Lawrence Berkeley National Laboratory
Recent Work

Title
DESIGN AND TESTS OP A PORTABLE CASK FOR EXPLOSIVE CHEMICALS

Permalink
https://escholarship.org/uc/item/00b822kx

Authors
Young, Jensen
Jelonek, H.J.
Gribben, R.W.

Publication Date
1969-08-01

eScholarship.org Powered by the California Digital Library
University of California

For the Western Area Research and
Development Safety Seminar, LRL,
Berkeley, January 26-27, 1970

UCRL-19331
Preprint

c.2

RECEIVED
LAWRENCE
RADIATION LABORATORY
JAN 23 1970
LIBRARY AND
DOCUMENTS SECTION

DESIGN AND TESTS OF A PORTABLE CASK FOR EXPLOSIVE CHEMICALS

Jensen Young, H. J. Jelonek, and R. W. Gribben

August 1969

AEC Contract No. W-7405-eng-48

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

LAWRENCE RADIATION LABORATORY
UNIVERSITY of CALIFORNIA BERKELEY

UCRL-19331

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

DESIGN AND TESTS OF A PORTABLE CASK FOR EXPLOSIVE CHEMICALS

Jensen Young, H. J. Jelonek, and R. W. Gribben

Lawrence Radiation Laboratory
University of California
Berkeley, California

August 1969

ABSTRACT

This paper describes the design and testing of a cask to transport potentially explosive chemicals. Prototype units withstood the blast effects of consecutive charges of up to one pound of Composition C; they were demolished with two-pound charges.

The final unit consists of a portion of a compressed gas cylinder embedded in polyfoam within a modified 30-gallon drum. The complete assembly weighs about 130 pounds and is dolly-mounted for mobility.

INTRODUCTION

The handling and disposal of potentially explosive chemicals can be a nerve-racking experience. The literature notes several cases in which detonations have accompanied the disposal of aged ether wastes.[1] One fatality is reported, also.[2] The best explanation for these detonations is the formation of peroxides in the ethers, especially isopropyl ether.[2,3]

The Safety Services Department at LRL-Berkeley has the responsibility for handling and disposing of all chemical wastes. We have been called upon to remove from laboratories countless bottles of chemicals left by departing researchers. These bottles have included such potentially explosive chemicals as aged dioxane, benzoyl peroxide, and crystallized isopropyl and ethyl ethers. In addition, we have been faced with the problem of disposing of unknown incendiary devices left at various locations within the Laboratory by pranksters. Although we have never had a serious incident, our people still run a risk in handling something that might accidentally detonate.

The greatest hazard to the greatest number of people would involve removal of an unknown material from a laboratory to a safe disposal area. We decided, therefore, that a specially constructed cask should be built to contain the suspect material during this phase of disposal.

SELECTION OF EXPLOSIVES

We set the design limitations of the cask at small laboratory quantities of potentially explosive chemicals. For handling larger quantities of chemicals or known explosive devices we would call in military demolition experts.

After consultation with specialists at Site 300, Livermore, we chose Composition C as being the easiest material to use for our container tests. Choosing the minimum test charge posed a problem--how is the "strength" of a chemical compared to that of an explosive? This is like trying to compare oranges to apples. An explosive gives a high-order detonation whereas a chemical goes low-order. The effects are totally different. However, with these differences in mind, we compared the "strength" of NH_4NO_3 (a common laboratory chemical) with that of Composition C. The U. S. Bureau of Mines in a recent report suggests that a good rating to use to compare strengths is the detonating velocities.[4] For the substances we are concerned with, these are

NH_4NO_3: 1100 to 2700 m/sec,

Composition C-4: 8040 m/sec.[5]

Since NH_4NO_3 is hard to detonate, it is not used alone but as an ingredient in explosives. The lower velocity, therefore, seems more appropriate for our conditions. The ratio of velocities is then 1:8. Since we can expect to handle 1-pound containers of NH_4NO_3, we used as our starting charge 1/8 pound of Composition C (see Fig. 1).

