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INTERIOR CORROSION OF STEEL FIVE-GALLON MILITARY WATER CANS

by

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FOREWORD

This study to uncover causes of excessive interior corrosion of the standard steel five-gallon military water can was authorized by Headquarters, Army Materiel Command. The incidence of rusting in water cans can be greatly decreased as a result of this study, through the specification revision it recommends. Current development of a plastic water can will, if successful, give total freedom from the corrosion problem.

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ABSTRACT

A study has been made of the occurrence of interior corrosion in the steel five-gallon military water can. The study covered used as well as new cans. It was found that much of the rusting is attributable to excessively sharp edges at lap seams, creating a condition that coatings generally cannot be expected to overcome. Other rusting was found to be of limited extent and to vary in location from can to can. The exact cause of this variable corrosion was not proven, but the condition is characteristic of that commonly resulting from locally inadequate surface preparation. It is concluded that the specification should be revised to include a) smoothing of seam edges, b) more frequent testing, and c) simplification of some of the tests so that they will be more amenable to frequent application.

INTERIOR CORROSION OF STEEL FIVE-GALLON MILITARY WATER CANS

A. Summary

1. Object

This study was conducted to determine the causes of corrosion occurring in the interior of the standard steel five-gallon military water can (Type I, MIL-C-13984), FSN 7240-242-6153.

2. Scope

The study included a) examination of salvaged cans, b) laboratory performance testing of unused 1965-manufacture cans, and c) review of the specification requirements for water cans.

3. Results and Conclusions

The excessively sharp edges of metal at lapped seams, particularly at the soldered neck seam and at the welded shoulder seam, were found to be a major source of rusting.

An occasional cause of rusting was the exposure of the metal when the coating was cracked by impact during use.

There was no indication that the coating material was inadequate. Large areas of the cans were unaffected, including many severely impacted areas.

Indications of variable quality within cans and among cans strongly suggest ineffectual quality control, particularly of the surface preparation.

It is concluded that the specification for the water can should undergo revision. It should incorporate requirements for a) smoothing sharp edges at lap seams (already incorporated in the recent Revision C), and b) testing cans by lot in lieu of the presently specified bi-monthly testing. Also, the requirements for end-item testing should be simplified so as to be more responsive to the needs of testing by lot (see D,3).

B. Introduction

This study was directed by Headquarters, U. S. Army Materiel Command, as a result of a reportedly high incidence of rusting and consequent salvage of the steel five-gallon military water can (coated interior). AMC is considering the replacement of the steel can by the Marine Corps aluminum can (uncoated interior) or by a plastic can now undergoing development.

The applicable maintenance manual for the water can of this study is TM 10-7240-201-23. This manual specifies that "other than minimal pinpoint rust is not permissible" in the can interior when noted during monthly inspection or after field maneuvers as part of preventive maintenance services.

For a detailed understanding of the can parts cited in this report, reference may be made to the drawings in the specification (MIL-C-13984). It should be understood that, in production of the cans, the interior coating is applied to the lids, bottoms, and bodies in separate operations that are conducted prior to assembly. Since these parts may be treated, coated, and cured at different times and at different stations in the production line, there is opportunity for variation in the quality of the surface within any one can.

C. Data

1. Examination of Salvaged Cans

Thirty-two salvaged cans were examined. Twenty-nine of these were examined at Fort Devens, Mass. in October, 1965. The other three, which had been sent from Alaska as representative of conditions reported under an Equipment Improvement Report (U.S. Army Mobility Center Case 5167-4835-02), were examined in October, 1965 at the U.S. Army Natick Laboratories. Observations of the can interiors, the year of their manufacture, and their manufacturer (in code) are tabulated in Appendix I. Rust locations and frequency are summarized in Appendix II.

2. Laboratory Performance Testing of 1965 Production Cans

Eighteen unused cans of 1965 production (Contract DSA4-043845) were tested at the Natick Laboratories between September 1965 and February, 1966. All of these cans were drawn from Defense General Supply Center stock.

The cans were tested for impact resistance and resistance to boiling, water storage, and salt water aeration. In all tests using water, the cans were emptied for observation and then refilled with the same water. A description of the tests and the results are given in Appendix III. A summary of the water storage test findings is given in Appendix IV.

