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AUTHORITY

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U.S. COAST GUARD
TESTING *and* DEVELOPMENT DIVISION

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REPORT

FIELD TESTING AND DEVELOPMENT CENTER

REPORT NO. 407

PROJECT 3982/02/0[illegible]

CORROSION TEST OF GASOLINE SAFETY CANS

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12 FEB 1965

FIELD TESTING AND DEVELOPMENT CENTER

PROJECT 3982/02/02

CORROSION TEST OF GASOLINE SAFETY CANS

By

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Date: 12 FEB 1965

Submitted: ____________________
P. O. CHAPMAN, CDR, USCG
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Authority: This project was performed under the authority of Comdt(ETD) ltr 3982/02/02 Ser 1086 of 26 October 1964.

ABSTRACT

This project covers the exposure of six (6) different flammable liquid containers to a 240-hour salt spray environment. Five (5) of the containers were fabricated of steel with various protective coatings including terne-plate, hot tin dipped and galvanized. One container was fabricated of stainless steel with no protective coating. The purpose of this project was to determine the relative corrosion resistance of these containers in such an environment.

The test results confirmed theory in that the stainless steel was most resistive; the galvanized coating protected the base metal with an associated calcareous deposit on the coating; the base metal corroded wherever breaks existed in the terne-plate and hot tin dipped coatings.

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1. INTRODUCTION:

Current instructions on the handling and stowage of gasoline require the use of safety cans. The safety cans in current use were purchased by the Coast Guard under Federal Specification RR-S-30A. The cans built to this specification are made from terne-plate. This is a coating applied in the course of the plate manufacture and is an alloy of approximately 4 parts lead to 1 part tin. A limited number of these cans have failed in service as the result of localized pitting occurring on the interior of the cans where the protective coating has been broken in fabrication. As a result of these failures it was suggested that hot tin dipped containers be used and some cans of this construction are now in the Coast Guard Supply System.

The value of the hot tin dipped coating was questioned because such a coating is normally porous and the maximum coating thickness obtained in production is approximately .0015 inches. Since both terne-plate and tin are cathodic with respect to the base steel of the container, theory indicates localized corrosion of the base steel would occur at a break in the coating in a salt-laden atmosphere. On the other hand, a coating which was anodic with respect to the steel would provide protection even if a break did occur. Since zinc is anodic with respect to steel, this would indicate a galvanized coating would provide greater protection. The purpose of the project was to compare the relative corrosion resistance of a number of cans with different protective coatings, including terne-plate, hot tin dipped and galvanized when subjected to a 240-hour salt spray test.

2. MATERIALS TESTED:

A total of six cans were tested. These cans are identified as follows:

CAN A - A galvanized oil can of 5-gallons capacity. Seamless drawn from hot dipped, 26-gauge steel. Exterior surface painted yellow. Fitted with a fill cap, pour spout with cap and wood carrying handle. No screens or strainers or spring loaded closures - not a "safety" can. Manufactured by Eagle Manufacturing Company, Wellsburg, W. Va. and identified as their No. 405-NS. Procured from CG YARD Supply at a cost of $2.75. This can is shown on the left in Figure 1.

CAN B - Manufactured by Protectoseal Company, Chicago, Illinois. A heavy, well built safety can, 5-gallon capacity, No. 4615. This can has a single top opening with spring loaded cap. Spout is fitted with an internal screen of fine mesh referred to as a "fire baffle". This can has the Underwriters' Laboratory label soldered on and the Factory Mutual diamond marking embossed.

This can is hot tin dipped and has no other coating. It is not seamless drawn but is rolled up and has a vertical seam and circumferential seams at top and bottom. Top and vertical seams appear to be seam welded and bottom seam rolled with an additional retaining ring soldered at the bottom. The lever for lifting the gasketed cap against spring force is riveted to the can lifting handle which itself is not movable. This can is available from the CG Supply Center, Brooklyn, New York, under stock no. CG-7240-600-1833 for $17.46. This can is shown in the center of Figure 1.

CAN C - This can, manufactured by Eagle Manufacturing Company, is a 5-gallon safety can with the UL label spot welded on and the FM diamond embossed. The single filling and pouring spout has a spring loaded, gasketed cap which is operated by the lifting handle when a notched lever from the cap is depressed to engage a fixed pin in the movable handle. This can has a seamless drawn body with a crimped circumferential seam at the top, possibly seam welded. Can material is 24-gauge terne coated steel and can exterior is painted red. There are no screens or flame arrestors. This can was procured commercially at a cost of $7.16. This can is shown on the right in Figure 1.