PROTOTYPE CASKS AND TESTS

The design criteria we set for the cask were as follows:

Cavity size: to handle a gallon bottle of solvent.

Dimensions: small enough to maneuver in a laboratory.

Weight: capable of being carried by two men even though it would be dolly-mounted.

A literature search indicated no published data on a container for our application. Since we had no prototype to copy, we used a portable box magazine design as our point of departure.[6] This first series of casks consisted of 1-inch-thick tongue-and-groove hardwood boxes, one inside the other. A 1-inch void between the boxes was filled with sand and the exterior surfaces were metal-clad. Another cask of the same design was filled with polyfoam. Detonation of 1/8-pound charges demolished both casks completely (Fig. 2).

Casks in the second series were 15-gallon drums with 5-gallon lard-can liners; the void space in between was filled with sand. These units were damaged with 1/8-pound charges, and completely demolished with 1/4-pound charges (Figs. 3 and 7). To evaluate the shrapnel effect of a bottle of solvent blowing up, we placed a bottle of colored water in one of the above containers (Fig. 3) Cardboard silhouettes were placed around to simulate persons carrying the cask (Fig. 4), and a 1/4-pound charge was detonated. The effects were dramatic (Fig. 5). Any person within a radius of a few feet of the cask would have been seriously peppered with glass (Fig. 6). The cask was completely demolished, and the top screen was recovered

about 75 feet away (Fig. 7).

Polyfoam filling around a 1/4-inch steel liner inside a 15-gallon drum was used for our third test series [Fig. 8(a)]. The weakness in this unit was the bottom weld of the cylinder. This broke loose with a 1/8-pound charge [Fig. 8(b)]. Nevertheless, even with this defect, the cask withstood charges of up to 1/2 pound before it was demolished [Fig. 8(c)].

The above test series gave us a good basis for further design of our carrying cask. If the 1/4-inch steel liner were used, the bottom weld would have to be strengthened or eliminated. At this time, we recovered several size E compressed gas cylinders which were being discarded. Low-level residual induced radioactivity made them unsuitable for return to the factory. By cutting off sections from each end, we had two ready-made 1/4-inch-thick steel liners. The bottom of the cylinder was perfect; the top needed a plug welded in to seal the valve opening. These liners were then placed in modified 30-gallon drums (15-gallon drums were no longer available). One cask was polyfoam filled (total weight of cask 122 pounds), and the second was sand filled (total weight of cask 328 pounds) (Fig. 9).

Our concluding test series indicated that either of these casks was adequate for our needs. They both held up well to consecutive detonations of up to 1 pound of charge (Figs. 10 and 11). At this point the plug weld in the top portion of the gas cylinder blew out, the walls of both liners bowed outward, and the upper edges of the 30-gallon drums were distorted (Figs. 12 and 13). At 2 pounds charge, both units disintegrated completely (Figs. 14, 15, 16, and 17).

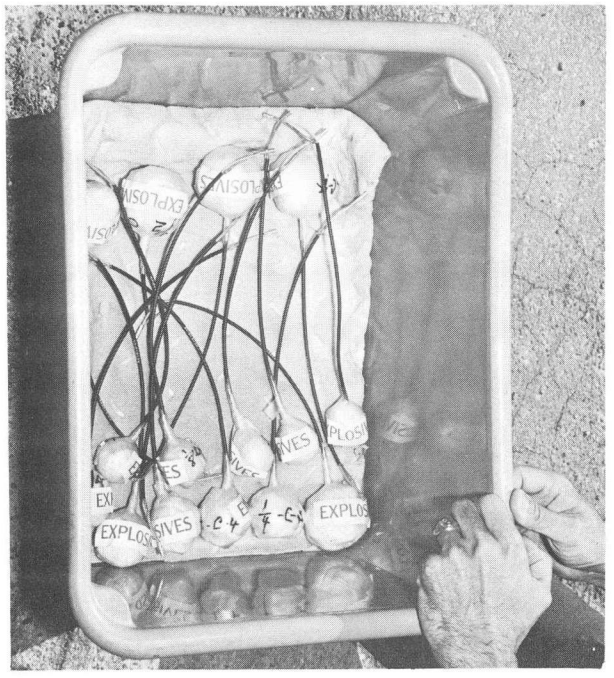
The information from the above tests provided us with the final design. The liner is a portion of a compressed gas cylinder which is positioned upright by an interior support (Fig. 18). A modified 30-gallon drum filled with polyfoam surrounds the liner (Fig. 19). The lip of the liner protrudes one inch above the upper steel retainer plate. Chemicals are placed in a plastic bucket and cushioned with vermiculite before being inserted into the cask. This bucket reduces the possibility of breaking glass containers from the shocks that may occur in transportation (Fig. 20). The complete cask is 18.5 inches in diameter by 18 inches high, and weighs about 130 pounds. The cavity size is 8 inches internal diameter by 16.5 inches high. In actual use, the cask is mounted on a four-wheel dolly with a long handle (Fig. 21). This makes it highly mobile and easily maneuverable in laboratory areas.

