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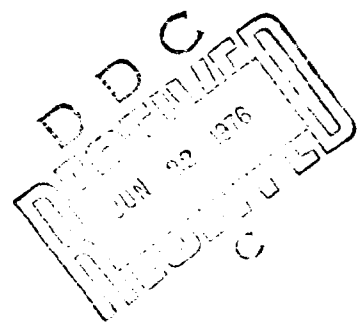

OUTDOOR EVALUATION--STUDY MEANS OF ASSURING MIL-D-6054 STEEL DRUMS ARE HERMETICALLY SEALED

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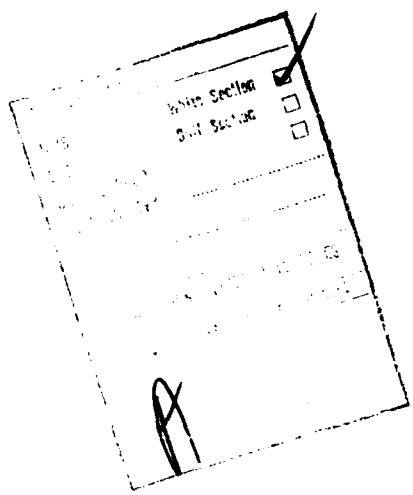
ABSTRACT

The requirement in accordance with MIL-P-116 that Method IId (rigid metal containers) have a water vaporproof seal is well understood. What is not well understood is that simply closing the container may, in fact, not assure an effective seal. This outdoor test study describes a simple, inexpensive valve to test and assure a hermetic seal or, through the use of a new "question mark" shaped type of gasket, be reasonably certain that a seal was obtained without testing.



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INTRODUCTION

In the past, it was assumed that MIL-D-6054 open-head steel drums with desiccant permitted high value items to be stored (corrosion free) for extended periods in accordance with MIL-P-116, Method IId preservation. These containers were believed to be hermetically sealed because of a half round neoprene gasket located in the lid. This lid was drawn down tightly against the rolled lip of the drum by tightening a locking ring with a nut and bolt. After the nut and bolt was partially tensioned (radial pressure), the locking ring was tapped with a fiber, rubber, or plastic mallet, starting opposite the bolt lugs and tapping in both directions toward the lugs. Rarely were these drums challenged whether or not they were water vapor tight or hermetically sealed because of this tightening procedure. Prior to this study, of fifty drums (both new and reconditioned) that were closed following the procedure given in T.O. 00-85-10, Metal Container Preservation and Packaging, none were found to be hermetically sealed. This was substantiated by the great difficulty encountered trying to hermetically seal five of ten drums for testing. Only after applying grease to the gasket and the "U" channelled locking ring, plus extensive hammering of this locking ring and frequent tightening of the bolt was it possible to obtain a seal after two or three attempts.

The objective of this study was twofold: (1) to evaluate a simple and inexpensive quality assurance test procedure to ascertain a hermetic seal of the drum by using a high performance low profile valve, and (2) to evaluate a unique "question mark" shaped open-head drum gasket "Multi Seal", which gives added assurance of seal by the exclusive multi-seal.

TEST STUDY

An outdoor storage test was designed and initiated in Jan 1974 at the Wright-Patterson Air Force Base Outdoor Storage Testing Area. This test study involved ten MIL-D-6054 steel drums, 16-gallon open-head, desiccated and preserved in accordance with MIL-P-116. They were then subjected to 18 months of local weathering environment. The drums were picked up after the first ten months and brought into the Air Force Packaging Evaluation Agency (AFPEA) laboratory for a visual inspection and quantitative moisture measurement. Following this, they were returned to the outdoor storage area for eight more months to complete the test study. At the completion of the test

they were brought back to the laboratory for final evaluation.

FIELD TEST AREA

AFPEA was assigned an 80 ft x 100 ft fenced area for use as an outdoor environmental test site, to be used in studying the effects of local weathering elements on assorted packaging materials. In this study ten drums were grouped in a corner of the lot and spaced in two rows of five drums each, one foot apart, set upright, directly on the ground surface and exposed to the weathering elements without any protection. There were no trees near the area so that the subjected drums would receive complete weathering exposure.

