AFCRL - 67-0676

DESIGN & FABRICATION OF A SMALL LIGHTWEIGHT EXPENDABLE TYPE GAS CYLINDER FOR USE WITH HELIUM

T.F. Hunter

Walter Kidde & Company, Inc.
675 Main Street
Belleville, New Jersey 07109

Contract No. AF19(628)-6050
Project No. 6670
Task No. 667003
Unit No. 66700301

FINAL REPORT

Period Covered: May 1966 through November 1967

WK Report No. R-1919

Date of Report: December 1967

Contract Monitor: Bernard D. Weiss
Aerospace Instrumentation Laboratory

Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

Prepared
for

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS
01730

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ABSTRACT

This program was undertaken to design and fabricate a pilot run quantity of a small lightweight expendable type cylinder and valve assembly charged with helium to be used by Combat Weather Teams for inflating small meteorological balloons.

The cylinders were designed in accordance with Interstate Commerce Commission Specification 3HT, with an internal volume of fifteen cubic inches to contain 1.6 to 1.8 free cubic feet of helium at a filling pressure of 3600 psig and a temperature of 70°F.

The cylinder assembly was designed to be sealed after filling, with gas discharge accomplished manually by means of a pierced disc technique, using a non-integral puncturing stem device. The assembly was designed to permit seal-off and flow control after disc puncture by manipulation of the stem.

A total of 100 charged cylinder assemblies and 14 puncture stems were supplied under this program. 24 cylinders and 4 stems were used for development tests at Walter Kidde and the balance were delivered to AFCRL for environmental and field tests. All test results to date have demonstrated full compliance with the desired performance requirements.

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1.0 DESIGN

As originally established, this program called for the design of a small lightweight cylinder to be filled with helium for inflating small meteorological balloons. The cylinder was to be sized to contain 0.8 to 0.9 free cubic feet of helium at a filling temperature of 68°F and a service pressure of approximately 1800 psig, and was to be designed in accordance with ICC regulations to permit shipment in the pressurized condition.

The cylinder assembly was to incorporate a means of sealing after filling, with gas discharge to be accomplished by piercing the seal. Piercing of the seal was to be accomplished using a separate valve member designed to permit easy and rapid assembly to, and removal from the cylinder assembly. This valve was to be capable of regulating the rate and amount of gas discharge and was to incorporate an output nozzle for connection to a 1/4" rubber or plastic tube.

The assembly was to be operable over an ambient temperature range of from +160°F to -65°F, a relative humidity of 5% to 95% and an atmospheric pressure of 29.92" Hg to 20.58" Hg, or any combination thereof.

At the outset of the program, a meeting was held between AFCRL and Kidde personnel to discuss the requirements and make sure that there was complete understanding as to the need for assembly, how it was to be used, and the practical design limitations that existed. In the course of this discussion, it developed that the 1800 psig storage pressure was established on the basis of its being the most common rating for ICC cylinders, and the helium contained in each cylinder would be only sufficient to half fill the particular balloon in question. Thus, two cylinders would be expended for each filling. It was pointed out that higher pressures could be utilized with very little, if any, weight penalty by designing the cylinder to more stringent ICC specifications, and, in fact, a cylinder with twice the gas capacity could be designed within the envelope and weight limitations originally proposed, to permit filling the balloon with a single cylinder. On this basis, the design requirement for the cylinder was modified to call for 1.6 to 1.8 cubic feet of free helium at approximately 3600 psig.

The final design configuration of the helium cylinder assembly is shown on Kidde drawing no. 875200. The helium reservoir is a 15 cubic inch capacity high pressure gas cylinder designed and fabricated in accordance with ICC Specification 3HT for 3600 psig service. Closure after pressurization is accomplished using a metal disc with a copper gasket seal which together effect a positive seal of the gas charge through the application of a predetermined torque load to a brass retainer. Gas discharge is affected by means of a non-integral piercing stem and o-ring assembly. When screwed into the retainer, the o-ring seals against the bore to prevent leakage around the stem and the point of the stem pierces the disc to permit gas discharge through the stem and out the hose connection nipple. The flow rate of the gas can be controlled by backing off or tightening down on the stem assembly, with approximately one sixth of a turn of the stem required between seal-off and full-flow. Seal-off is accomplished by means of a brass seat member placed between the disc and the retainer which seals against the nose of the stem when the latter is screwed all the way into the retainer.

The seat member has a shear edge on the side contacting the disc, with a diameter designed to permit rupture of the disc at a cylinder internal gas pressure of between 4400 and 5400 psig such as might be caused by exposure to fire. Violent recoil effects in the event of rupture of the disc are prevented by a cross drilled recoil plug which is included as a part of the charged cylinder assembly for shipping, storage, and handling. This plug must be removed prior to actual use to permit insertion of the piercing stem.

It was originally intended to provide sufficient material in the neck of the cylinder so that the seat for the copper gasket seal could be machined into the cylinder at the base of the threads. Fabrication difficulties with the first lot of cylinders proved that this was not feasible so a separate adapter with a crush gasket seal at the face of the cylinder neck is incorporated to provide the seat for the gasket.

The requirement for 1.6 to 1.8 cubic feet of free helium is equivalent to .01685 lb (7.65gm) to .01895 lb (8.60gm) of helium. At 3600 psig the 15 cubic inch cylinder contains .01945 usable lbs of helium (8.82gm) which is equivalent to 1.85 free cubic feet as a minimum. If it were to be necessary to work precisely within the 1.6 to 1.8 cubic foot requirement, the cylinder volume would have to be controlled to 13.8 ±.8 cubic inches, and the filling pressure and temperature carefully monitored, or the filling controlled on a gas weight basis.

Figure 1 is a photograph of the cylinder assembly with the piercing stem in the operated position and Figure 2 shows the piercing stem, retainer, recoil plug, seat and disc (after piercing).

2.0 DEVELOPMENT

2.1 Function

The initial phase of the development program consisted of fabricating a pilot lot of the various cylinder assembly components to demonstrate the ability of the original design to function as desired. Because of the lead time

FIGURE 1

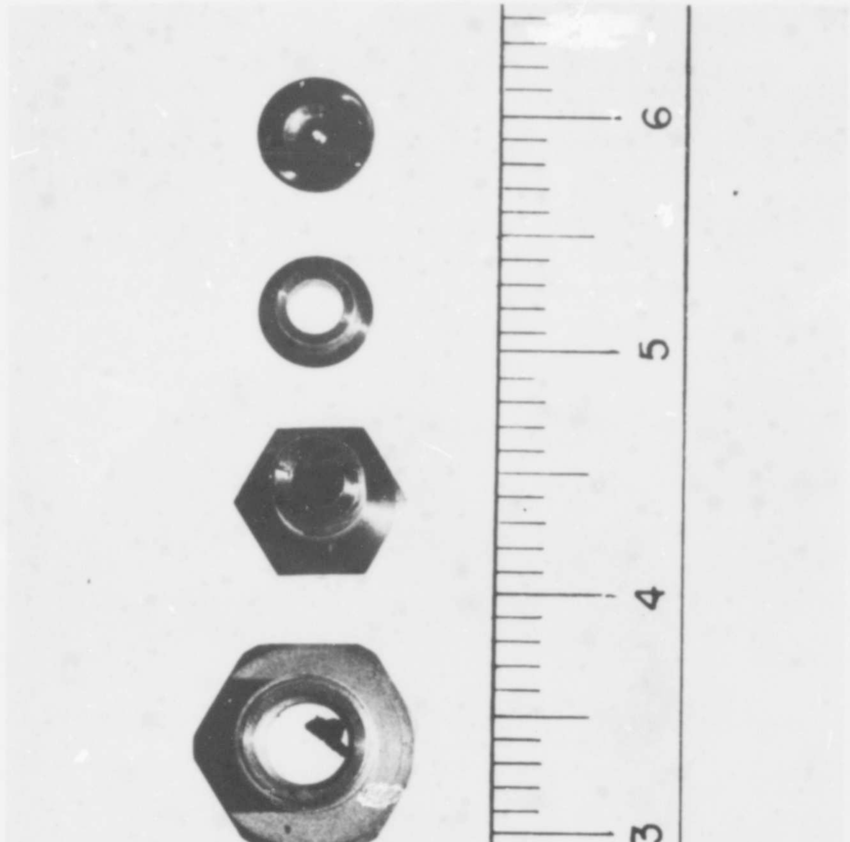


FIGURE 2

required to fabricate the cylinders, a test fixture designed to simulate the neck thread and seat configuration of the cylinder was fabricated for these tests.