ACKNOWLEDGMENTS

We acknowledge all the help and constructive suggestions given to us by the technical staff at Site 300, Livermore. Without their assistance and facilities, these tests would never have taken place. We are indebted to Richard P. Grill for enthusiastic encouragements on this project, and to James T. Haley for his assistance and suggestions during the tests.

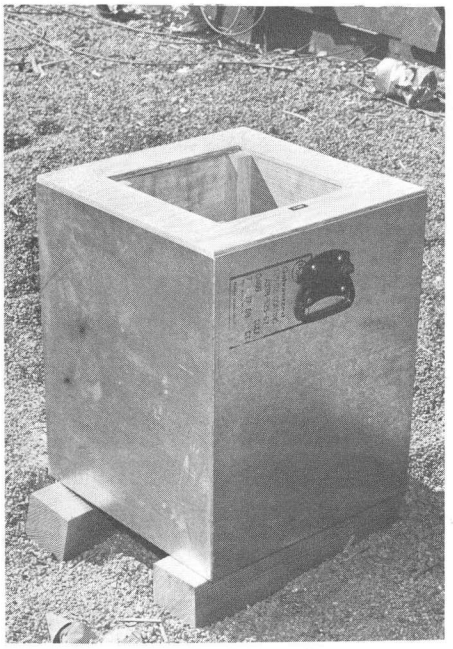
REFERENCES

1. N. V. Steere, Ed., Control of Hazards from Peroxides in Ethers, in Safety in the Chemical Laboratory (Division of Chemical Education, American Chemical Society, Easton, Penn., 1967), pp 68-70.
2. Peroxide Formation in Stored Ether--the Disposal Problem, Health and Safety Information (United States Atomic Energy Commission) Issue No. 138, May 21, 1962.
3. How Safe is the Empty Reagent Bottle? Serious Accidents (United States Atomic Energy Commission) Issue No. 227, August 14, 1967.
4. R. A. Dick, Factors in Selecting and Applying Commercial Explosives and Blasting Agents, Information Circular 8405 (Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.).
5. Military Explosives, TM 9-1300-214 (Departments of the Army and Air Force, Washington D. C.), November 28, 1967.
6. Portable Box Magazine (drawing), DuPont de Nemours and Company, Wilmington, Delaware.