3. Review of Specification Requirement MIL-C-13984B and Amendment 2

The present specification requires that the interior coating be a phenol-formaldehyde resin type of baking quality. A comprehensive battery of performance-type tests is included. These tests cover resistance of the interior coating to severe impact, abrasion (as by river sand), freezing, thawing, steaming, acid, hypochlorite and trisodium phosphate (as in cleaning and sterilizing), boiling, and warm-water storage. It is stipulated that after such exposure, the coating must show no blistering, checking, cracking, flaking, alligatoring, or pinholing. The only reference to rust is that there be no rust in the water.

Testing is required on an "initial production unit" basis for each batch of interior enamel and then twice a month thereafter. Lot-by-lot testing is not required.

D. Discussion of Data

1. Salvaged Cans

Rusting occurred frequently as line rust at lap seams, i.e., at

the upper and vertical welded seams and at the soldered neck-flange seam. When rusting was reproduced in the laboratory tests, it was noted to occur where the lap edge of the seam (the "break-edge" of sheared metal) was unduly sharp. In some cases, rusting was noted to begin at the "crevice" of the seam. Since long segments of the seam were not rusted, however, there is indication that corrosion prevention in these areas is possible. Additional care in shearing, deburring, smoothing, welding, and coating, for instance, could be expected to reduce materially the incidence of rusting in these locations.

There was frequent but localized rusting, generally covering less than 1 percent of the area, on the bottom and body. In a few cases, rusting was noted on a thinly coated area near the embossed "X" on the front and back of the can, and at a few impact points. However, on the same cans, there was no rust on other severe impact points. Significantly, the condition of the bottom was often quite different from that of the body. Of the 15 salvaged cans that had rust on the bottom, and of the 9 that had rust on the body, only 3 had rust on both bottom and body. Undoubtedly, this is related to the fact that each of these areas is coated separately. Although the exact cause of much of this rusting is unknown, it is believed to be the result of local or temporary deficiencies in the surface preparation and cleaning.

Frequent rusting of the neck exclusive of the seam edge was observed. The rusting above the seam appeared to be associated with physical damage during use, damage severe enough not only to crack the coating but also to cut into the tin coating that had been hot-applied to that portion of the neck. Rusting below the seam line (on the flange as far as the area where it flares into the head) occurred in small but significant amounts. The cause of this rusting is not known, but it is probably related to incomplete cleaning of the soldering flux from the adjacent neck seam.

Rust appeared within the bottom seam in 5 cans, 4 of which were of 1951 manufacture. Several years ago, rust in the bottom seam was determined to be due to locally insufficient paint coverage and to bare spots within the seam. Remedial specification action was taken. Current production practices appear to have substantially corrected the condition. No further action in this matter is contemplated.

Rust appeared infrequently on the underside of the lid.

The performance of the head space appeared to be satisfactory.

2. New Cans

Trends of the data with respect to the location of rust and the variability of its locations in the new cans are similar to those noted in the used ones. However, these data show a vulnerability of the lid (which is coated separately from the rest of the can) to early blistering. On the other hand, the head space, which was exposed to the same high humidity and condensate as the lid, showed blistering in only one can. Coatings that blister become less adherent and are more susceptible to physical and chemical damage and subsequent rusting.

There was some blistering on the bodies and bottoms, also. Its cause is unknown but its localized and variable nature indicates marginal quality control during the surface preparation stage of the coating process.

Resistance to severe impact, both before and after water storage, generally appeared to be good at 75° and 40°F but was not good at 0°F. (The specification requires resistance to severe impact at 20°F.)

3. Specification Requirements

In view of the variations in surface preparation, coating application, and coating cure to which the finishing operation is susceptible, bimonthly testing of the interior finish of the production cans is considered inadequate. Testing by lot is preferred. However, conducting all presently specified end-item tests would prove burdensome if performed on each lot. Study of these tests and their purpose indicates that end-item testing on a lot-by-lot basis can be reduced to a reasonable level without loss of quality assurance. This reduction of end-item testing can be accomplished by means of a) transfer of the conduct of the three chemical resistance tests to the Inspection of Materials section, and b) replacement of the boil test by the boil-impact test of this report (Appendix III, Section D, Cans No. 107 and 112).