The initial tests revealed the following deficiencies in performance:

1. The bursting pressure of the sealing disc was higher than desired.

2. The number of turns required on the piercing stem to seal off the gas flow after piercing the disc was excessive.

3. The rate of gas leakage at seal off was excessive.

To compensate for these deficiencies the following modifications were incorporated in the design:

1. The shearing edge diameter in the seat was increased.

2. The nose of the stem was modified to contact the seat immediately after piercing the disc.

The parts were reworked to the modified configuration and retested with the following results:

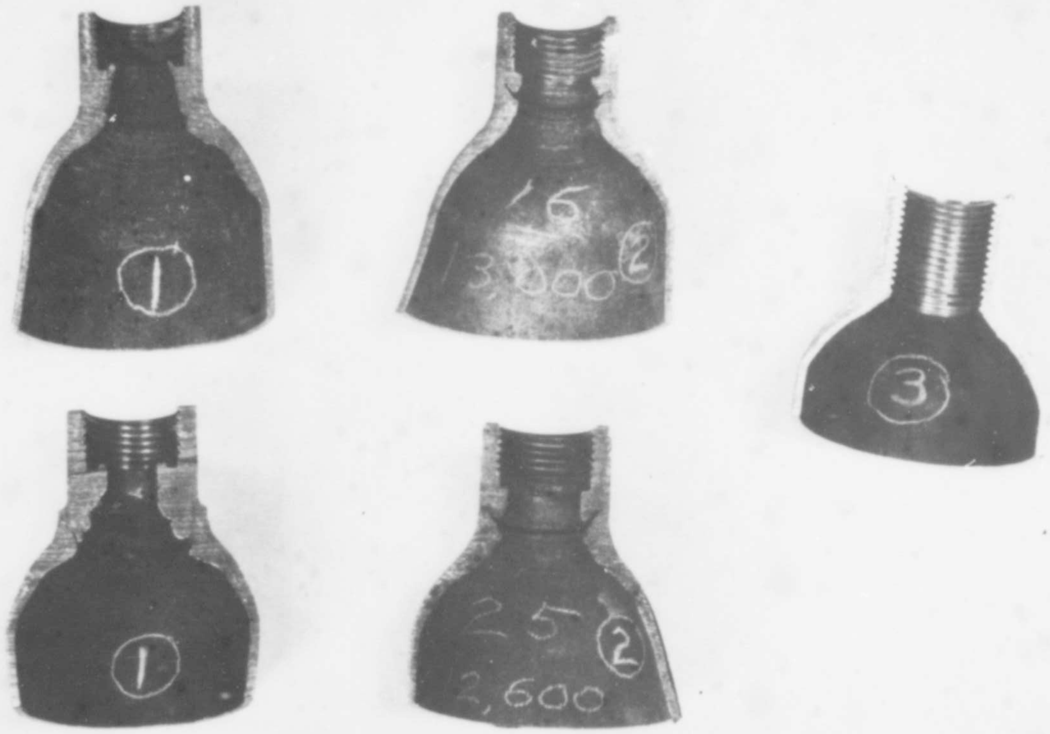
1. The first two deficiencies described above were corrected in that the disc burst well within the desired range and the nose of the stem contacted the seat sealing edge within one-quarter of a turn after piercing the disc.

2. The last deficiency remained in that it was impossible to obtain a satisfactory seal off.

This last characteristic was attributed to the lack of concentricity between the stem and the seat and the relative inflexibility of the parts to permit self-alignment. To correct for this condition, a thin walled reduced diameter cylindrical extension was added to the seat to locate within the inside diameter of the retainer to control the concentricity relative to the stem and provide for a certain amount of flexibility when in contact with the conical surface of the nose of the stem. This required a further modification in the design of the stem to shorten the nose to accommodate the increased length of the seat. New parts were fabricated in accordance with these modifications and when tested performed with complete satisfaction. On the basis of these results, the designs for the assembly components were released for fabrication of the twenty-four cylinder assemblies and four valves required for full development testing.

At this point in the program, trouble was encountered with fabricating the cylinders with the desired neck configuration. The cylinders are chrome-molybdenum 4130 steel cold drawn cylindrical shells with the neck and dome formed by a hot spinning process. In attempting to obtain the material build-up in the neck area necessary to provide for the gasket seat specified in the original design, severe folds were being developed on the interior to such an extent that in some cases the neck separated completely from the dome when the cylinder was machined. In an attempt to alleviate this problem, a modified seat design was developed which required less material build-up in the neck.

The next lot of cylinders produced showed a marked improvement over the first group in that all were machined without difficulty. However, when crack indications which could not be removed by light grinding were picked up by magnetic particle inspection, this group also became suspect. To be positively assured as to the condition of this second lot, all of the cylinders machined at this point were radiographically inspected in the area of the dome and neck and a substantial number found to have serious folds and cracks. It should be noted that in the case of both of these initial lots, random samples which passed the magnetic particle inspection requirements successfully met the cycle life and burst pressure requirements of the ICC-3HT Specification. Figure 3 is a photograph which shows the three neck configurations produced, noted as (1), (2), and (3). The two sectioned samples identified as configuration (1) burst wihtin a range of from 11,200 psig to 12,000 psig after being subjected to 10,000 hydrostatic pressurization cycles from 0 to 3600 psig. Those identified as configuration (2) were not cycled but were selected as the worst units as determined by the radiographic inspection discussed above to be subjected to a burst pressure test. As noted, these samples burst at 13,000 and 12,600 psig respectively. In all cases the burst pressure exceeded the 8000 psig minimum required, and in all cases burst occurred in the cylinder side wall and was not associated with the neck and dome defects observed. Thus, while the defects noted did not affect passage of all tests necessary for qualification in accordance with the ICC Specification requirements, they were unacceptable from the standpoint of possible difficulties which could arise due to moisture entrapment and corrosion which could cause subsequent failures. To eliminate this problem the assembly was redesigned to eliminate the interior seat at the base of the cylinder threads entirely and provide for sealing of the disc and gasket in a separate adapter which would seal on the face of the cylinder neck using a crush metal gasket. The adapter to cylinder seal configuration was taken from a design previously qualified for a critical long time pressure storage application developed by Kidde. The final neck configuration thus evolved is identified as (3) in Figure 3.



NECK DETAILS
CYL. P/N 276166

FIGURE 3

The addition of this separate adapter required design modifications to the disc sealing gasket, disc, seat and retainer. In all instances, we were able to incorporate these modifications on the parts already fabricated by rework.

The function of the modified design was again checked using the cylinder simulating test fixture with completely satisfactory results.

The twenty-four cylinders required for the development tests were then fabricated without further incident.

2.2 Charging

The charging fixture was designed to restrain the cylinder, and provide for applying the necessary sealing torque to the retainer with the supply pressure applied to the cylinder. Helium leakage during filling was prevented by an o-ring seal on the outside diameter of the cylinder neck. To permit gas entry into the cylinder past the disc and gasket, the disc is bent so the gas can flow around it. The retainer and seat are assembled so they just contact the disc but do not flatten it. After the desired filling pressure is attained, the retainer is tightened, flattening the disc against the gasket, and sealing completed by application of the specified torque. The only difficulty experienced during charging was when the filling gas was introduced too rapidly causing the disc to flatten against the gasket and seal against the incoming pressure. This resulted in the disc bending in reverse and blowing through the adapter seat and into the cylinder when the filling pressure became sufficiently high. This problem was eliminated by controlling the rate of pressurization.

2.3 Development Testing

Testing was performed on 24 charged assemblies using 4 piercing stem assemblies. In addition the cylinders were subjected to the qualification tests required by the ICC-3HT Specification.

The tests performed were as follows:

A. Cylinder ICC Tests (Copies of all ICC Test Reports are contained in Appendix I).

1. Burst Test

One sample from each lot of 200 cylinders for each heat of steel. The cylinders were pressurized hydrostatically at room temperature until rupture occurred. 8000 psig minimum burst pressure required. A total of five cylinders were tested with burst pressures ranging from 10,600 to 12,000 psig.

2. Cycle Test

Three samples for initial lot of 200 cylinders of new design; one sample for each lot of 200 thereafter. The cylinders were hydraulically cycled between zero and 3600 psig at room temperature for the required 10,000 cycles. A total of five cylinders were tested without failure (These same cylinders were used for the burst test per A.1. above).

3. Flattening Test

One sample per lot of 200 cylinders. One cylinder was flattened to the required 10 times the wall thickness with no evidence of cracking. Flattening was performed perpendicular to the longitudinal axis of the cylinder between 60° wedge shaped knife edges, rounded to a 1/2" radius.

B. Cylinder Assembly Tests (See Appendix II for Test Data)

1. Leakage

All charged assemblies were checked for leakage using a helium leak detector. No leakage was found.

2. Safety Disc Burst

Four discs were burst using the cylinder simulating fixture; two at room temperature (+65°F) and two at +160°F. The results were 5000 and 5100 psig at room temperature and 5000 psig for both at +160°F; well within the required range of 4400 to 5400 psig.