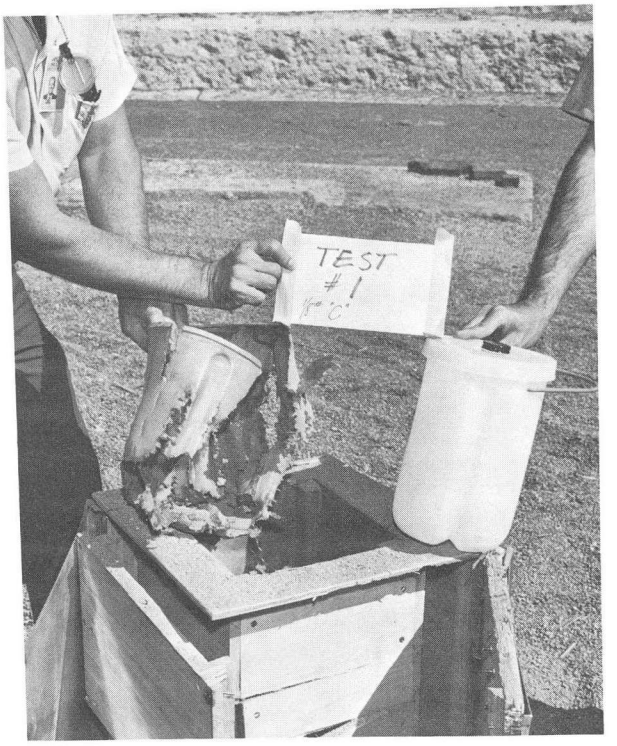


XBB 695-3064

Figure 1. Composition C explosive charges: 1/8, 1/4, and 1/2 pound.



XBB695-3070

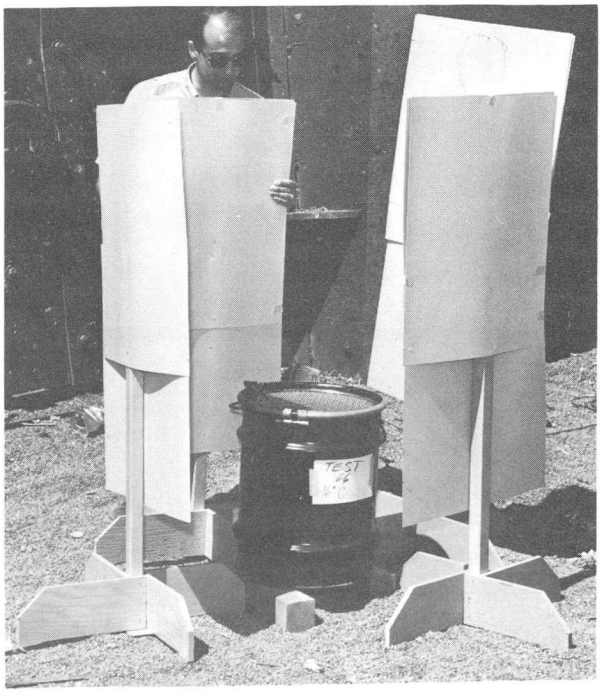


XBB695-3066

Figure 2. Sand-filled hardwood box, before test, and after denotation of 1/8-pound charge (new bucket included for comparison). Plastic carrying buckets before and after test.

XBB695-3091

Figure 3. Fifteen-gallon drum with 5-gallon lard can, sand-filled.

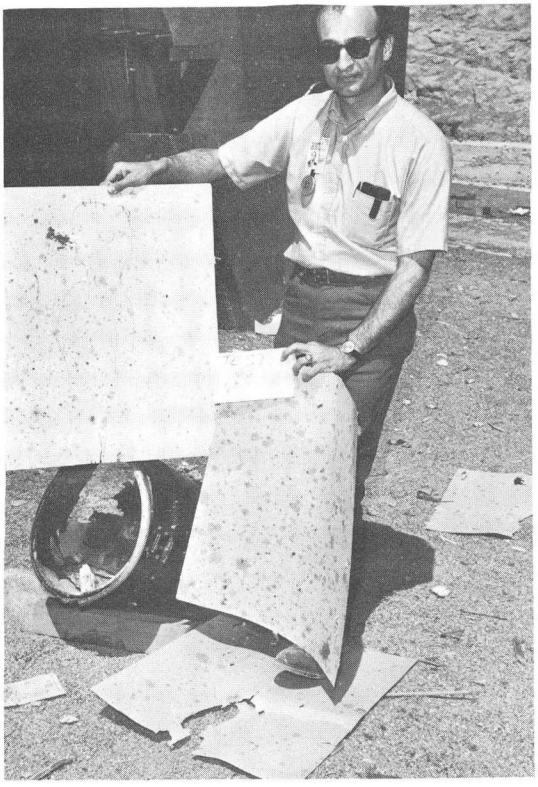


XBB695-3092

Figure 4. Preparations to test the effects of blast and shrapnel.