CAN D - This is a 5-gallon safety can manufactured by Protectoseal Company, Chicago, Illinois. This is a hot tin dipped can described as having one coat of gasoline resistant red enamel over one coat of zinc chromate primer. There are two top openings, one fill and one pour - both spring loaded and gasketed. This can is fitted with a brass flexible spout and brass fire baffle. The body of the can is rolled with a vertical welded seam and circumferential welded seam at the top. The bottom section is recessed, flanged down and rolled up with body. A heavy gauge supporting ring is spot soldered to the bottom of the can. The UL label is soldered on and the FM diamond is embossed. This can was forwarded to FT&DC from Coast Guard Headquarters and its cost is unknown. Can D is shown on the left in Figure 2.

CAN E - This can was procured from the Just-Rite Manufacturing Company, Chicago, Illinois. It is a 5-gallon safety can with body of non-magnetic stainless steel. The can body is rolled up with a vertical seam and circumferential seams at top and bottom, all soldered on the outside. The single fill and pour spout, the base support ring and handle are of steel, not stainless. There is no paint or other finish applied to this can. The UL label is soldered on and the FM diamond is embossed. The cost of this can was $27.72. The spout is fitted with a fine mesh woven wire screen, non removable, which appears to be made from stainless steel wire. This screen extends into the can body approximately three inches. This can is shown on the right in Figure 2.

CAN F - This can, manufactured by the Protectoseal Company, was forwarded to FT&DC from Coast Guard Headquarters and its cost is unknown. It is a galvanized 5-gallon can, unpainted, with a brass fire baffle and brass flexible spout. This can is shown in Figure 3. Except for the coating of galvanize rather than tin and paint, it appears to be identical to Can D.

3. TESTS CONDUCTED:

All cans were checked for ease of handling, liquid tightness, empty weight and thickness of coating, where applicable. Empty can weights were as follows:

CAN	WEIGHT
A	4 lbs. 5 oz.
B	8 lbs. 14 oz.
C	6 lbs. 2 oz.
D	11 lbs. 0 oz.
E	6 lbs. 12 oz.
F	11 lbs. 4 oz.

Each can was filled with water and tipped upside down as a check of the spring loaded fittings. There was no leakage from any of the cans. Can B was considered easiest to hold open and pour from.

To permit a comparison of internal and external corrosion resistance among the six cans, they were cut open with a power saw. Two sections of each can were used for salt spray exposure. One section contained the UL label, the lifting handle and all top fittings. The other section, made by a vertical cut through the can, consisted of top, body and bottom with no fittings. Coating thicknesses before exposure were measured using an Elcometer dry film thickness gauge. Results were as follows:

CAN	EXTERIOR	INTERIOR
A	3.5 mils	1 mil
B	1-2 mils	1-2 mils
C	1 mil	$<$1 mil
D	3-4 mils	$<$1 mil
E	No coating	
F	2 mils	2 mils

A salt spray test was conducted in accordance with ASTM-B-117-57T. Specimen positions were changed daily and photographs taken whenever significant differences were observed. Since the salt spray cabinet is not large enough to contain all twelve specimens at one time, a series of three tests was required. One test period consisted of 238 hours of exposure, the other two periods were 240 hours each.

4. RESULTS OF SALT SPRAY:

a. After approximately 24 hours:

CAN A - (galvanized) - No corrosion but interior galvanized coating covered with loose, paste-like coating which also covers all cut edges.

CAN B - (hot tin dipped) - Considerable corrosion at seams and cut edges, some rusting apparent on fire baffle.

CAN C - (terne plate) - Corrosion showing on handle, on spot welds on inside and on seams and cut edges. Exterior painted surface is good.

CAN D - (hot tin interior, red paint exterior) - Corrosion showing at internal seams and cut edges, staining on brass fittings, exterior paint looks good.

CAN E - (stainless steel) - Heavy gauge metal of spout and base reinforcing ring are rusting, otherwise no corrosion.

CAN F - (galvanized) - Same appearance as Can A plus rusting of ring around fire screen and base reinforcing ring.

b. After approximately 138 hours:

CAN A - As before but calcareous deposit more extensive. Also, yellow paint beginning to flake off.