3. Cylinder Assembly Function

Twenty assemblies were divided into four groups of five each. Three cylinders from each group were tested for operating force, seal-off force, flow characteristics and reseat characteristics, and two were tested for discharge characteristics after exposure to the following ambients:

Group I - Room temperature
Group II - 4 hours at +160°F
Group III- 4 hours at -65°F
Group IV - 48 hours at +100°F and 95% R.H.

Testing was performed at room temperature immediately after removal from the ambients noted. In all cases actuation and seal-off were attained manually with ease. Repeated seal-off was accomplished without leakage and full-flow was attained at about one sixth of a turn of the stem with uninterrupted discharge until the cylinder was empty.

4. Leakage After Extreme Temperature Cycling

The four remaining samples were subjected to two temperature cycles consisting of four hours at +160°F followed by four hours at -65°F. They were checked visually for leakage between soaks, and with a helium leak detector after all four soaks. No leakage was observed.

5. Balloon Inflation

This was combined with the discharge tests on the two samples from Group III described in paragraph 3 above. Both samples after the four hour soak at -65°F successfully filled a balloon with the desired amount of gas.

6. Gunfire Test

Two samples used for the Extreme Temperature Cycle test of paragraph 4 above, were used for this test. The cylinders were subjected to a straight shot into the side wall using .50 caliber armor piercing ammunition. The entrance and exit holes are shown in Figures 4 and 5.

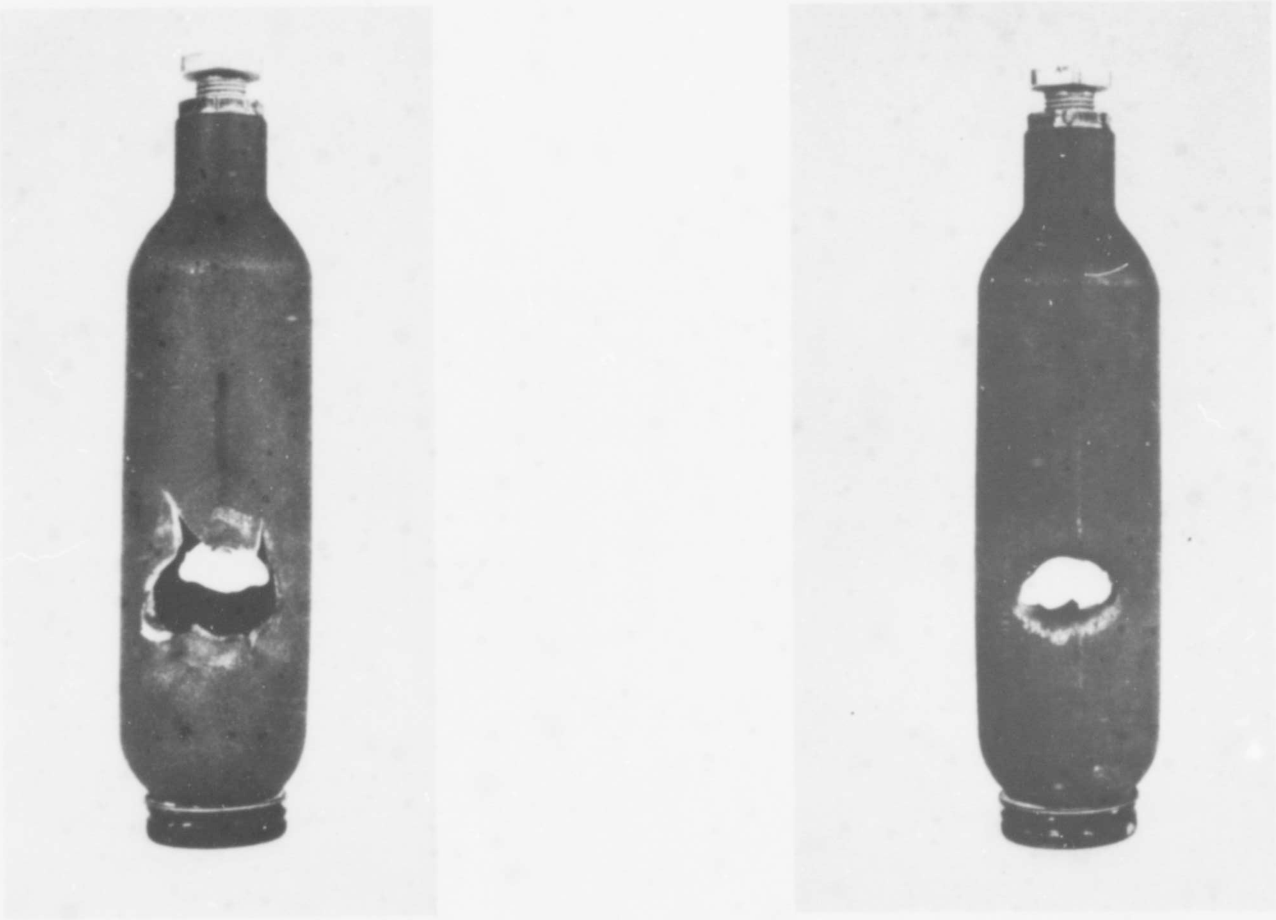


FIGURE 4

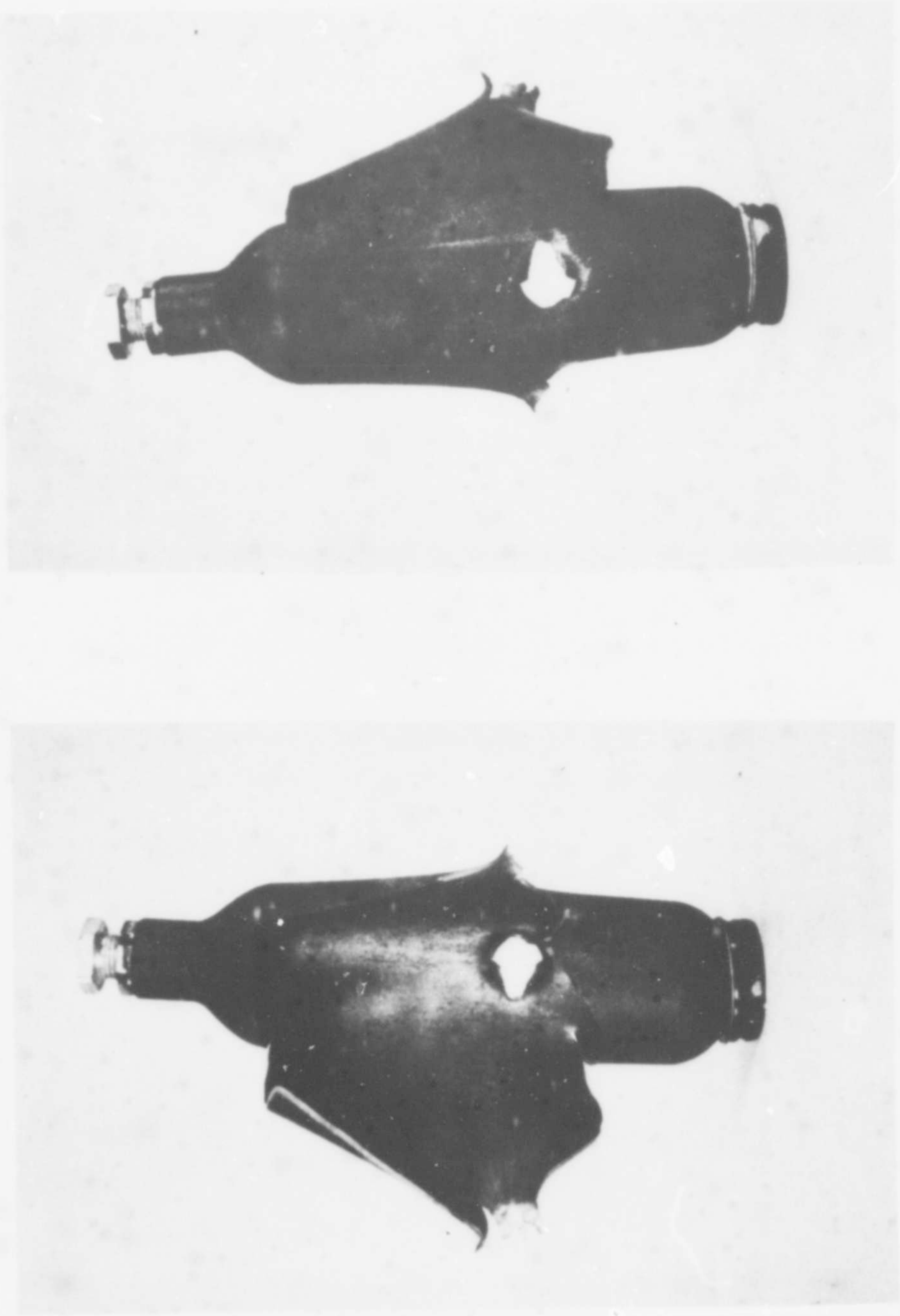


FIGURE 5

3.0 ENVIRONMENTAL AND FIELD TESTING

Seventy-six charged cylinder assemblies were delivered to AFCRL for environmental and field tests. Of these, 28 were subjected to extreme temperature tests in the laboratory, and the remaining 48 units with 10 piercing stem assemblies were distributed to the field for usage under actual service conditions.