XBB695-3093

Figure 5. Blast effects of 1/4-pound charge.



XBB695-3095

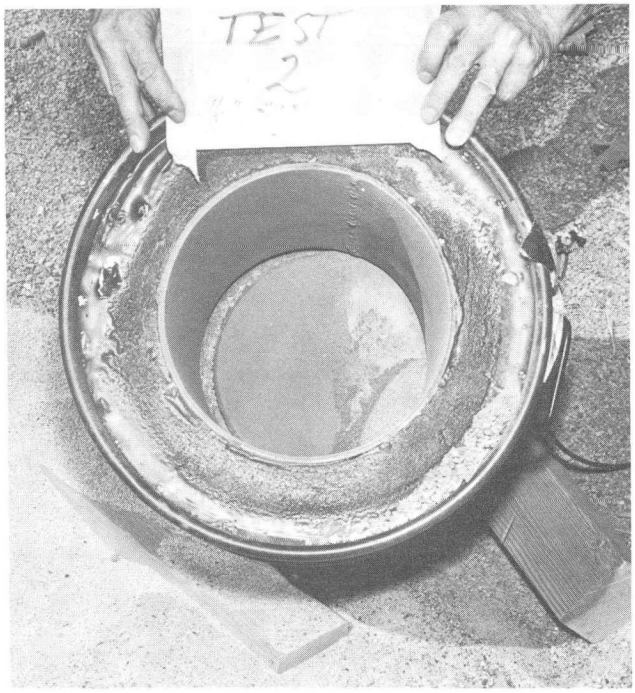
Figure 6. Shrapnel effects.

XBB695-3099

Figure 7. Carrying cask after detonation of 1/4-pound charge.

XBB695-3078

Figure 8(a). Fifteen-gallon drum with 1/4-inch steel liner, polyfoam filled, before test.

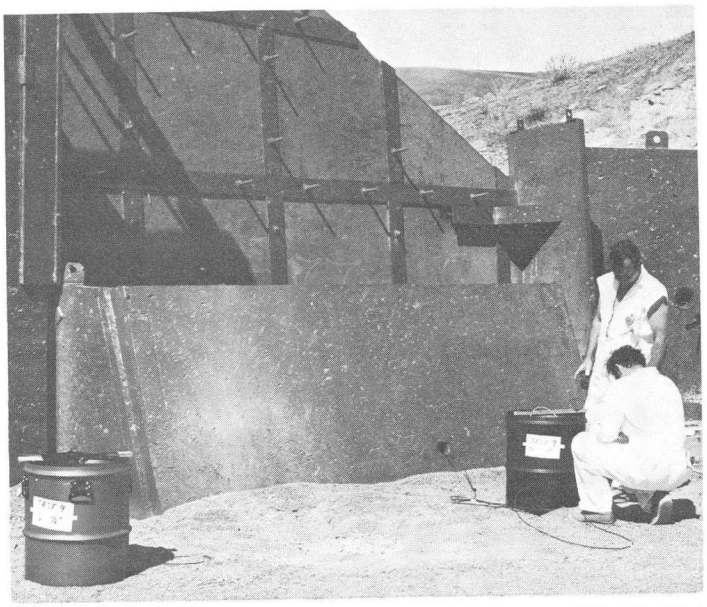


XBB695-3075

Figure 8(b). Effects after detonation of 1/8-pound charge (note damage to bottom of liner).

XBB695-3085

Figure 8(c). Effects after detonation of 1/2-pound charge.



XBB697-4493

Figure 9. Modified 30-gallon drums with compressed gas cylinders for liners. Left-hand unit filled with sand, right-hand unit filled with polyfoam. Preparation for tests.

XBB697-4514

Figure 10. Blast effects on cask after detonation of 1/2-pound charge. Preparation to use 1-pound charge next.