CAN B - Pronounced corrosion at seams, cut edges and handle.

CAN C - Handle, cut edges and rivets are slightly rusted.

CAN D - Seams, cut edges and screws attaching brass hose nozzle - all badly rusted. Red enamel coating still glossy and unbroken.

CAN E - Handle and spout badly rusted. White deposit along exterior seams. Interior shows few spots of brown stain.

CAN F - Heavy calcareous deposit on cut edges, ring around fire screen and base ring rusting heavily. Working parts of handle and nozzle coated with corrosion products but still operable.

c. After approximately 240 hours:

CAN A - Yellow paint exterior coating nearly all flaked off. Very extensive loose, calcareous deposit throughout and some rust staining on bottom of can interior and near the fill cap.

CAN B - Extensive corrosion at seams, cut edges and handle. Body of fill tube the only part not showing rust.

CAN C - Extensive corrosion of handle and working parts, rivets and cut edges. Interior of can body has only slight rust. Red paint surface still intact.

CAN D - Extensive corrosion at seams and cut edges. Working parts are now inoperable and coated with white deposit. Green corrosion products on brass and copper parts. Exterior paint remains unbroken and glossy.

CAN E - Handle, pour spout, spring, base ring all badly rusted. White corrosion product on exterior seams. Interior shows slight stain in a few places.

CAN F - Very heavily coated with zinc corrosion products. All working parts are inoperable. Ring around fire baffle and base reinforcing ring are badly rusted.

5. DISCUSSION OF RESULTS:

The galvanized coating of Cans A and D afforded cathodic protection to the cut edges where the base metal was exposed. This continued until the end of the test at which time the galvanized coating was nearly depleted and rust was forming in some spots. The heavy, loose whitish deposit was presumably zinc carbonate.

The corrosion which appeared quickly at the seams of the terne plate and tin dipped containers indicated that these coatings were either perous or damaged during manufacture. In this respect the hot tin dipped container was the worst.

Of the surfaces tested, the most resistant to attack by the salt spray was the glossy red enamel surface of Can D. The next most resistant was the red painted surface of Can C. There was very little attack evident on the stainless steel of Can E and it seems likely that this would be the best interior surface for a gasoline container kept in a mariner atmosphere.

6. CONCLUSIONS:

Based on resistance to salt spray alone the can which showed the least overall corrosion (interior and exterior) was the stainless steel safety can manufactured by the Just-Rite Manufacturing Company of Chicago, Illinois.