The laboratory tests consisted of the following (See Appendix III for test data).

1. Low Temperature Tests

All of these tests were to be conducted at -65°F, however, due to difficulties with the functioning of the test chamber, the lowest temperature attainable for the first group of 12 cylinders was -30°F. The actual chamber temperature varied from -6°F to -30°F for these units, with the average being in the neighborhood of -20°F. The cylinders were soaked at -70°F in a small cold chamber prior to testing.

In these tests the cylinder was removed from the cold soak chamber, the piercing stem assembly was installed and actuated to seal-off, and connected to a balloon through a length of 1/4" plastic tubing and a weight controlled inflation nozzle. The cylinder was positioned in a holder in the test chamber. The piercing stem was actuated through a port in the side of the chamber to inflate the balloon. After inflation the balloon and inflation nozzle were removed, the nozzle port sealed off and sufficient weights added to prevent the balloon from rising. Four of the tests were nullified because of inadvertent gas loss, two because of holes in the balloon, and two because of loss of the hose or balloon connection. In the remaining eight tests, the cylinder provided from 5.2 to 7.7 gms excess lift. The piercing stem was replaced after the eighth inflation in this series because the peircing point appeared to be deformed, although it had performed satisfactorily in all tests. This unit had seen far more useage than would be anticipated in the field.

After repair of the test chamber, five additional units were tested. In the first test at a chamber temperature of -60°F, the balloon ripped during inflation. In the second, at -50°F, the balloon did not float in the chamber, but after 2 minutes at room temperature, provided 2.2 gm excess lift. In the third test, at -48°F, the balloon slipped off the nozzle during inflation, was replaced, and exhibited a 3.3 gm lift deficiency after 3 minutes at room temperature. In the fourth and fifth tests, at -40°F, the balloon broke the first time and on the second try did not float in the chamber, but exhibited 5.0 gm excess lift after 2 minutes at room temperature.

2. High Temperature Tests

All tests were performed as above except the chamber temperature was at +160°F (except +155°F for the first test) with the cylinders previously soaked at +165°F. In one test, the gas was lost when the hose slipped off the nozzle but in the remaining 10 tests the balloons exhibited an excess lift from 4.0 to 9.7 gms, with an average of 7.6 gms.

3. Field Tests

At this juncture, full details on the results obtained in actual field usage are not available, but preliminary tests indicate that the few cylinders used to date have performed satisfactorily.

4.0 SUMMARY

The testing performed has proven that the cylinder assembly developed under the auspices of this program meets or exceeds all of the performance goals stipulated in the contract Statement of Work. As such, it is ready for immediate quantity production without further modification. One change which has been incorporated in the design but not reflected in the parts supplied, is the addition of a standard hose connection buttress to the piercing stem outlet nozzle.

Further design modifications, not associated with functional performance, but rather to simplify the design, are certainly possible and should be studied. One such is the adapter and crush gasket seal. The adapter is now made from high strength 17-4 PH stainless steel to withstand the high torque load necessary for sealing. This part could be made from lower cost brass to less stringent tolerances and the gasket eliminated if a taper pipe thread connection between the adapter and the cylinder were employed. Kidde has successfully used this type of connection for equally demanding applications.

Another area for further study might be closer control of the gas charge, which can be attained either by close controls on cylinder capacity and charging conditions or charging by gas weight. It is questionable whether this is desireable or necessary for this particular application given the variations encountered in balloon weights.

In conclusion, the design produced, while certainly subject to minor modifications with further study, can be considered as fully qualified and completely capable of performing with reliability the functions required of it as specified in the contract.

EXHIBIT I

Arrowhead Industrial Services, Inc.
I.C.C. Test Reports Nos. 5188, 5417, & 5478

Our File WK
Our Order WK-67
Client's Order 198488-1

P/N 276166

Arrowhead Industrial Services, Inc.
Compressed Gas Container Specialists
18 Colonial Woods Drive
West Orange, N. J. 07052

REPORT
No. 5188
Sheet No. 1
of 4 Sheets

REPORT OF INSPECTION OF GAS CYLINDERS

February 27, 1967

Manufactured for **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Manufactured by **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Consigned to **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Quantity 25 Size 1.99 inches outside diameter by 7.20 inches long.
Vol. 15 Cu. In.

Marks stamped into the shoulder of the cylinder are:

Specification I C C – 3HT 3600

Serial numbers 42352CY to 42376CY inclusive

Inspector's Mark

Identifying symbol (registered) WK

Test date 10Ⓚ 66 42352CY to 42363CY incl.
12Ⓚ 66 42364CY to 42376CY incl.

Tare weights (yes or no) No

Other marks (if dny) SHOP IDENTIFICATION NUMBER EE(CC'S)

These cylinders were made by process of seamless drawing. These cylinders were heat treated by process of quenching in oil at 1700 deg. F., tempered at 1200 deg. F.

The material used was identified by the following heat numbers see sheet 3

The material used was verified as to chemical analysis and record thereof is attached hereto. The heat numbers were marked on the material

All material, such as plates, billets and seamless tubing, was inspected and each cylinder was inspected both before and after closing in the ends; all that was accepted was found free from seams, cracks, laminations, and other defects which might prove injurious to the strength of the cylinder. The processes of manufacture and heat treatment of cylinders were supervised and found to be efficient and satisfactory.

The cylinder walls were measured and the minimum thickness noted was .050 inch. The outside diameter was determined by a close approximation to be 1.99 inches. The wall stress was calculated to be 102000 pounds per square inch under an internal pressure of 6000 pounds per square inch.

Hydrostatic tests, flattening tests, tensile tests of material, and other tests as prescribed in specification No. 3HT were made in the presence of the inspector and all material and cylinders accepted were found to be in compliance with the requirements of that specification. Records thereof are attached hereto.

I hereby certify that all of these cylinders proved satisfactory in every way and comply with the requirements of Interstate Commerce Commission specification No. 3HT except as follows:

Exceptions: ....

Arrowhead Industrial Services, Inc.
T. F. Vassallo

Inspector T. F. Vassallo

FORM 100-1

Our File WK
Our Order WK-67
Client's Order 198488-1

Arrowhead Industrial Services, Inc.

REPORT
No. 5188
Sheet No. 2
of 4 Sheets

RECORD OF PHYSICAL TESTS OF MATERIAL FOR CONTAINERS

West Orange, New Jersey
February 27, 1967

Numbered 42352CY **to** 42376CY **inclusive.**
Size 1.99 **inches outside diameter by** 7.20 **inches long.**
Made by **Walter Kidde & Co., Inc.**
For Walter Kidde & Co., Inc.

~~XXXXXX~~ Heat	Containers represented by test (serial Nos.)	Yield strength (pounds per square inch) At 0.2% Offset	Tensile Strength (pounds per square inch)	Elongation per cent in 24XT	Reduction of area (per cent)	Flattening test
C6286	42352CY 42355CY 42357CY 42363CY 42368CY	137000 140000	150000 152000	9.6 9.4	53.0 51.0	Satis-factory
	Cycle - 10,000 cyclic pressurizations, 0-3600 PSI, no failure Burst - 11,500 PSI to destruction					
			Lab. No. 9635			
C5988	42353CY	140000 143000	153500 157000	8.1 10.3	54.0 51.0	Satis-factory
	Cycle - 10,000 cyclic pressurizations, 0-3600 PSI, no failure Burst - 12,000 PSI to destruction					
			Lab. No. 9636			
B6504	42354CY 42356CY 42358CY to 42361CY incl. 42364CY 42366CY 42367CY 42369CY to 42376CY incl.	138000 135500	146000 145000	9.0 9.7	57.1 58.1	Satis-factory
	Cycle - 10,000 cyclic pressurizations, 0-3600 PSI, no failure Burst - 11,200 PSI to destruction					
			Lab. No. 9637			
V54	42363CY 42365CY	132000 137000	146500 148500	10.1 9.6	57.0 56.0	Satis-factory
	Cycle - 10,000 cyclic pressurizations, 0-3600 PSI, no failure Burst - 12,000 PSI to destruction					
			Lab. No. 9638			

T. F. Vassallo
Inspector.

Arrowhead Industrial Services, Inc.