XBB697-4511

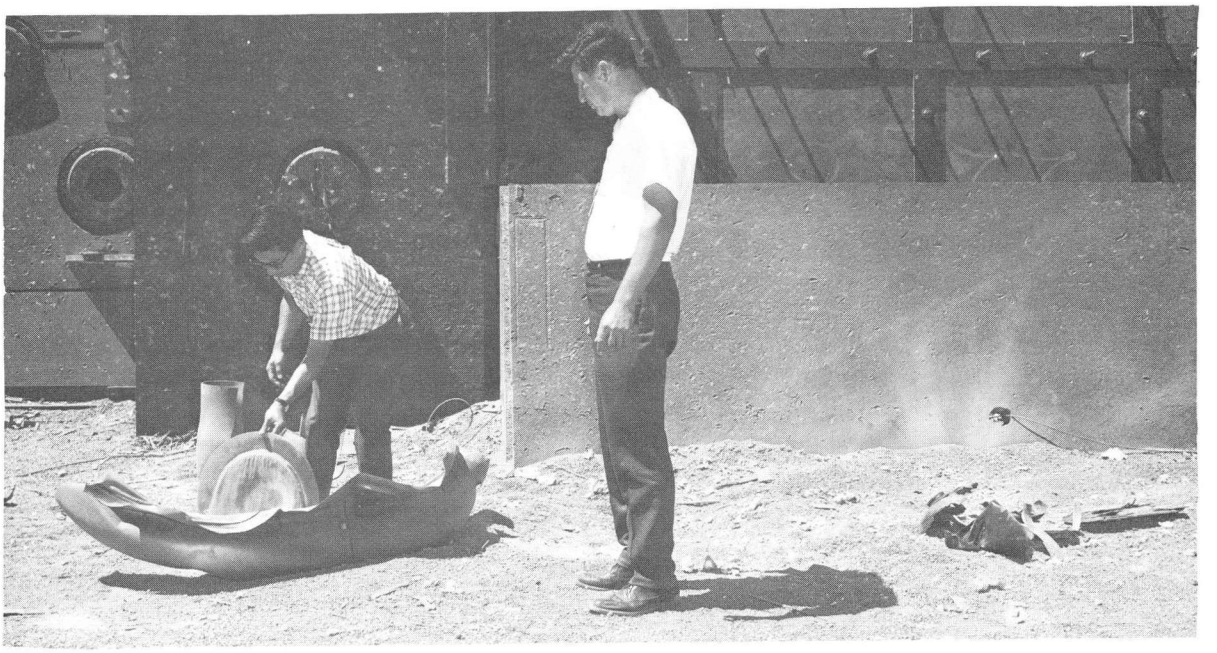
Figure 11. Sand-filled unit after detonation of 1-pound charge.

XBB697-4512

Fig. 12. Polyfoam unit after detonation of 1-pound charge.

XBB697-4513

Fig. 13. Preparation for 2-pound charge.



XBB697-4515

Figure 14. Blast effects of 2-pound charge.

XBB697-4522

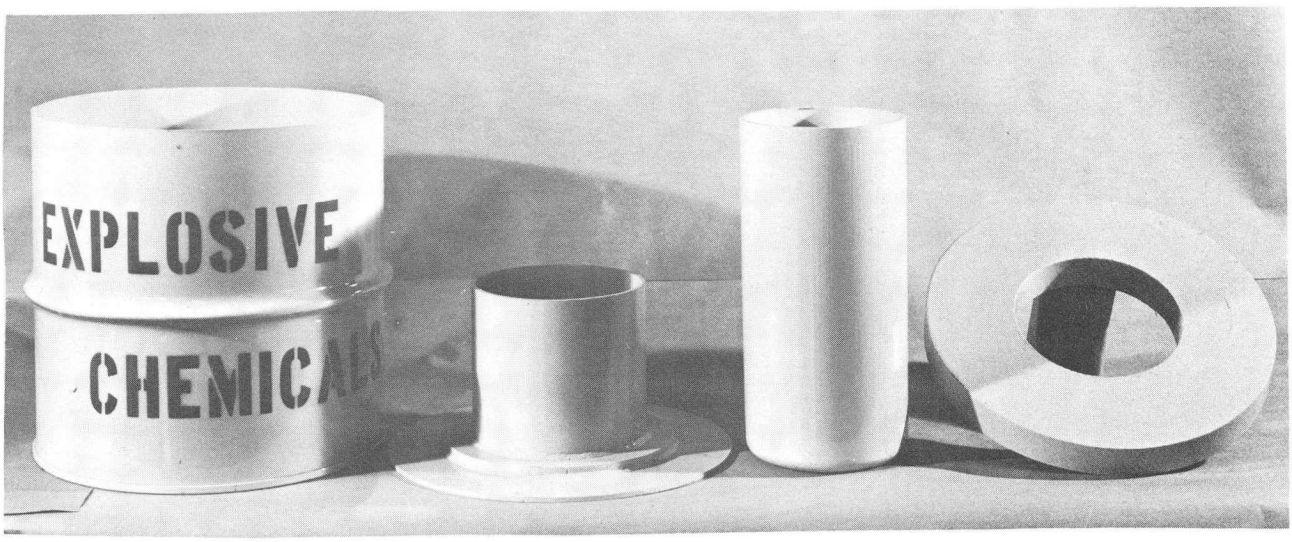
Figure 15. Remains of polyfoam-filled unit.