APPENDIX A

PHOTOGRAPHS

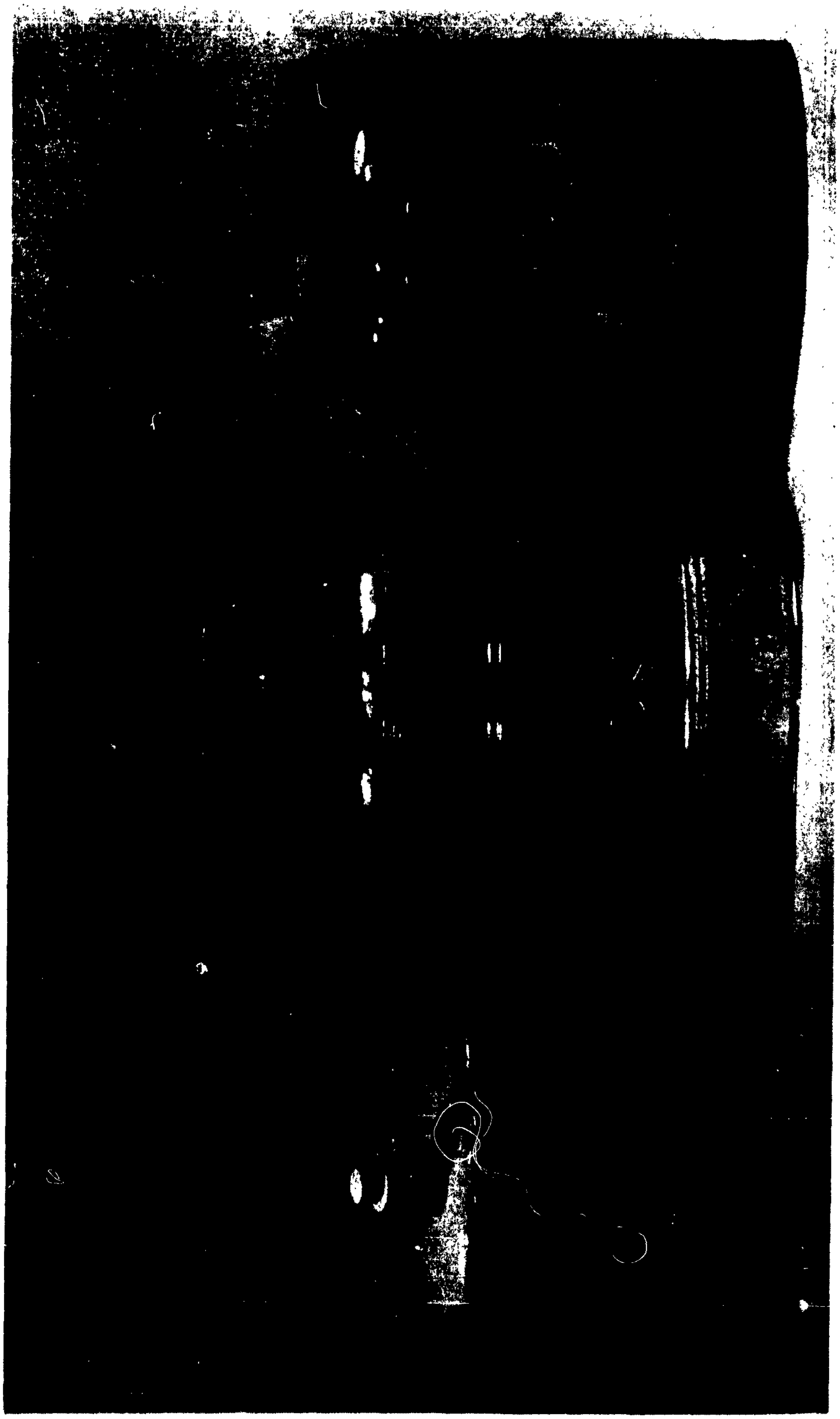

FIGURE 1

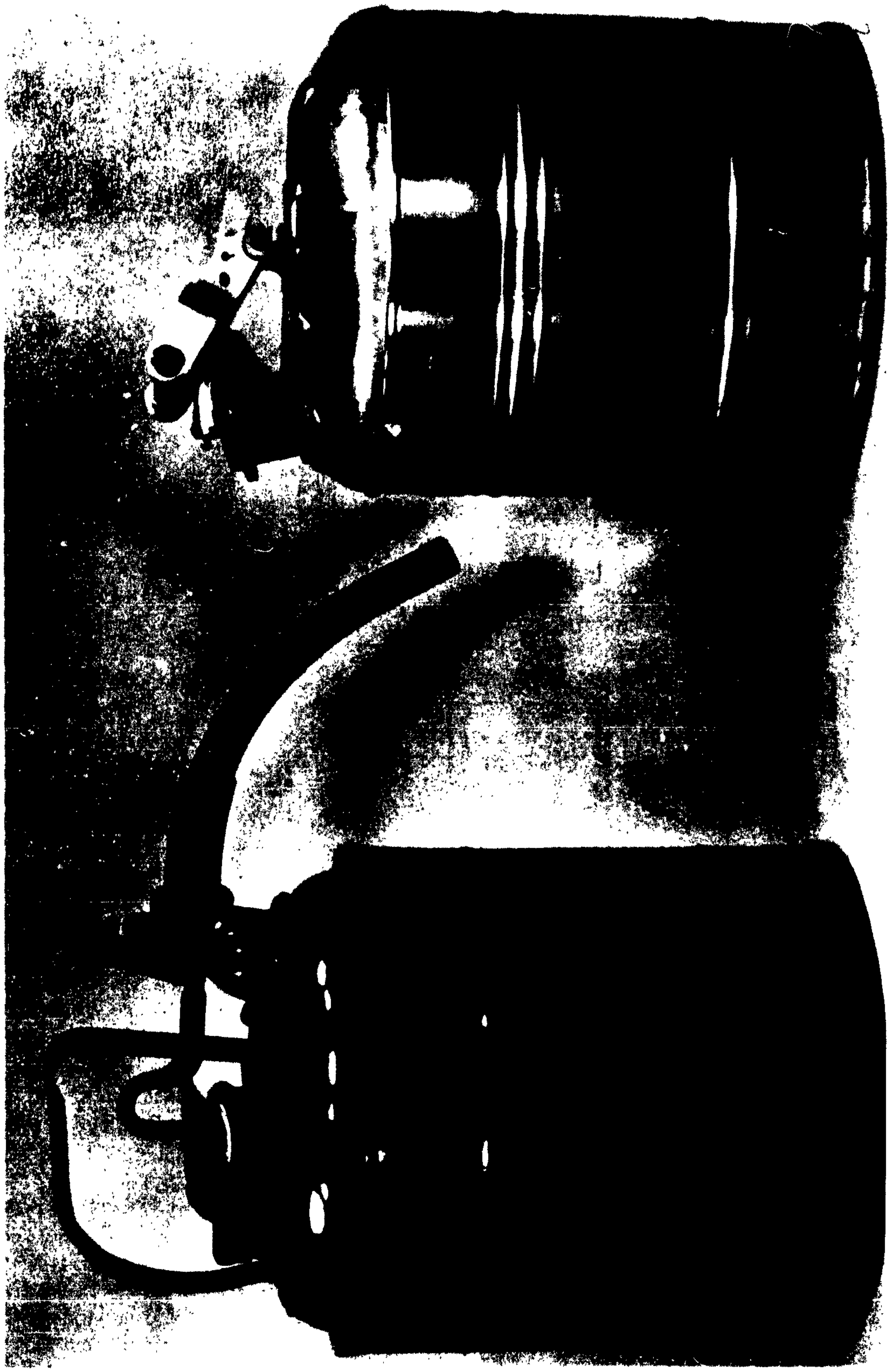

FIGURE 2

FIGURE 3

FIGURE A-1 - Sections from