FORM 100-2

Our File WK
Our Order WK-67
Client's Order 198488-1

Arrowhead Industrial Services, Inc.

REPORT No. 5188
Sheet No. 3
of 4 Sheets

RECORD OF CHEMICAL ANALYSIS OF MATERIAL FOR CONTAINERS

West Orange, New Jersey
February 27, 1967

Numbered / Same as sheet 2 **to** **inclusive.**
Size **inches outside diameter by** **inches long.**
Made by Walter Kidde & Co., Inc.
For Walter Kidde & Co., Inc.

Test No.	Heat No.	Code	Containers represented (Serial Nos.)	Chemical analysis								
				C	P	S	Si	Mn	Cr	Moly		
	C6286		See sheet 2 for serial number.	.31	.007	.017	.31	.53	.93	.19		
	C5988			.33	.007	.016	.27	.60	1.01	.19		
	B6504			.28	.008	.015	.27	.54	.94	.19		
	V54			.30	.008	.023	.27	.55	.97	.21		

The analyses were made by Interlake Steel Corp.

T. F. Vassallo
Inspector.

Arrowhead Industrial Services, Inc.

FORM 100-3

Our File WK
Our Order WK-67
Client's Order 198488-1

Arrowhead Industrial Services, Inc.

REPORT
No. 5188
Sheet No. 4
of 4 Sheets

RECORD OF HYDROSTATIC TESTS ON CONTAINERS

West Orange, New Jersey
February 27, 1967

Numbered 42352CY to 42376CY inclusive.
Size 1.99 inches outside diameter by 7.20 inches long.
Made by **Walter Kidde & Co., Inc.** Vol. 15 Cu. In.
For Walter Kidde & Co., Inc.

Serial Nos. of cylinders tested	Actual test pressure (pounds) per square inch	Total expansion cubic centimeters	Permanent expansion cubic centimeters	Per cent ratio of permanent expansion to total expansion	Note Tare weight (pounds) lbs.	oz.	Volumetric capacity cubic inches CODE
42352CY	6000	1.35	.05		1	0	15
53		1.50	.05	LESS THAN 10%	1	0	15
54	All cylinders tested at above pressure.	1.55	.05		1	0	15
55		1.35	.10		1	0	15
56		1.50	.05		1	0	15
57		1.25	.10		1	0	15
58		1.25	.05		1	0	15
59		1.05	.00		1	0	15
60		1.50	.05		1	0	15
61		1.50	.05		1	0	15
62		1.30	.10		1	0	15
63		1.30	.10		1	0	15
64		1.25	.00		1	0	15
65		1.40	.10			14	15
66		1.30	.10			14	15
67		1.25	.10			14	15
68		1.40	.15			14	15
69		1.30	.00			14	15
70		1.50	.25			14	15
71		1.35	.10			14	15
72		1.30	.05			14	15
73		1.40	.20			14	15
74		1.30	.05			14	15
75		1.05	.10			14	15
76		1.35	.15		1	0	15

Note: Without Valves.
All weight & capacities checked by inspector.

T. F. Vassallo, Inspector

ARROWHEAD INDUSTRIAL SERVICES, INC.

T. F. Vassallo

T. F. Vassallo

Our File WK
Our Order WK-67
Client's Order 198488-1
P/N 276166

Arrowhead Industrial Services, Inc.
Compressed Gas Container Specialists
18 Colonial Woods Drive
West Orange, N. J. 07052

REPORT
No. 5417
Sheet No. 1
of 5 Sheets

REPORT OF INSPECTION OF GAS CYLINDERS

May 15, 1967

Manufactured for **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Manufactured by **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Consigned to **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Quantity 74 Size 1.99 inches outside diameter by 7.20 inches long.
Vol. 15 Cu. In.

Marks stamped into the shoulder of the cylinder are:

Specification I C C – 3HT3600

Serial numbers 42378CY to 42451CY inclusive

Inspector's Mark 

Identifying symbol (registered) WK

Test date 3 Ⓚ 67

Tare weights (yes or no) No

Other marks (if any) SHOP IDENTIFICATION NUMBER EE (cc's)

These cylinders were made by process of seamless drawing. These cylinders were Heat treated by process of quenching in oil at 1700 deg. F., tempered at 1200 deg. F.

The material used was identified by the following heat ~~numbers~~ number U33

~~The~~ material used was verified as to chemical analysis and record thereof is attached hereto. The heat ~~numbers~~ number was marked on the material

All material, such as plates, billets and seamless tubing, was inspected and each cylinder was inspected both before and after closing in the ends; all that was accepted was found free from seams, cracks, laminations, and other defects which might prove injurious to the strength of the cylinder. The processes of manufacture and heat treatment of cylinders were supervised and found to be efficient and satisfactory.

The cylinder walls were measured and the minimum thickness noted was .050 inch. The outside diameter was determined by a close approximation to be 1.99 inches. The wall stress was calculated to be 102000 pounds per square inch under an internal pressure of 6000 pounds per square inch.

Hydrostatic tests, flattening tests, tensile tests of material, and other tests as prescribed in specification No. 3HT were made in the presence of the inspector and all material and cylinders accepted were found to be in compliance with the requirements of that specification. Records thereof are attached hereto.

I hereby certify that all of these cylinders proved satisfactory in every way and comply with the requirements of Interstate Commerce Commission specification No. 3HT except as follows:

Exceptions: ....

Arrowhead Industrial Services, Inc.
T. F. Vassallo

Inspector T. F. Vassallo

FORM 100-1

Our File ....WK........
Our Order ....WK-67........
Client's Order ....190488-1........

Arrowhead Industrial Services, Inc.

REPORT
No. ....5417........
Sheet No. ....2........
of ....5........ Sheets

RECORD OF PHYSICAL TESTS OF MATERIAL FOR CONTAINERS

~~West Orange, New Jersey~~
May 15, 1967

Numbered 42378CY **to** 42451CY **inclusive.**
Size 1.99 **inches outside diameter by** 7.20 **inches long.**
Made by Walter Kidde & Co., Inc.
For " " " " "

~~Lot No.~~ Heat	Containers represented by test (serial Nos.)	Yield strength (pounds per square inch) At 0.2% Offset	Tensile Strength (pounds per square inch)	Elongation per cent in 24XT	Reduction of area (per cent)	Flattening test
U33	42378CY to 42451CY incl.	138500 137500	152000 160000	10.7 10.7	58.3 54.0	Satis-factory

Cycle - 10,000 cyclic pressurizations, 0-3600 PSI, no failure.

Burst - 10,600 PSI to destruction.

Lab. No. 58A

T. F. Vassallo
Inspector.

FORM 100-2

Arrowhead Industrial Services, Inc.

Our File ......WK................
Our Order ......WK-67..........
Client's Order .....198488-1.....

Arrowhead Industrial Services, Inc.

REPORT
No. ....5417...........
Sheet No. ....3...........
of ....5..... Sheets

RECORD OF CHEMICAL ANALYSIS OF MATERIAL FOR CONTAINERS

West Orange, New Jersey
May 15, 1967

Numbered / Same as sheet 2 **to** **inclusive.**
Size **inches outside diameter by** **inches long.**
Made by Walter Kidde & Co., Inc.
For " " " " "

Test No.	Heat No.	Code	Containers represented (Serial Nos.)	Chemical analysis								
				C	P	S	Si	Mn	Cr	Moly		
	U33		42378CY to 42451CY incl	.33	.009	.016	.34	.59	.99	.21		

The analyses were made by Interlake Steel Corp.

T. F. Vassallo
Inspector.

Arrowhead Industrial Services, Inc

FORM 100-3

Our File .....WK.................
Our Order ....WK-67..........
Client's Order ....198488-1.....

Arrowhead Industrial Services, Inc.