XBB697-4518

Figure 16. Remains of sand-filled unit.

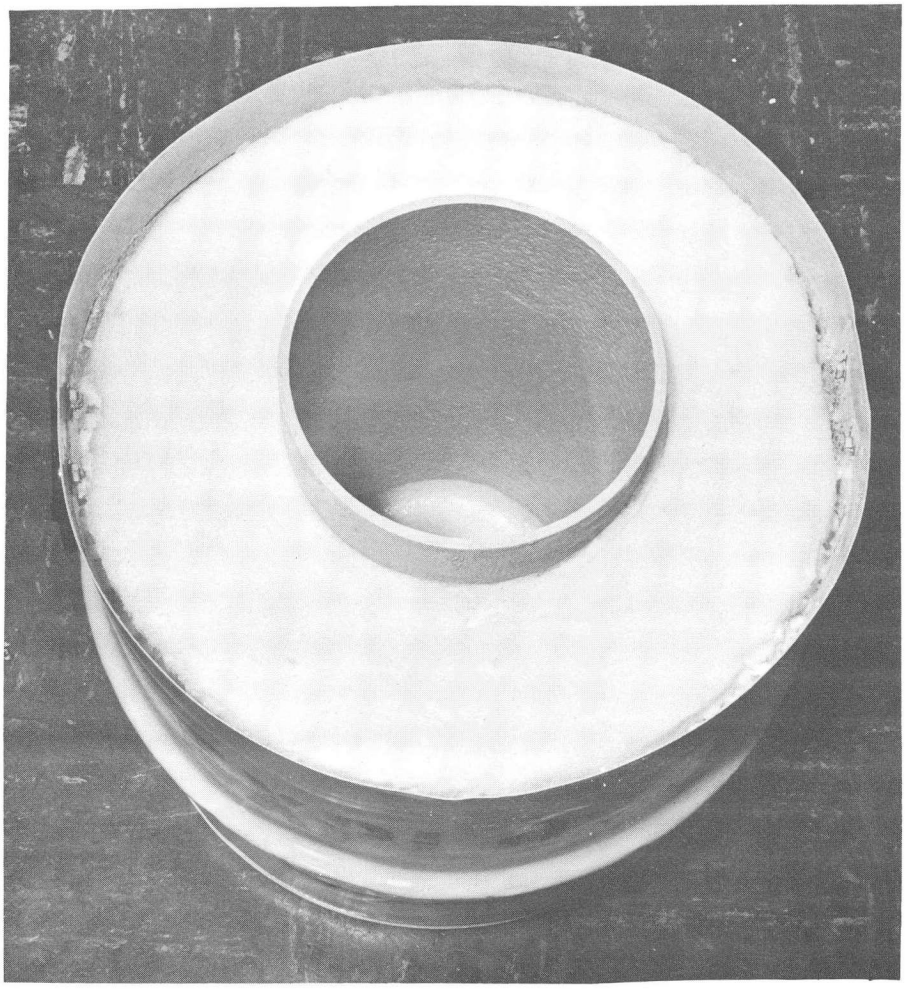
XBB697-4517

Figure 17. Gas cylinder bottom and portion of interior support.