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APPENDIX I

RESULTS OF E[illegible]NATION OF SALVAGED CANS FOR RUSTING OF INTERIOR

("Pinpoint rust", up to about 1/64" in diam.; "rust specks", about 1/32" in diam.; "LR" line rust; "OK" no defects)

Can No.	Contractor Code	Yr of Mfr	Upper Seam (Welded)	Vertical Seam (Welded)	Bottom Seam (double seamed)	Lid	Neck (not including seam line)	Neck-Flange Seam Line	Bottom (exclusive of seam)	Body (exclusive of seam)	Head Space
1	A	51	4" L.R.	OK	OK	OK	Four small spots (1/8") above seam and four specks on flange	Five specks	2" L.R. One ¾" spot	OK (can dented in a few spots)	OK
2	A	51	Complete L.R.	OK	OK	OK	OK	2" L.R.	1/3 of one side	OK	OK
3	A	51	Complete L.R.	OK	OK	1 speck	¼" spot above seam	One speck	One area of 25 sq.in.	OK	OK
4	A	51	No rust. Apparently salvaged for mechanical reasons.								
5	A	51	OK	OK	OK	OK	Numerous small spots on flange	OK	OK	OK	OK
6	A	51	Minor L.R.	OK	OK	1 speck	OK	½" L.R.	2 sq. in. area (not impacted)	OK	OK
7	A	51	Complete L.R.	Complete L.R.	OK	OK	OK	½" L.R.	4 sq. in. area near seam	OK	OK
8	A	51	Complete L.R.	Complete L.R.	OK	OK	OK	OK	20 sq. in. in four areas	OK	OK
9	A	51	Minor L.R.	Minor L.R.	OK	OK	OK	OK	One ½" spot (not impacted)	OK (badly dented side)	OK

APPENDIX I (continued)

Can No.	Contractor Code	Yr of Mfr	Upper Seam (Welded)	Vertical Seam (Welded	Bottom Seam (double seamed)	Lid	Neck (not including seam line)	Neck-Flange Seam Line	Bottom (exclusive of seam)	Body (exclusive of seam)	Head Space
10	B	51	Complete L.R.	OK	5" L.R.	OK	1½" above seam	1½" L.R.	OK	OK	OK
11	B	51	Complete L.R.	OK	8" L.R.	OK	Ten 1/8" spots above seam	¼" L.R.	Four 1" lines	OK	OK
12	B	51	Complete L.R.	Complete L.R.	Very fine rust line	OK	OK	1½" L.R.	OK	½" spot (impacted)	OK
13	B	51	Complete L.R.	Complete L.R.	OK	1/8" spot (impacted)	2" narrow band at bottom of flange	3" L.R.	Scattered small spots and one 1 sq.in. spot	Twenty small spots	OK
14	B	51	Complete L.R.	Complete L.R.	OK	OK	½" spot below seam	2" L.R.	One ½" spot (not impacted)	OK. Bad dent on side	OK
15	B	51	No corrosion, can punctured.								
16	B	51	Complete L.R.	OK	OK	OK	OK	OK	Two ½" spots	OK	OK
17	B	51	Complete L.R.	OK	One side	OK	Several spots above seam	OK	OK	One 1 sq.in. spot	OK
18	B	51	Complete L.R. (wide band)	Complete L.R.	OK	OK	OK	Ten specks	OK	OK	OK
19	C	58	Complete L.R.	Complete L.R.	OK	4" line in recess	OK	1/8" L.R.	OK	Three small spots (dents)	OK
20	D	62	Complete L.R.	½" L.R.	OK	OK	OK	¼" L.R.	OK	OK	OK
21	D	62	Partial L.R.	OK	OK	OK	Two ¼" spots at bottom of flange	OK	OK	1" line at dent	OK

APPENDIX I (continued)

Can No.	Contractor Code	Yr of Mfr	Upper Seam (Welded)	Vertical Seam (Welded)	Bottom Seam (double seamed)	Lid	Neck (not including seam line)	Neck-Flange Seam Line	Bottom (exclusive of seam)	Body (exclusive of seam)	Head Space
22	D	62	Residue of oily gunk masked condition of coating.								
23	D	62	Complete L.R.	OK	OK (Residue of dirty, sandy water)	OK	OK	OK	OK	OK	OK
24	D	62	Partial L.R.	OK	OK	OK	Two ½" spots at bottom of flange	OK	OK	OK	OK
25	D	62	Complete L.R.	OK	OK	OK	OK	Complete L.R.	Two large spots, one at an impact dent	OK	OK
26	D	62	Complete L.R.	OK	OK	OK	OK	1" L.R.	Three ½" spots (impacted)	OK(impacted)	OK
27	D	62	Complete L.R.	OK	OK	OK	Many spots at bottom of flange	3" L.R.	OK	OK	OK
28	D	62	Complete L.R.	Complete L.R.	OK	OK	OK	Complete L.R. (faint)	OK	Faint 3/4" line	OK
29	D	64	Complete L.R.	Complete L.R.	Faint rust	Blistered (no rust)	OK	5" L.R.	OK	OK	OK