REPORT
No. ....5417...........
Sheet No. ....4............
of ....5..... Sheets

RECORD OF HYDROSTATIC TESTS ON CONTAINERS

West Orange, New Jersey
May 15, 1967

Numbered 42378CY to 42451CY inclusive.
Size 1.99 inches outside diameter by 7.20 inches long.
Made by Walter Kidde & Co., Inc.
For " " " " "

Serial Nos. of cylinders tested	Actual test pressure (pounds) per square inch	Total expansion cubic centimeters	Permanent expansion cubic centimeters	Per cent ratio of permanent expansion to total expansion	Note Tare weight (pounds)		Volumetric capacity cubic inches
					lbs.	oz.	CODE
42378CY	6000	1.80	.15	LESS THAN 10%		15	15
79		1.60	.10			15	15
80	All cylinders tested at above pressure.	1.65	.10			14	15
81		1.75	.10			14	15
82		1.85	.15			14	15
83		1.65	.10			14	15
84		1.80	.20			15	15
85		1.70	.10			14	15
86		1.45	.00			15	15
87		1.75	.10			14	15
88		1.75	.20			15	15
89		1.60	.10			15	15
90		1.65	.10			15	15
91		1.40	.00			14	15
92		1.75	.15			15	15
93		1.75	.15			14	15
94		1.75	.10			15	15
95		1.65	.10			15	15
96		1.55	.05			15	15
97		1.40	.00			14	15
98		1.70	.10			15	15
99		1.85	.15			15	15
400		1.70	.05			15	15
01		1.55	.05			15	15
02		1.60	.15			14	15
03		1.65	.10			15	15
04		1.75	.15			15	15
05		1.55	.05			15	15
06		1.75	.15			15	15
07		1.50	.05			15	15
08		1.90	.15			15	15
09		1.75	.10			15	15
10		1.65	.10			14	15
11		1.50	.00			14	15
12		1.75	.10			15	15
13		1.60	.05			15	15
14		1.80	.15			15	15
15		1.60	.05			15	15
16		1.45	.05			15	15
17		1.75	.15			15	15
18		1.75	.15			15	15
19		1.75	.15			14	15

FORM 100-4

Our File JK
Our Order SA-67
Client's Order 1[illegible]408-1

Arrowhead Industrial Services, Inc.

REPORT
No. 5417
Sheet No. 5
of 5 Sheets

Serial Nos. of cylinders tested	Actual test pressure (pounds per square inch)	Total expansion cubic centimeters	Permanent expansion cubic centimeters	Per cent ratio of permanent expansion to total expansion	Note Tare weight (pounds)		Volumetric capacity Cubic inches
					lbs.	oz.	CODE
42420CY	6000	1.60	.05	LESS THAN 10%		15	15
21		1.75	.10			15	15
22	All cylinders tested at above pressure.	1.55	.05			15	15
23		1.35	.00		1	0	15
24		1.65	.15			15	15
25		1.75	.10			14	15
26		1.55	.00		1	0	15
27		1.65	.15			15	15
28		1.60	.15			15	15
29		1.85	.15			15	15
30		1.65	.05			15	15
31		1.75	.15			15	15
32		1.50	.05			14	15
33		1.85	.15			15	15
34		1.60	.05			15	15
35		1.35	.00		1	0	15
36		1.80	.15		1	0	15
37		1.65	.10			14	15
38		1.65	.10			14	15
39		1.50	.05			14	15
40		1.80	.15			15	15
41		1.60	.10			15	15
42		1.50	.05			15	15
43		1.65	.10			15	15
44		1.60	.10		1	0	15
45		1.75	.10		1	0	15
46		1.75	.10			15	15
47		1.70	.15			15	15
48		1.50	.00		1	0	15
49		1.90	.15			15	15
50		1.85	.15			15	15
51		1.75	.15			15	15

Note: Without Valves.
All weights & capacities checked by inspector.

T. F. Vassallo, Inspector
ARROWHEAD INDUSTRIAL SERVICES, INC.

T. F. Vassallo
T. F. Vassallo

Our File ...WK...
Our Order ...WK-67...
Client's Order ...198488-1...

P/N 276166

Arrowhead Industrial Services, Inc.
Compressed Gas Container Specialists
18 Colonial Woods Drive
West Orange, N. J. 07052

REPORT
No. ...5478...
Sheet No. ...1...
of ...4... Sheets

REPORT OF INSPECTION OF GAS CYLINDERS

May 21, 1967

Manufactured for **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Manufactured by **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Consigned to **Walter Kidde & Co., Inc.**
Location at **Belleville 9, New Jersey**
Quantity 24 Size 1.99 inches outside diameter by 7.20 inches long.
Vol. 15 Cu. In.

Marks stamped into the shoulder of the cylinder are:

Specification I C C — 3HT3600

Serial numbers 95926CZ to 95949CZ inclusive

Inspector's Mark 

Identifying symbol (registered) WK

Test date 3Ⓚ67

Tare weights (yes or no) No

Other marks (if any) SHOP IDENTIFICATION NUMBER EE (cc's)

These cylinders were made by process of seamless drawing. These cylinders were heat treated by process of quenching in oil at 1700 deg. F., tempered at 1200 deg. F.

The material used was identified by the following **heat** numbers See sheet 3

The material used was verified as to chemical analysis and record thereof is attached hereto. The heat numbers **were** marked on the material

All material, such as plates, billets and seamless tubing, was inspected and each cylinder was inspected both before and after closing in the ends; all that was accepted was found free from seams, cracks, laminations, and other defects which might prove injurious to the strength of the cylinder. The processes of manufacture and heat treatment of cylinders were supervised and found to be efficient and satisfactory.

The cylinder walls were measured and the minimum thickness noted was .050 inch. The outside diameter was determined by a close approximation to be 1.99 inches. The wall stress was calculated to be 102000 pounds per square inch under an internal pressure of 6000 pounds per square inch.

Hydrostatic tests, flattening tests, tensile tests of material, and other tests as prescribed in specification No. 3HT were made in the presence of the inspector and all material and cylinders accepted were found to be in compliance with the requirements of that specification. Records thereof are attached hereto.

I hereby certify that all of these cylinders proved satisfactory in every way and comply with the requirements of Interstate Commerce Commission specification No. 3HT except as follows:

Exceptions: ...

Arrowhead Industrial Services, Inc.
T. F. Vassallo

Inspector ...T. F. Vassallo...

FORM 100-1

Our File ....WK..................
Our Order ...WK-67............
Client's Order ...198488-1......

Arrowhead Industrial Services, Inc.

REPORT
No. ....5478..........
Sheet No. ....2........
of ....4..... Sheets

RECORD OF PHYSICAL TESTS OF MATERIAL FOR CONTAINERS

~~West Orange, New Jersey~~
May 21, 1967

Numbered 95926CZ to 95949CZ inclusive.
Size 1.99 inches outside diameter by 7.20 inches long.
Made by **Walter Kidde & Co., Inc.**
For " " " " "

~~Lot No.~~ Heat	Containers represented by test (serial Nos.)	Yield strength (pounds per square inch) At 0.2% Offset	Tensile Strength (pounds per square inch)	Elongation per cent in 24XT	Reduction of area (per cent)	Flattening test
U33	95926CZ to 95934CZ incl.	138500 137500	152000 160000	10.7 10.7	58.3 54.0	Satis-factory
	Cycle - 10,000 Burst - 10,600	cyclic pressurizations, 0-3600 PSI, no failure. PSI to destruction.	Lab. No. 58A			
C5908	95935CZ 95936CZ 95949CZ	140000 143000	153500 157000	8.1 10.3	54.0 51.0	"
	Cycle - 10,000 Burst - 12,000	cyclic pressurizations, 0-3600 PSI, no failure. PSI to destruction.	Lab. No. 9636			
V54	95937CZ	132000 137000	146500 148500	10.1 9.6	57.0 56.0	"
	Cycle - 10,000 Burst - 12,000	cyclic pressurizations, 0-3600 PSI, no failure. PSI to destruction.	Lab. No. 9638			
B6504	95938CZ to 95948CZ incl.	138000 135500	146000 145000	9.0 9.7	57.1 58.1	"
	Cycle - 10,000 Burst - 11,200	cyclic pressurizations, 0-3600 PSI, no failure. PSI to destruction.	Lab. No. 9637			

.....................T. F. Vassallo...........
Inspector.

Arrowhead Industrial Services, Inc.

FORM 100-2

Our File ....WK................
Our Order ....WK-67..........
Client's Order ....198488-1.....

Arrowhead Industrial Services, Inc.

REPORT
No. ......5473..............
Sheet No. ....3............
of ....4........ Sheets

RECORD OF CHEMICAL ANALYSIS OF MATERIAL FOR CONTAINERS

West Orange, New Jersey
May 21, 1967

Numbered Same as sheet 2 **to** **inclusive.**
Size **inches outside diameter by** **inches long.**
Made by Walter Kidde & Co., Inc.
For " " " " "

Test No.	Heat No.	Code	Containers represented (Serial Nos.)	Chemical analysis								
				C	P	S	Si	Mn	Cr	Moly		
	U33		See sheet 2 for serial numbers.	.33	.009	.016	.34	.59	.99	.21		
	C5988			.33	.007	.016	.27	.60	1.01	.19		
	V54			.30	.008	.023	.27	.55	.97	.21		
	B6504			.28	.008	.015	.27	.54	.94	.19		

The analyses were made by Interlake Steel Corp.

........T. F. Vassallo..................................
Inspector.

Arrowhead Industrial Services, Inc.