Cans A, B & C before exposure.

FIGURE A-2 - Cans A, B and C after 27 hours.

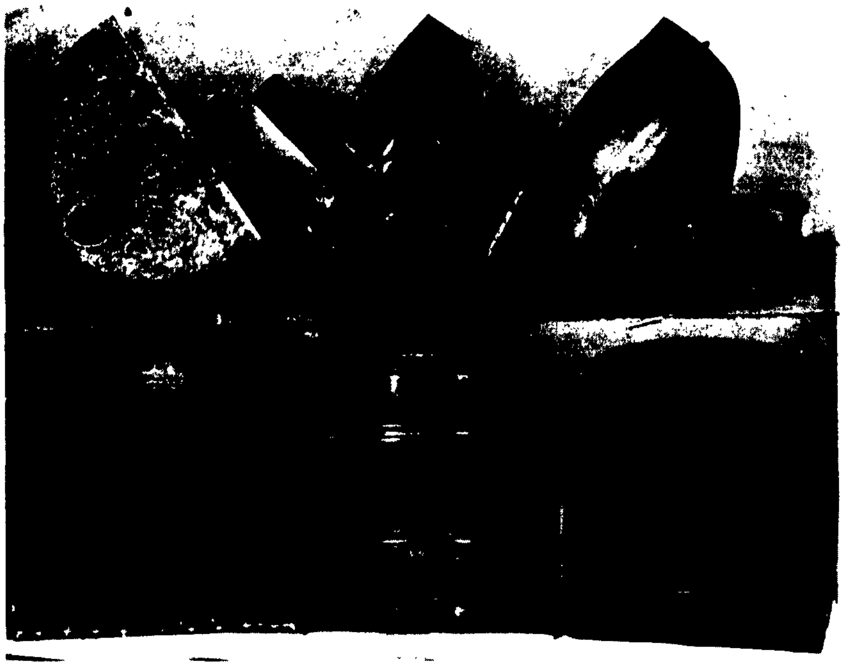

FIGURE A-3 - Cans A, B and C after 138 hours.