APPENDIX I (continued)

Can No.	Contractor Code	Yr of Mfr	Upper Seam (Welded)	Vertical Seam (Welded)	Bottom Seam (double seamed)	Lid	Neck (not including seam line)	Neck-Flange Seam Line	Bottom (exclusive of seam)	Body (exclusive of seam)	Head Space
30	B	51	Complete L.R.	Complete L.R. Seven peeled spots totaling approx. 3" x ¼"	OK	Border rust	OK	OK	Rusted around entire border as far as 2" from seam. 4 sq. in of other corrosion	1 sq.in. area where thinly coated on embossed "X"	OK
31	E	54	Complete L.R.	Complete L.R.	OK	Near gasket	Moderate above seam	2" line rust	Almost completely rusted	About fifty corroded spots, ranging from .1 to 1 sq. in., associated with shallow dents. Coating turned brown in one area where torch had obviously been applied.	OK
32	D	61	Complete L.R.	Complete L.R.	OK	OK	Pinhole rust in 1" x 1/8" area of flange	Six specks	OK	One ½ sq.in.area at impact pt. Another deeply impacted spot has no flaking or rust. Coating tan in one area where torch had obviously been applied.	OK

Note: Cans 1-29 were from Ft. Devens, 30-32 from Alaska.

APPENDIX II

SUMMARY OF RUST LOCATIONS AND FREQUENCY IN THIRTY-TWO SALVAGED CANS

	Location of Rust	Frequency (No. of cans)	Nature and Extent of Rusting
1.	Upper (welded) seam	28	Ranging from 4" to complete line rust.
2.	Vertical (welded) seam	14	Ranging from ½" to complete line rust.
3.	Bottom seam (rust beginning within the seam)	5	Ranging up to 8" of seam rusted.
4.	Underside of lid	6	Three cans with border rust near gasket, three with a single spot of rust.
5.	Neck (not including seam line)	13	Eight cans with rust on flange, five with rust above soldered seam. Generally, a small amount of spot rust.
6.	Neck-flange seam line (soldered)	20	Four cans had a few rust specks only, 14 had from 1/8 to 5" line rust, two had complete line rust.
7.	Bottom (exclusive of seam)	15	Ranging from one ½" rust spot to 50 sq. in. Nine cans had rusted spots of 4 sq. in. or less.
8.	Body (exclusive of seam)	9	Ranging from one ½" rust spot to 50 small rusted spots. All but one can had 1 sq. in. or less of rusted area.
9.	Head space	0	

APPENDIX III

LABORATORY PERFORMANCE TESTS ON 1965 PRODUCTION CANS
(No. cans tested = 18)

A. Tap Water Storage (at room temperature)

Can No. 1

After 4 days:	general blistering* on lid; 3/4" line rust on neck seam; 4" line rust on upper welded seam.
After 15 weeks:	more blistering on lid; blistering on body; no change on bottom and head space; 2 1/2" line rust on neck seam; 4" line rust on upper welded seam.

Can No. 105

After 1 day:	no change.
After 1 week:	no change.
After 1 month:	about 20 specks of rust on edge of neck seam; 1 speck of rust near bottom of neck flange.

Can No. 110

After 1 day:	no change.
After 3 days:	blistering in one small spot (about 1/2" square) on body.
After 1 week:	blistering increased to about 1 square inch; blistered area non-adherent to thumbnail scraping; otherwise no change.
After 1 month:	5 pinpoint specks of rust and fine cracking at edge of neck seam; blistered area on left side approximately 3 square inches.

Can No. 115

After 1 day:	no change.
After 1 week:	no change.
After 1 month:	about 3/4" of fine line rust at bottom seam.

Can No. 120

After 1 day:	no change.
After 1 week:	no change.
After 1 month:	about 2 1/2" of very fine line rust at sharp edge of neck seam.