TESTING PROCEDURE

Ten reconditioned drums were used in this field test study. In the side of each drum, near the bolt lugs, a 29/64-inch standard hole was drilled and a special low profile "racing valve" was inserted to permit air pressurization and pressure measurement of the container (see Figures 1, 2, and 3). Two humidity or corrosion identifiers were introduced into each drum to detect adverse environmental conditions. One of the detectors was a cobaltous chloride spot card humidity indicator and the other was a 1-1/2" x 4-1/2" x 1/8" thick polished piece of mild steel (see Figure 4). Two units of desiccant were also added to each drum to conform to MIL-P-116, Method IId requirements.

The humidity indicator card, steel plate, and desiccant were added to each drum prior to placement of the lid over the drum to close off the system for the test study. Also, it should be mentioned that these items were placed in a desiccator prior to use as test controls. To get accurate weighs of the desiccant, prior to closing them off in their respective drums they were wrapped tightly in an 18" x 12" piece of Saran Wrap (polyvinylidene chloride film) and weighed to the nearest milligram.

The ten test drums were closed and sealed in accordance with T.O. 00-85-10 using the proper tapping procedure and torque tightened to 6 ft-lb. The sealing procedure, mentioned in the technical order, is to use a wire and crimped-metal seal after closure is completed, effecting a "tamper detecting" seal on the container. However, there

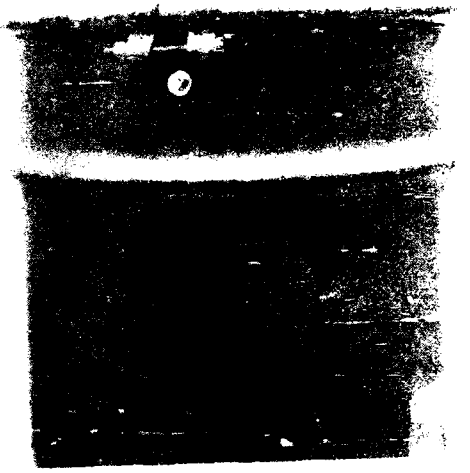

Figure 1. Racing Valve Below Lug Bolt

Figure 2. Protected Low Profile Valve

Figure 3. Two Nuts Hold and Lock Valve In Place

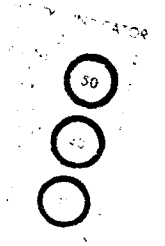

Figure 4. The Two Humidity or Corrosion Identifiers

is no quality assurance test in the technical order to assure that each unit is hermetically sealed.

With a low profile special tire valve inserted in each drum, it was easy to air pressurize the system to 3-1/2 pounds per square inch gauge pressure (psig). An inexpensive low pressure tire gauge, similar to those used to check automobile tire pressure, was used to measure this low pressure accurately to within 1/4 psig (see Figure 5). In order to pass the pneumatic pressure technique of leakage test, the gauge pressure must be held over a 30 minute period. All ten containers failed this test. Five units held some pressure for approximately five minutes and were carefully worked on so that they eventually held pressure for the required 30 minutes and ultimately passed the leak test. Drum numbers 1, 2, 3, 5 and 6 were ultimately hermetically sealed to begin the test and numbers 4, 7, 8, 9 and 10 were not sealed and therefore leaked.

After seven months of this outdoor exposure test, AFPEA personnel became aware of a new multi-seal gasket. The seal was put on drum number 10 (one of the five that leaked), pressurized, and returned to the outdoor test site for three more months (see Figure 6). All ten drums were given visual and quantitative evaluation after the first ten months of exposure to the weathering elements of WPAFB. Since the multi-seal held so well for the short three month trial, another eight month study was started to evaluate the multi-seal gasket system. Two drums in this second phase study were easily sealed, using the special multi-seal gasket system. Attempts were made to seal the remaining eight drums that had the conventional half round gaskets in accordance with T.C. 00-85-10. Only one of the remaining eight drums was found to be properly sealed. With the special valves in the drums, the pneumatic air pressure technique was used to assure the items were hermetically sealed. This gave further evidence that the half round gaskets that had been used by DOD to date were unreliable for sealing a Method IId container. Figure 7 shows a sketch which compares the sealing areas of the two gasket designs. The "question mark" configuration permits a three point contact of seal. The old style (half round) gasket, that fitted into the lid, has only one point of contact to make the seal and this is reliant on a resultant vertical force. The half round gasket does not appear to be adequate for a reliable and consistent seal while the multi-seal gasket does afford a consistent reproducable seal for open-head steel drums. With a good seal, it provides moisture-free protection to the corrosion prone contents.