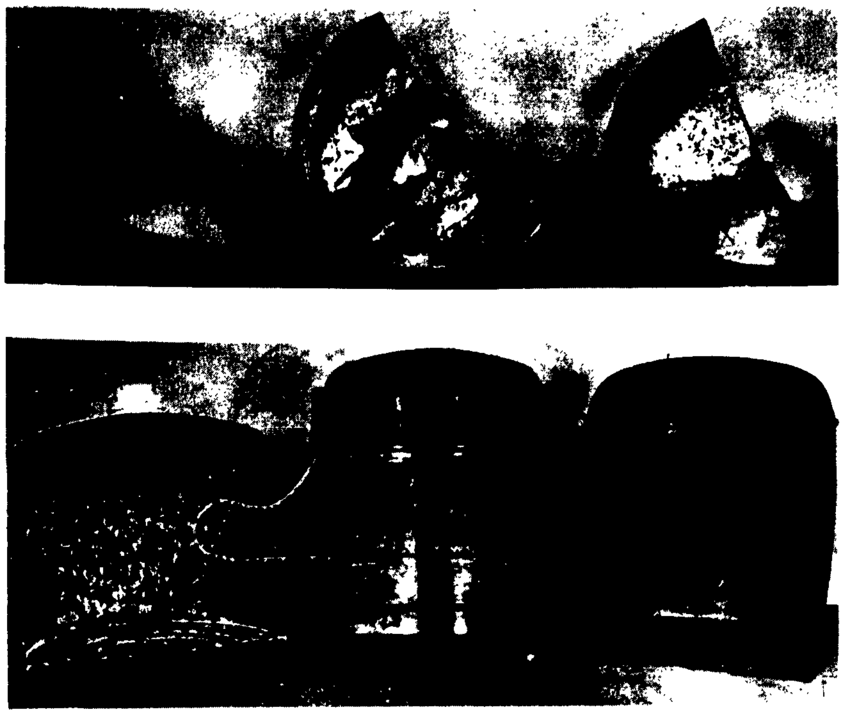

FIGURE A-4 - Cans A, B and C after 238 hours

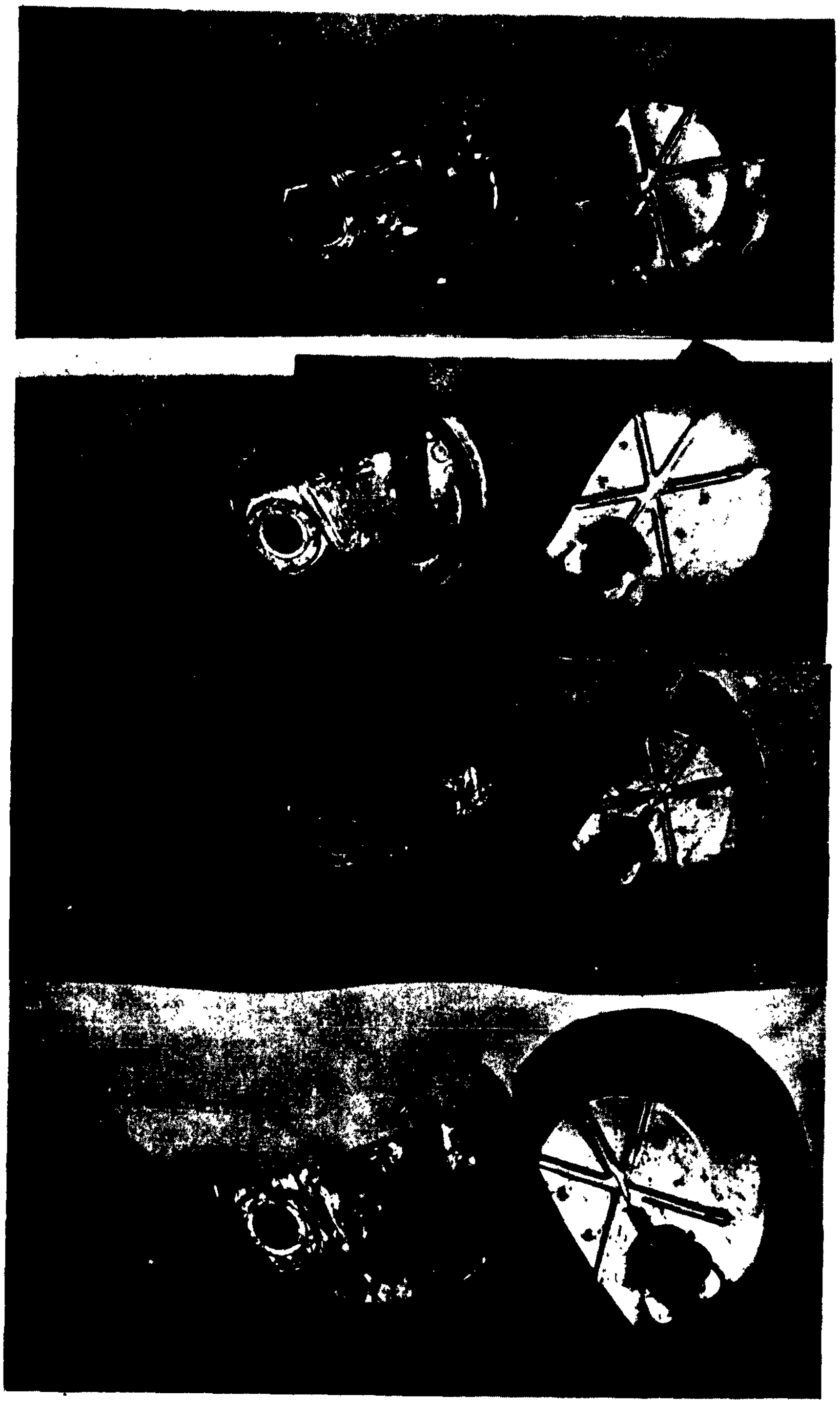

FIGURE B-1 - Showing progressive corrosion during test period - Cans D and E.