B. Warm Water Storage (120°F, distilled water)

Procedure: The conditions of this test were the same as for the Taste Test of the can specification except that the specification requires 3 days storage.

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*Blister size was approximately 1/32 inch (ASTM No. 8 of Method D714-45) unless otherwise noted.

Can No. 5

After 1 day: general blistering of lid; much local blistering of left side of can body, in 1/8" clusters of about 6 blisters per cluster, and of parts of back of can. (Test discontinued.)

Can No. 102

After 4 days: blistering on lid (No. 9 blisters, i.e. smaller than No. 8); blistering on one small area of body; 1" line rust on upper welded seam.

After 8 days: same, plus No. 9 blistering of the neck.

After 1 month: No. 9 blistering of lid and neck; approximately 1" line rust at crevice of upper welded seam and about 2" of pinhole rust at sharp edge of upper welded seam; blistering at small area of left side of body; three 1/32" specks of rust on bottom.

C. One-cycle Boil and Storage Tests

Procedure: A can filled with distilled water was placed on a 2000-watt electric hot plate. Only the edge of the bottom seam contacted the hot-plate surface. The lid of the can was closed but, for safety reasons, was not locked. The water was brought just to a boil, then allowed to cool for five hours. The can was emptied and the interior examined for presence of rust, blisters, or other defects. After examination, the can was refilled with the same water for storage test.

Can No. 103

After 5 hour cooling: no change.

After 3 days storage: general blistering (size No. 9) on lid; 13 pinpoint specks of rust on upper welded seam.

After 7 days storage: no change except one 1/16" spot of rust just below upper welded seam.

After 1 month: blisters on lid receded; 13 pinpoints of rust on shoulder seam; 1/8" spot of rust just below upper welded seam; 1/2" line rust on bottom seam; one 1/16" x 1/32" line of rust on bottom.

Can No. 104

After 5 hour cooling: general blistering (size No. 8) on lid and neck; one 1/2" rust spot at bottom of neck flange; portion of head space blistered; three spots of coating peeled away from body adjacent to bottom seam (the peeled spots were 1", 1/2", and 1/2" in size); the area around the peeled spot for a distance of about an inch showed poor adhesion to scraping by thumbnail.

Can No. 104 (contd)

After 1 day storage:	same as above; also 1/2" line rust and five pinpoints of rust on shoulder seam.
After 1 week:	same as above; area of poor adhesion around peeled spots was further enlarged; when tested by knife-blade, entire left side had poor adhesion whereas right side had good adhesion.

Can No. 111

After 5 hour cooling:	no change.
After 1 week storage:	no change.
After 1 month:	fine pinhole rust at one portion of neck seam, equal to about 1/4 of periphery; 1" line rust on upper welded seam; 1/2" line rust at bottom seam.

Can No. 106

After 5 hour cooling:	blistering (No. 8 size) on lid; otherwise no change.
After 1 month storage:	no further change.

Can No. 116

After 5 hour cooling:	blistering (No. 8) on lid and neck; five spots of coating peeled away from body, adjacent to bottom seam, similar to Can No. 104. (Test discontinued.)

D. Impact Tests, Followed by Water Storage

Can No. 4

Procedure: An 8-lb. steel ball was dropped from a 5-foot height onto the broad side of a can resting on the floor. Impacts were made after conditioning the can overnight at 75°, 40°, and 0°F. Examination of the coating was made after impact and after subsequent storage with tap water.

After impact:	no change in coating.
After 3 days water storage:	blistering (No. 8 size) on lid; two 1/16" specks of rust and a 3/8 x 1/16" spot of rust at 0°F impact point.
After 2 months storage:	blistering (1/16" in size) on lid; two pinpoints of rust on neck seam; 1/2" line rust on upper welded seam; 1/8" spot of rust at top of side seam; no change in rust at 0°F impacted spots, but now surrounded by blisters.

Can No. 2

Procedure: A 2-lb. steel rod, with the impacting end rounded into a 1/2" diameter curvature, was dropped at room temperature through a guide tube from a 10" height onto the broad side of the can resting on the floor. The can was similarly impacted on the bottom, with the can placed upside down. Note: Although the resulting dimple in the metal was small, the stress on the coating was concentrated, and thus this test was rated as more severe than when the can was more severely dented from the 8-lb. steel ball.