FORM 100-3

Our File ......WK..................
Our Order ......WK-67..........
Client's Order .....19488-1.....

Arrowhead Industrial Services, Inc.

REPORT
No. ....5476..........
Sheet No. ....4.........
of ....4... Sheets

RECORD OF HYDROSTATIC TESTS ON CONTAINERS

West Orange, New Jersey
May 21, 1967

Numbered 95926CZ **to** 95949CZ **inclusive.**
Size 1.99 **inches outside diameter by** 7.20 **inches long.**
Made by Walter Kidde & Co., Inc.
For " " " " "

Serial Nos. of cylinders tested	Actual test pressure (pounds) per square inch	Total expansion cubic centimeters	Permanent expansion cubic centimeters	Per cent ratio of permanent expansion to total expansion	Note Tare weight (pounds) lbs.	oz.	Volumetric capacity cubic inches	CODE
95926CZ	6000	1.70	.10	LESS THAN 10%		15	15	U33
27		1.55	.05			15	15	"
28	All cylinders tested at above pressure.	1.55	.05			14	15	"
29		1.60	.05		1	0	15	"
30		1.50	.00			15	15	"
31		1.30	.00			15	15	"
32		1.80	.00			15	15	"
33		1.50	.10			15	15	"
34		1.60	.05			14	15	"
35		1.45	.10		1	0	15	C5988
36		1.60	.15		1	2	15	"
37		1.40	.05		1	1	15	V54
38		1.40	.10		1	2	15	B6504
39		1.45	.10		1	2	15	"
40		1.50	.15		1	2	15	"
41		1.30	.05		1	2	15	"
42		1.70	.15		1	3	15	"
43		1.35	.10		1	2	15	"
44		1.40	.05		1	2	15	"
45		1.15	.00		1	2	15	"
46		1.50	.10		1	2	15	"
47		1.45	.10		1	2	15	"
48		1.45	.10		1	2	15	"
49		1.65	.15		1	2	15	C5988

Note: Without Valves.
All weights & capacities checked by inspector.

T. F. Vassallo, Inspector
ARROWHEAD INDUSTRIAL SERVICES, INC.

T. F. Vassallo
T. F. Vassallo

FORM 100-4

EXHIBIT II

Development Test Data

TEST DATA FOR DEVELOPMENT TEST PLAN

BALLOON INFLATION CYLINDER

Contract No. 19(628)-6050   Project No. 4423

3.1 Cylinder Test per [illegible] Specification (See Arrowhead Test Reports Nos. 5188, 5417, and 5478)

A. Burst Test

Serial No. ________   Pressure __________ psi

B. Cycle Test

Serial No. ________   ________   ________

No. of Cycles ________   ________   ________

C. Flatten Test

C Serial No. ________   Accepted ________   Rejected ________

3.2 Charged Cylinder Assembly Leakage Test

Ser. No.	Accept	Reject	Ser. No.	Accept	Reject	Ser. No.	Accept	Reject
42435CY	X		42431CY	X		95937CZ	X	
95930CZ	X		95927CY	X		42445CY	X	
95940CZ	X		42447CY	X		42451CY	X	
42388CY	X		42439CY	X		42446CY	X	
95934CZ	X		42423CY	X		42391CY	X	
42437CY	X		95928CZ	X		42379CY	X	
95947CY	X		42408CY	X		95949CZ	X	
42384CY	X		42409CY	X		42407CY	X	

3.3 Safety Disc Burst

Temperature	Pressure	Temperature	Pressure
+65 °F	5000 psi	+160 °F	5000 psi
+65 °F	5100 psi	+160 °F	5000 psi

3.4 Cylinder and Valve Function

Group I			II		Soak	III			IV			
Ser. No.	Time	Temp.	Ser. No.	Time	Temp.	Ser. No.	Time	Temp.	Ser. No.	Time	Temp	Humid.
42451CY		+65°F	42384CY	4 hr	160	95928CZ	4 hr	-65	42423CY	50 hr	100°F	95%
42445CY		+65°F	42431CY	4 hr	160	42379CY	4 hr	-65	42439CY	50 hr	100°F	95%
95947CZ		+65°F	42430CY	4 hr	160	42407CY	4 hr	-65	42447CY	50 hr	100°F	95%
42399CY		+65°F	95927CZ	4 hr	160	42421CY	4 hr	-65	42446CY	50 hr	100°F	95%
95937CZ		+65°F	42408C	4hr	160	42409CY	4 hr	-65	95934CZ	50 hr	100°F	95%

3.4.1 Valve Operation

A. Operating Force Results	Serial No. Group I	B. Seal-Off Force Results
Good	95937CZ	Good
Good	42399CY	Good
Good	95947CZ	Good
	Group II	
Good	42384CY	Good
Good	42431CY	Good
Good	42430CY	Good
	Group III	
Good	95928CZ	Good
Good	42379CY	Good
Good	42407CY	Good
	Group IV	
Good	42423CY	Good
Good	42439CY	Good
Good	42447CY	Good

C. Flow | **D. Reseat Leakage Check**

Turns to Obtain full flow	Serial No.	1	2	3	4
	Group I				
1/8 Turn	95947CZ	OK	OK	OK	OK
1/6 Turn	42399CY	OK	OK	OK	OK
1/6 Turn	95937CZ	OK	OK	OK	OK
	Group II				
1/8 Turn	42384CY	OK	OK	OK	OK
1/6 Turn	42431CY	OK	OK	OK	OK
1/6 Turn	42430CY	OK	OK	OK	OK
	Group III				
1/6 Turn	95928CZ	OK	OK	OK	OK
1/2 Turn	42379CY	OK	OK	OK	OK
1/6 Turn	42407CY	OK	OK	OK	OK
	Group IV				
1/6 Turn	42423CY	OK	OK	OK	OK
1/6 Turn	42439CY	OK	OK	OK	OK
1/6 Turn	42447CY	OK	OK	OK	OK

3.4.2 Discharge Characteristics

A. Leakage Check	Serial No. Group I	B. Flow Results
No Leak	42445CY	Excellent
No Leak	42451CY	Excellent
	Group II	
No Leak	95927CZ	Excellent
No Leak	42408CY	Excellent
	Group III	
No Leak	42421CY	Excellent*
No Leak	42409CY	Excellent*
	Group IV	
No Leak	42446CY	Excellent
No Leak	95934CZ	Excellent

*See Paragraph 3.5, Balloon Inflation

Visual Leakage Check

Serial No.	After 1 st Exposure At +160°F	After 1 st Exposure At -65°F	After 2 nd Exposure At +160°F	After 2 nd Exposure At -65°F	Leakage Check Using Leak Detector
42436CY	OK	OK	OK	OK	OK
95949CZ	OK	OK	OK	OK	OK
42391CY	OK	OK	OK	OK	OK
42437CY	OK	OK	OK	OK	OK

3.5 Ballon Inflation

Serial No.	Result
42421CY	Inflated Balloon after -65°F Soak
42409CY	Inflated Balloon after -65°F Soak

3.6 Gunfire Straight Shot

Serial No.	Result Entrance hole - 1/2" x 1"
95940CZ	Exit - 7/8" x 1 1/4"
42388CY	Entrance - 5/8" x 7/8"
	Exit - tore open but remained in 1 piece

All Tests Completed 5/15/67

EXHIBIT III

Environmental Test Data

TABLE A

Inflation Number	Cylinder Weight Full	Cylinder Weight Empty	Weight of Gas	Balloon Weight	Excess Lift	Chamber Temp. °F	Remarks
1	498.9	490.5	8.4	9.8	--	--	Hose slipped off valve during inflation'
2	436.6	427.3	9.3	9.8	7.3	-20	None
3	431.7	422.6	9.1	10.8	--	-23	Balloon had 2 small holes in side
4	428.4	419.6	8.8	10.8	--	-30	Balloon had 2 small holes in side
5	430.3	421.2	9.1	10.6	5.2	-20	None
6	428.3	419.5	8.8	9.8	5.9	-6	None
7	431.3	422.8	8.5	9.5	7.7	-8	None
8	432.2	423.3	8.9	10.6		-21	Balloon floated, then slipped off nozzle before it could be weighed
9	431.3	421.6	9.7	10.6	5.7	-26	Point on valve showed signs of distortion. Replaced valve & "O" ring
10	431.0	421.9	9.1	10.3	6.7	-19	None
11	430.6	421.2	9.4	9.8	5.7	-17	None
12	438.8	429.9	8.9	9.2	6.4	-22	None
			Average 9.0 gms		Average 6.3 gms		

NOTES: 1. All cylinder temperatures were approximately -65°F when placed in chamber.
2. All weights and lift are in grams.

