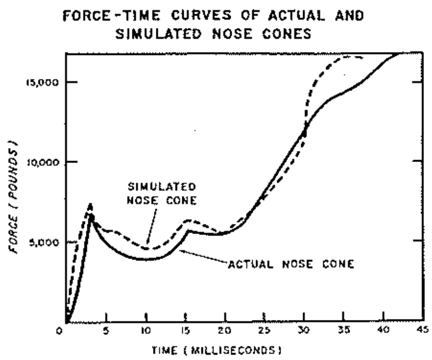
Although the Institute has no high speed aircraft available for testing purposes, its drop test facilities have proven quite adequate for making simulated air drops. A stairwell suitable for making free-fall drops from heights up to 68 feet is used for testing the nose cone of the M-4A container and various individual load components. An elevator shaft, suitable for free-fall drops from heights up to 60 feet, is used in making simulated air drops of the M-4A container. The elevator in the shaft is used as the lift device. An electrically actuated bomb release is mounted on the bottom of the elevator. The controls for

DISPLACEMENT - ENERGY CURVE OF M-4 NOSE CONE



FORCE - DISPLACEMENT CURVE OF M-4 NOSE CONE





the operation of the elevator and the bomb release are mounted at the bottom of the shaft. After release from the elevator the load is guided in its fall by means of a guide bar which slides down the elevator rails.

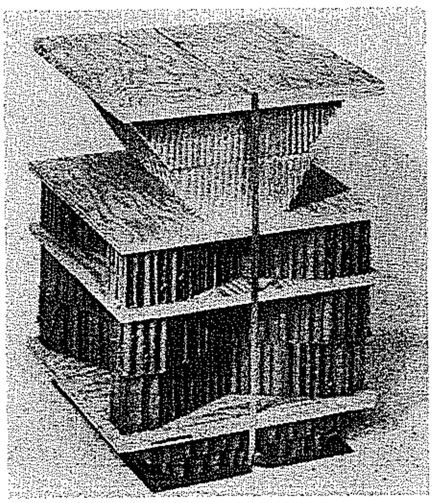
An advantage of using drop shafts rather than aircraft for testing is the ease with which the load can be instrumented to measure the impact forces and velocities. This information is of value in the design of load configurations.

Predict Load Configuration Performance

The work at the Institute has been pointed toward the development of a method by which load configuration performance can be predicted from "desk" calculations. Using this method, only a single test drop is necessary to verify the calculated performance. This eliminates the relatively large number of test drops required in trial and error design methods and therefore results in a saving of time, money, and materials.

The method requires both a knowledge of the shock ratings of the items being dropped and the dynamic characteristics of the M-4A container nose cone expressed in the form of energy-displacement and force-displacement curves. This information was obtained by means of instrumented laboratory drop tests. The impact energy involved is determined from the preselected weight and impact velocity values. With this energy value and the graphs cited above, the force of impact can easily be determined. If the force value obtained is less than the shock rating of the load being dropped, then it can be assumed that the load configuration is a suitable one. However, if the force value is greater than the shock rating of the load, damage would be expected and therefore suitable cushioning and bracing could be employed to prevent damage to the load. The above method thus far has been successfully employed in designing load configurations for 5-in-1 and C Rations.

Early in the program it became apparent that the limited supply of nose cones would not be sufficient. Since the M-4A container is not yet a production item, difficulty in procuring additional nose cones was expected. Therefore, a simulated nose cone was designed as a substi-

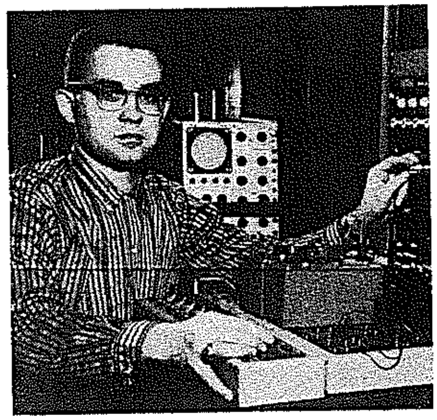


Simulated nose cone of aluminum and paper honeycomb is used in load configuration testing because of the limited supply of the actual nose cones. The nose cone is crushed upon impact.

tute for the real M-4A nose cone. The simulated nose cone resulted in a substantial saving since it cost $5.00, as compared to $20.00 for the actual M-4A nose cone. The simulated nose cone was made up of various shapes and sizes of aluminum and paper honeycomb which were selected so as to duplicate closely the actual force-time curve of the real nose cone.

Current work on the M-4A container involves the design of a protective system for Army communications equipment, specifically the AN/GRC-3 radio set. This set weighs 200 pounds and contains 73 electron tubes. Preliminary testing of the electron tubes alone indicated that they were undamaged when subject to a deceleration of 50 G, a value which is greater than that produced in an actual drop of the M-4A container. A "G" is defined as the acceleration due to gravity, (32.2 ft/sec^2).

Simulated airdrops of the radio set have indicated its inherent strength since the nose cone alone provides sufficient protection against damage.



Matthew A. Venetos has been with the Container Division since 1951 and is assigned to the Research and Methods Analysis Branch. He works on the development of systems for aerial delivery of supplies, in packaging design, and in investigations in shock and vibration.

Mr. Venetos came to the Institute after graduating from Northwestern University, Evanston, Ill., where he received a bachelor's degree in chemical engineering. While at Northwestern, he participated in the University's cooperative work-education program and was employed as a process engineer by the E. I. duPont de Nemours Co., Chicago, and as a cement technician by the Portland Cement Association, Skokie, Ill.

He was a member of the Illinois National Guard from 1946 to 1955.

NOTE: An over-all view of the Army's ballistic transport development program is given in the article, "Army Rocket Transport," on page 248.