After impact:	no breaks in the coating.
After 1 week water storage:	blistering (No. 8) on lid; 1" line rusting at neck seam; no other change.
After 14 weeks water storage:	more blistering of lid, including some about 1/8" in size; line rust on one-half of neck seam (edge of metal has several cracks which are rusted); 1" and 1/2" band rust at bottom of flange.
After 4 months storage:	lid badly blistered; line rust on half of sharp edge of neck seam; one 1/8" spot of rust and 1" line rust on upper welded seam. The can was then impacted (2 lb. rod, 20 in-lbs.) in 20 places about the body and bottom with no resultant cracking, flaking, or roughening.

Can No. 3

Procedure: The can was impacted at five locations each at room temperature, 40°F, and 0°F, as Can No. 2 above, after conditioning overnight at each temperature.

After impact:	no effect in room temperature impacting and in all but one impact point at 40°F; about 1/8" spots of enamel flaked off in the 0°F impact spots in all except one spot.
After tap water storage for 3 days:	blistering on lid (No. 9); 12 specks of rust on neck seam; no other change except slight rust at flaked impact points.
After 5 weeks storage:	more blistering on lid; more rust specks on neck seam; about 20 rust specks at bottom of neck flange; 6" line rust on upper welded seam.
After 4 months storage:	badly blistered lid; two specks of rust on lid; numerous large rust specks at cracks in the metal at neck seam; about 15 specks of rust on neck below seam; two 1/16" spots of rust and 2" line rust on upper welded seam; 1/16" rust spot at 3 of the 4 0°F impact points; rust spot about 1 x 1/4" and fine blisters at front end of can; two rust spots at 0°F impact points on bottom.

Can No. 107

Procedure: The can was impacted at room temperature in the same manner as Can No. 2. After impact examination, the 1-cycle boil test (Section C above) and the distilled water storage test were conducted.

After impact:	no change.
After 5 hour cooling:	no change.
After 1 week storage:	no change.

Can No. 112

Procedure: Same as Can No. 107 above.

After impact:	no change.
After 5 hour cooling:	no change.
After 1 week storage:	12 pinpoints of rust and 3/4" line rust on shoulder seam; no other change.

E. Salt-Water Aeration Test

Can No. 101

Procedure: The can was subjected to the salt water aeration test of the specification (3 days air bubbling in a 0.5% sodium chloride solution).

Condition of can before test:	At two points of the border of the bottom of the can there were two damaged areas of paint (as though the paint had been scraped off prior to attaching bottom).
After 3 days storage of salt water, including aeration:	No change in the coating; rust formed at the two bared metal areas present in the can at start of test.

APPENDIX IV

SUMMARY OF RUSTING AND BLISTERING IN WATER-STORAGE TESTS OF NEW CANS

	Type and Location of Defect	No. of Days of Water Storage	No. of Cans Tested	No. of Cans With Defect
1.	Line rust on upper welded seam	1	18	1
		7	15	5
		30	12	5
2.	Line rust on vertical seam	1	18	0
		30	12	0
		60	4	1
3.	Line rust on bottom seam	7	15	0
		30	12	3 (maximum defect is 3/4" line rust)
4.	Blisters on lid	1	18	4
		4	14	8
		30	12	10
5.	Blisters on neck	1	18	2
		30	12	3
6.	Rust on neck (exclusive of soldered seam)	1	18	1
		30	12	2
7.	Rust on soldered neck seam	7	15	3
		30	12	7
8.	Rust on bottom	7	15	1 (production damaged can)
		30	12	2 (maximum 3 specks of rust)
9.	Blisters on body	1	18	3
		7	15	5
		30	12	5
10.	Rust on body	1	18	2
		7	15	3
		30	12	3
11.	Blisters on head space	1	18	1
		30	12	1
12.	Rust on head space	30	12	0
		60	4	0

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13. ABSTRACT

A study has been made of the occurrence of interior corrosion in the steel five-gallon military water can. The study covered used as well as new cans. It was found that much of the rusting is attributable to excessively sharp edges at lap seams, creating a condition that coatings generally cannot be expected to overcome. Other rusting was found to be of limited extent and to vary in location from can to can. The exact cause of this variable corrosion was not proven, but the condition is characteristic of that commonly resulting from locally inadequate surface preparation. It is concluded that the specification should be revised to include a) smoothing of seam edges, b) more frequent testing, and c) simplification of some of the tests so that they will be more amenable to frequent application.

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