Figure 5. Low Pressure Tire Gauge

Figure 6. Multi-Seal Gasket on Drum Chime

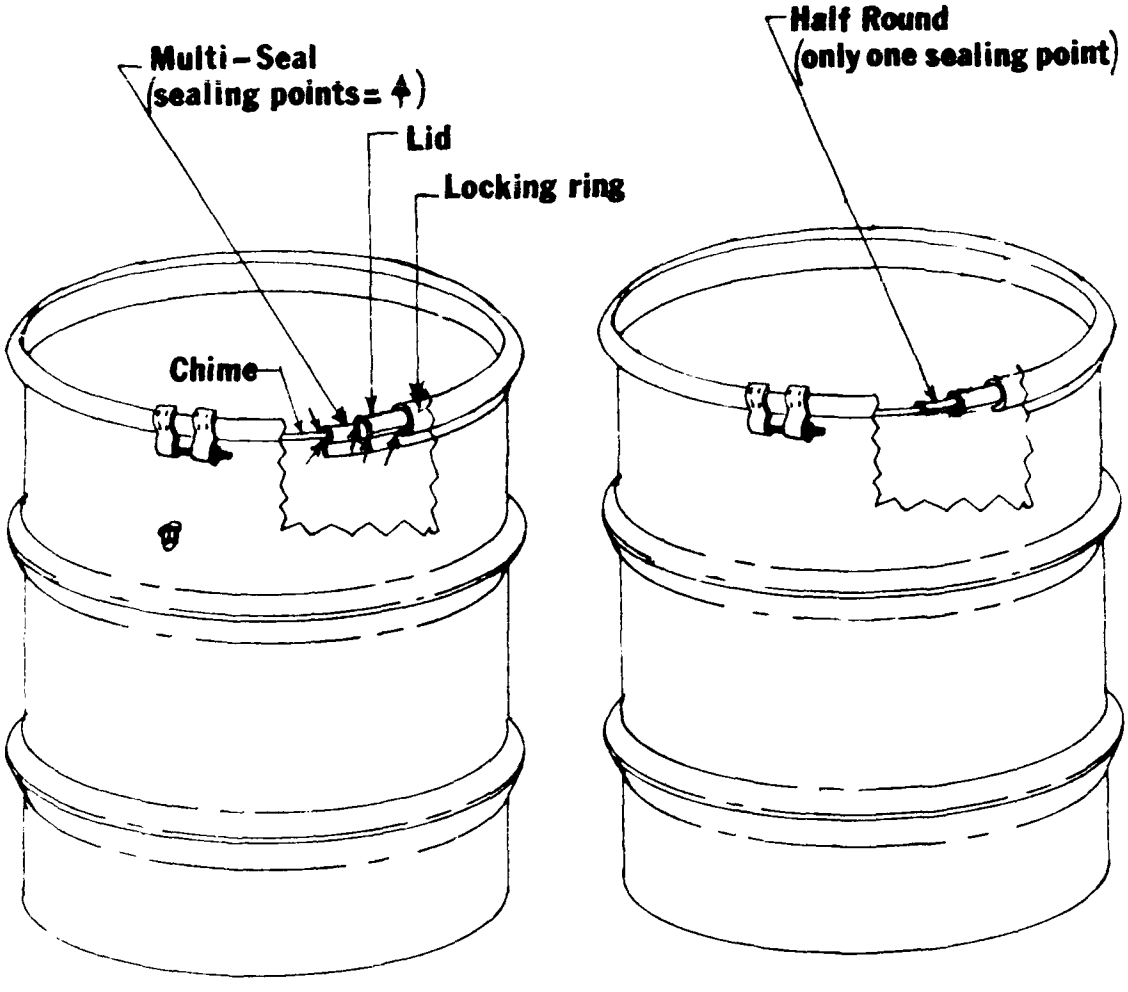

Figure 7. Multi-Seal Gasket vs Conventional Half Round Gasket

RESULTS

Table I tabulates the results of the 18 month test study. This includes visual and quantitative data accumulated on two independent tests. One test involved five sealed and five unsealed drums over a ten month period (with one exception of a pre-test of the multi-seal gasket, drum number 10, for the last three months). The other test also used the valve as a way to pressurize and ascertain whether the drums were sealed or not in 30 minutes. Further, the last eight month test was designed primarily to compare the two gasket designs to assure whether a hermetically tight seal was obtained.