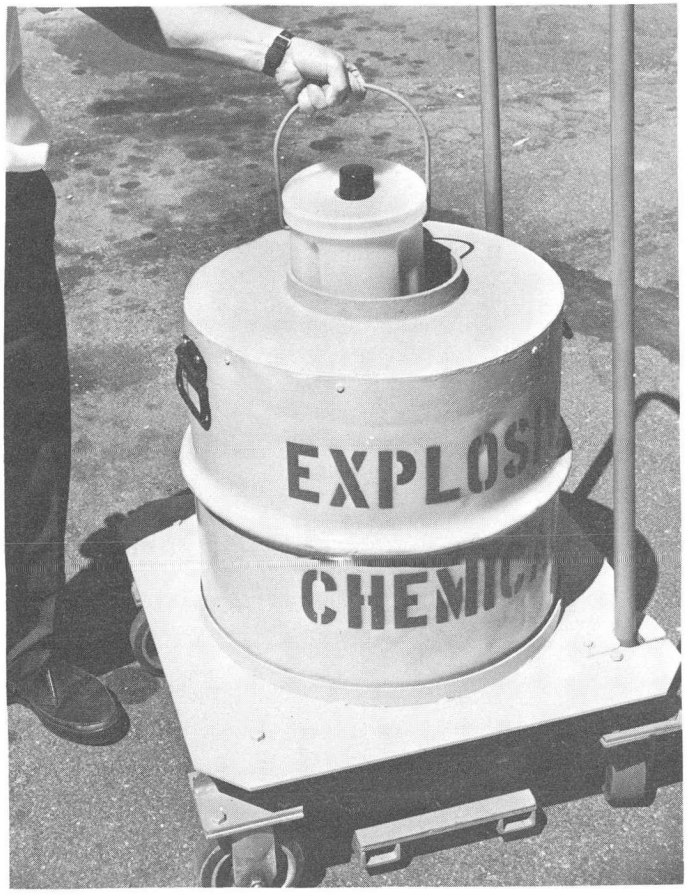
XBB698-5301

Figure 18. Components of carrying cask.



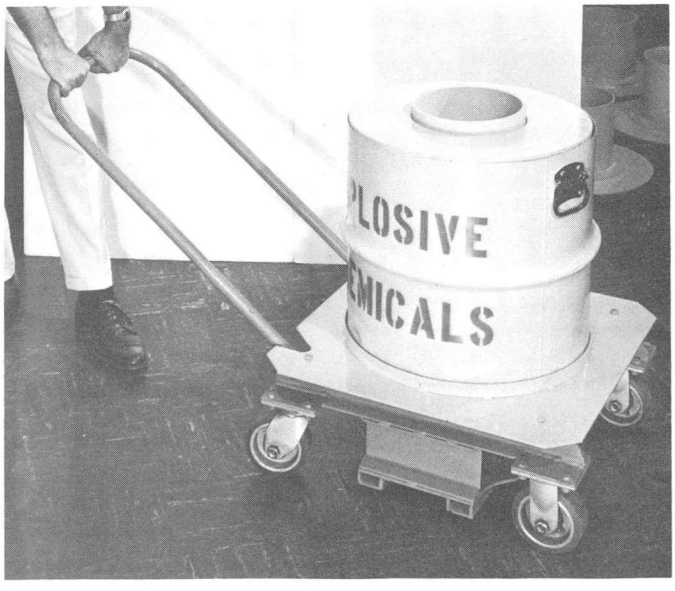
XBB697-4939

Figure 19. Polyfoam filling



XBB698-5300

Figure 20. Carrying bucket containing chemical being placed in container.



XBB697-4940

Figure 21. Assembly on dolly.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

TECHNICAL INFORMATION DIVISION
LAWRENCE RADIATION LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720