top - before exposure
2nd from top - after 24 hours
3rd from top - after 138 hours
bottom - after 240 hours

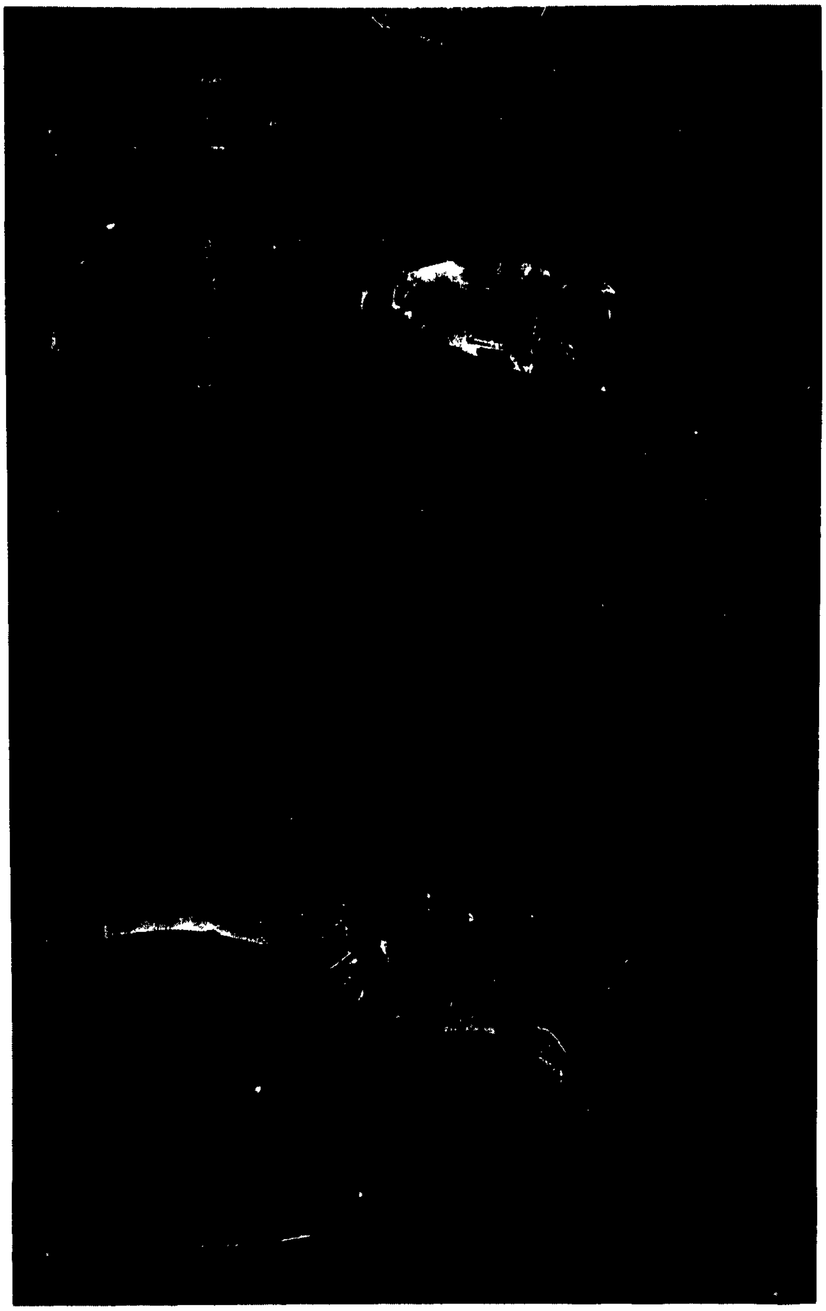

FIGURE B-2 - Progressive stages of exposure of Can F.