DISCUSSION

All ten drums were closed following the procedure given in T.O. 00-85-10 but none were hermetically sealed This was evidenced by the simple quality assurance pneumatic pressure technique through the use of the inexpensive No. 6008-50, extra low profile racing tire (Schrader Automotive Products). Any loss of gauge pressure over a 30 minute period indicated failure in accordance with MIL-P-116, para 4.4.3.5. Only after repeated effort which included solvent cleaning the gasket, applying grease, and applying RTV sealant on the lip of the drum in the seam welded area of the lip, were drum numbers 1, 2, 3, 5 and 6 properly sealed.

Drum No. 10 (not sealed) was recalled after seven months outdoor exposure to place a "multi-seal" gasket on the drum (see Figure 6). The desiccant, spot card, and steel plate sample were left unchanged. When tested using the pneumatic pressure technique, it passed easily the first time the lid was closed. The drum was then returned to the outdoor test area with the other nine drums for three more months. All ten drums were brought into the laboratory and given a careful visual and quantitative evaluation. Table I shows that numbers 1, 2, 3, 5 and 6 had greater than 1 psig air pressure remaining and thus remained sealed. The Schrader tire valve worked well to assure the container was sealed. Numbers 4, 7, 8 and 9 were not sealed during the outdoor exposure test. Numbers 7 and 8 were noted to have accumulated 25 to 150 ml of water as evidenced by the cobaltous chloride spot cards (all pink), rusted steel plate and high desiccant weight or water saturated desiccant in drum number 8. The drum numbers 4 and 9 had rust free steel sample plates but the 30% relative

TABLE I

DATA FROM OUTDOOR LABORATORY STUDY ---
SPECIAL AIR VALVES AND MULTI-SEAL GASKETS

FIRST 10 MONTHS TEST

SPL. NO.	SEALED (S) NOT SEALED (NS)	(30-40-50%) SPOT CARD HUMIDITY (%)	CONDITION OF STEEL SPL.	WATERVAPOR PICK-UP (%)	AIR PRESS.	REMARKS
1	S	All Blue	Rust Free	5.85	>1 psig	Very Good Seal
2	S	All Blue	Rust Free	1.45	>1 psig	Very Good Seal
3	S	All Blue	Rust Free	1.62	>1 psig	Very Good Seal
4	NS	30% Pink	Rust Free	21.56	0 psig	Dangerous Area, Could Cause Corrosion
5	S	All Blue	Rust Free	1.57	>1 psig	Very Good Seal
6	S	All Blue	Rust Free	3.97	>1 psig	Very Good Seal
7	NS	(>50% RH) All Pink	Spot Rusted	(38.39)	0 psig	25 to 50 ml water in Container
8	NS	(>50% RH) All Pink	Rusted	(Saturated)	0 psig	150 + ml water in Container
9	NS	30% Pink	Rust Free	13.62	0 psig	Dangerous Area, Could Cause Corrosion
(7 Mos) 10	NS	30% Pink	Rust Free	15.42	0 psig	Leaked for 7 months (Moisture Present)
(3 Mos) 10	S	30% Pink	Rust Free	19.56	>1 psig	Sealed for last 3 Months (Multi-Seal gasket) (Very Good Seal)

TABLE I (CONTINUED)

DATA FROM OUTDOOR LABORATORY STUDY ---
SPECIAL AIR VALVES AND MULTI-SEAL GASKETS

SECOND 8 MONTHS TEST

SPL. NO.	SEALED (S) NOT SEALED (NS)	(30-40-50%) SPOT CARD HUMIDITY (%)	CONDITION OF STEEL SPL.	WATERVAPOR PICK-UP (%)	AIR PRESS.	REMARKS
1	S	All Blue (>50% RH)	Rust Free	9.65	> 1 psig	Multi-Seal Gasket (Very Good Seal)
2	NS	All Pink	Spot Rusted	19.8	0 psig	Very Dangerous - Droplets of Water
3	S	(No Card)	Rust Free	(No Desiccant)	> 1 psig	Multi-Seal Gasket (Very Good Seal)
4	NS	40% Pink	Rust Free	20.12	0 psig	Very Dangerous Area, Could Cause Corrosion
5	NS	30% Pink	Rust Free	18.75	0 psig	Dangerous Area, Could Cause Rust
6	NS	All Pink (>50% RH)	Spot Rusted	27.11	0 psig	Very Dangerous - Droplets of Water
7	NS	All Pink (>50% RH)	Rusted	30.67	0 psig	Very Dangerous - Droplets of Water
8	NS	All Pink (>50% RH)	Rusted	(Saturated)	0 psig	50 to 100 ml water in Container
9	S	All Blue	Rust Free	5.34	< 1 psig (press)	Good Seal (1/2 Round Gasket)
10	NS	All Pink (>50% RH)	Rusted	(Saturated)	0 psig	150 + ml water in Container