TABLE B

Inflation Number	Cylinder Weight Full	Cylinder Weight Empty	Weight of Gas	Balloon Weight	Excess Lift	Chamber Temp. °F	Remarks
1	431.0	421.8	9.2	10.3	--	-60	Balloon ripped during inflation
2	500.6	492.2	8.4	10.2	+ 2.2	-50	Balloon did not float in chamber. After exposed to room temp. 2 min., it had excess lift.
3	429.0	419.9	9.1	10.6	- 3.3	-48	Balloon came off nozzle replaced and continued filling. Lift determined after exposed to room temp. for 3 min.
4	490.0	481.6	8.4	10.0	--	-40	Balloon broke
5	432.7	424.1	8.6	10.0	+5.0	-40	Balloon did not float in chamber, same as 2, above.
			Average8.7 gms				

NOTES:
1. Cylinder temperatures were approximately -65°F when placed in test chamber.
2. All weights and lifts are in grams.

TABLE C

Inflation Number	Cylinder Weight Full	Cylinder Weight Empty	Weight of Gas	Balloon Weight	Excess Lift	Chamber Temp. °F	Remarks
1	425.8	416.4	9.4	10.2	9.7	155	None
2	430.0	420.8	9.2	9.8	9.4	160	None
3	433.0	423.6	9.4	10.2	--	160	Hose slipped off nozzle
4	428.9	419.7	9.2	10.2	8.7	160	None
5	429.2	419.6	9.6	10.0	9.7	160	None
6	428.2	419.1	9.1	10.0	7.7	160	None*
7	430.0	420.7	9.3	9.5	7.7	160	None*
8	430.7	420.7	8.7	10.0	7.7	160	None*
9	431.0	422.4	8.6	9.8	8.7	160	None*
10	503.4	495.6	7.8	9.8	4.0	160	None*
11	430.8	422.2	8.6	10.0	6.7	160	None*
		Average	9.0 gms		Average 7.6 gms		

*Noticed shortly after start of inflation that gas flow increased significantly without any adjustment of valve assembly. Mr. Hunter of Kidde & Co. expressed the view thatthe disk was collapsing inwardly. (Normally bowed outward.) This occured on the last six inflations.

NOTES: 1. All cylinder temperatures were approximately 160°F when placed in chamber.
2. All weights and lifts are in grams.

EXHIBIT IV

Walter Kidde Drawing No. 875200

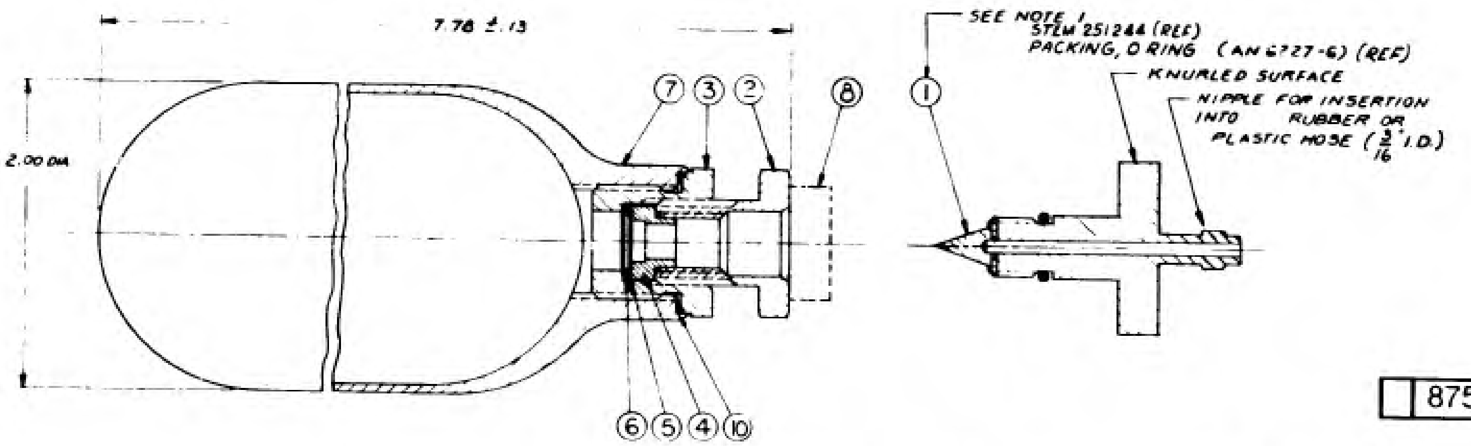
REVISIONS

SYM	DESCRIPTION	DATE	BY	APPD
D	REVISED SEAL CONFIGURATION OF BOTTLE	4-10-67	A.P	
E	REVISED PER DRA	6-6-67	A.P	P
F	REFER DRA & RELEASED FOR PRODUCTION	7-6-67	HP	FA
G	REFER DRA (NO PHYSICAL CHANGE)	10/13/67	HP	

T01T 8-10-66

DESIGN DATA

1. CONFORMS TO ICC - 3HT
2. FLUID — HELIUM
3. SERVICE PRESSURE 3600 PSIG
4. PROOF PRESSURE — 6000 PSIG
5. BURST PRESSURE — 8000 PSIG (MIN)
6. VOLUME — 15 CU IN MIN.
7. WEIGHT — 1.20 LBS NOM.
8. SAFETY DISC BURST RANGE 4400-5400 PSIG @ 160°F



NOTES.

1. ITEM NO. 1 (804965) IS NOT FURNISHED AS PART OF THIS ASSEMBLY. INSTALL RECOIL PLUG 251392 (ITEM 8) IN ITS PLACE AFTER CHARGING.

2. ASSEMBLE, CHARGE AND TEST PER WK 152252

875200

G

QTY REQD	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE	SPECIFICATION	ITEM NO
1	212300	GASKET	ALUM.	QQ-A-325	10
AR	205316	GREASE	~	MIL-G-4343	9
1	251392	PLUG, RECOIL	BRASS	QQ-B-626	8
1	276166	CYLINDER	STEEL	SAE 4130	7
1	251242	WASHER	COPPER	QQ-C-576	6
1	251246	DISC, SAFETY			5
1	251241	SEAT	BRASS	AMS 4610	4
1	252075	ADAPTER	CRES	AMS 5643	3
1	251243	RETAINER	BRASS	AMS 4610	2
REF	804965	STEM ASSY	ST & SYN RUB.	QQ-S-633 & AN6227-6	1

LIST OF MATERIALS OR PARTS LIST

AP 152252
IP

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
XX ± .02 XXX ± .005 ANGLES ± 1°
CONCENTRICITY TIR FINISH √
SQUARENESS PARALLELISM
MATERIAL ~
STK LG ~
STD PT NO ~
CODE NO ~
FINISH ~
SIMILAR TO ~
NEXT ASSY ~

DRAWN R. IANNUZZI DATE 6/6/66
CHECKED
7/6/67
ENGINEERING 7/11/67
MATL & PROC ENGRG

Walter Kidde & Company, Inc.
Belleville 9, New Jersey, U.S.A.

BALLOON INFLATION
CYLINDER & VALVE ASSY

CODE IDENT NO 33525
SIZE C
DWG NO & PART NO. 875200
SCALE 2/1
SHEET 1 OF 1

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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Walter Kidde & Company, Inc.
675 Main Street
Belleville, New Jersey 07109

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2b. GROUP
-

3. REPORT TITLE
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4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
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Approved
20 Dec 67

5. AUTHOR(S) *(First name, middle initial, last name)*
T.F. Hunter

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10. DISTRIBUTION STATEMENT
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11. SUPPLEMENTARY NOTES
TECH, OTHER

12. SPONSORING MILITARY ACTIVITY
Air Force Cambridge Research
Laboratories (CRE)
L.G. Hanscom Field
Bedford, Massachusetts 01730

13. ABSTRACT

This program was undertaken to design and fabricate a pilot run quantity of a small lightweight expendable type cylinder and valve assembly charged with helium to be used by combat weather teams for inflating small meteorological balloons.

The cylinders were designed in accordance with Interstate Commerce Commission Specification 3HT, with an internal volume of fifteen cubic inches to contain 1.6 to 1.8 free cubic feet of helium at a filling pressure of 3600 psig and a temperature of 70°F.

The cylinder assembly was designed to be sealed after filling, with gas discharge accomplished manually by means of a pierced disc technique, using a non-integral puncturing stem device. The assembly was designed to permit seal-off and flow control after disc puncture by manipulation of the stem.

A total of 100 charged cylinder assemblies and 14 puncture stems were supplied under this program. 24 cylinders and 4 stems were used for development tests at Walter Kidde and the balance were delivered to AFCRL for environmental and field tests. All test results to date have demonstrated full compliance with the desired performance requirements.

DD FORM 1 NOV 65 1473

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Helium Cylinder						
Weather Balloon Inflation						
Tactical Equipment						