top - before salt spray
Center - after 80 hours

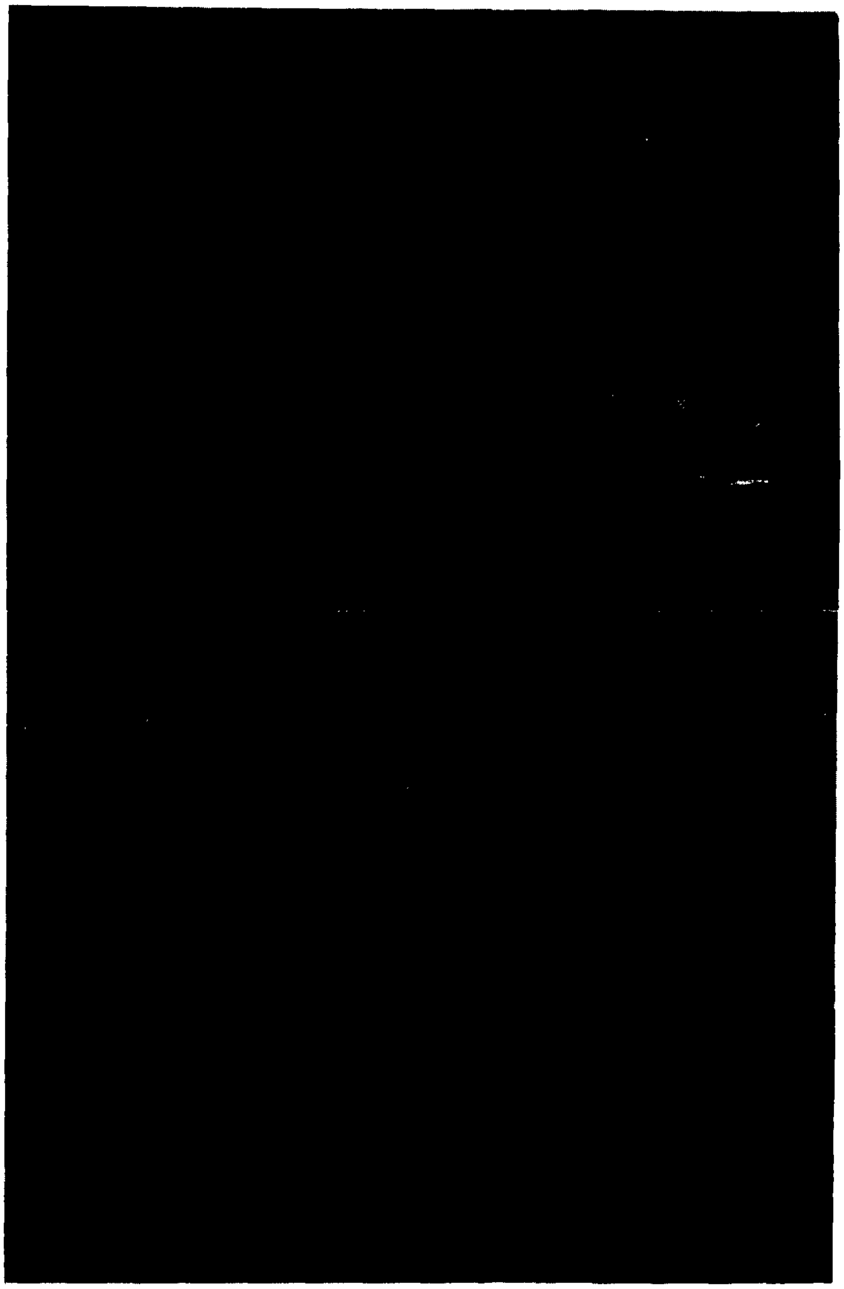

FIGURE B-3 - Top view: Cans D & E after 240 hours.
Bottom view: Can F after 240 hours.