humidity spot cards in each drum and high moisture content evidenced by desiccant weight increase put the atmosphere in the dangerous or warning area, relating there was corrosion potential. Drum number 10 was in this same dangerous area because much moisture had penetrated in the first seven months, before the multi-seal was put on. This was a pre-test of the new gasket seal, to see if it would hold air pressure. The danger area was already reached before it was applied so the corrosive atmosphere was already present as the 30% humidity card indicated.

Prior to the next eight months outdoor testing, all ten drums were emptied, cleaned, and thoroughly dried. Drum number 1 was randomly picked and a multi-seal gasket was stretched over the lip of the drum, a clean steel plate placed in it and the drum closed and seal assured by the 30 minute pneumatic pressure test. Drum number 3 also received a multi-seal gasket plus new weighed desiccant, spot card, and clean steel plate. It was found to immediately take and hold 3-1/2 psig pressure and was assured sealed. Drum numbers 2, 4, 5, 6, 7, 8, 9 and 10 had the half round standard gaskets and each received new spot cards, clean steel plates and accurately weighed desiccant. Each was carefully closed following the procedure given in T.O. 00-85-10. Only drum number 9 held and passed the pneumatic pressure test. All ten drums were stored for eight additional months in the outdoor storage site. Referencing Table I, the two multi-seal gaskets (number 1 and 3) held pressure greater than 1 psig and the rust free steel samples were indicative of a good atmoshpere. The only original assured seal (number 9) of the regular standard half round gasket had less than 1 psig pressure and had a good dry atmosphere. The remaining seven drums (numbers 2, 4, 5, 6, 7, 8 and 10) had a worse interior corrosive atmospheric condition.

CONCLUSIONS

a. In conclusion, MIL-D-6054 and other similar open-head steel drums are assumed to be sealed when in effect only a very small percentage are, even though they are closed in accordance with T.O. 00-85-10. From this test study, a quality assured hermetic seal is possible by using a low profile Schrader racing valve that permits air pressurization and easy low pressure (tire) gauge testing. This is an easy way to certify a hermetic seal of the closed container. The assurance technique is simple, inexpensive, and effective. It requires only that a standard size hole be drilled

into the side of the drum to insert this special low cost valve with a rubber grommet.

b. The presently used half round gaskets used on drums give an ineffective seal. An improved design, multi-seal Schlegel gasket gives an excellent seal and can be effectively reused with assurance of a good seal. The multi-seal gasket fits over the lip or chime of the the drum and the lid fits over it. When the locking ring is radially tightened, the cross sectioned "question mark" shaped gasket makes contact at three points affording an excellent seal as compared with the flat contact surface of the conventional half round gasket that makes only one contact to seal (see Figure 7).

RECOMMENDATIONS

When high value items, many of which are prone to corrosion, are packaged in a MIL-P-116, Method IId container (hermetically sealed and desiccated), better protection than these items presently receive will be obtained. The quality control test using the tire type valve, especially if the present half round gaskets are continued to be used, will improve the storing quality of these items. It is recommended that DOD accept the new multi-seal gasket and update the pertinent documents to include its use for all open-head drums where hermetically sealed units are required. This type of seal will unquestionably give nearly 100% assurance of seal.

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half round gasket	quality assurance	
hermetic seal	"question mark" shaped gasket	
leak tight	racing valve	
low profile valve	steel open-head drum	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The requirement in accordance with MIL-P-116 that Method IId (rigid metal containers) have a water vaporproof seal is well understood. What is not well understood is that simply closing the container may, in fact, not assure an effective seal. This outdoor test study describes a simple, inexpensive valve to test and assure a hermetic seal or, through the use of a new "question mark" shaped type of gasket, be reasonably certain that a seal was obtained without testing.

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