EVALUATION OF A FREEZING POINT TEST KIT FOR ANTIFREEZE

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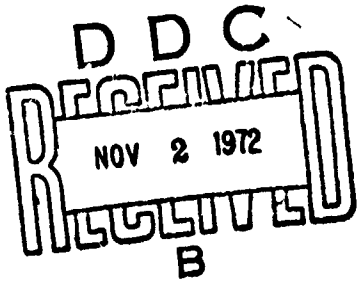
BY

CHARLES B. JORDAN

SEPTEMBER 1972



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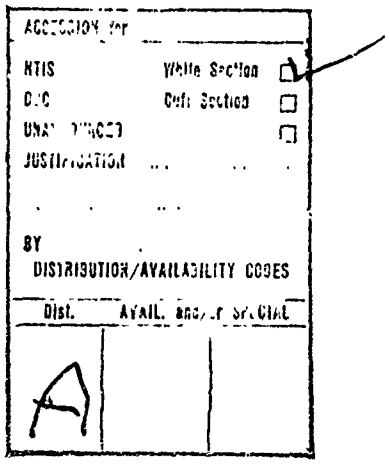

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The object of this study was to evaluate a test kit for the determination of the freezing point of antifreeze solutions in the field.

The kit consists of a plastic strip 3-1/4 inch by 1/4 inch with a dry reagent pad 1/4-inch square attached to one end. The reagent pad is chemically impregnated so that it changes color when dipped into various concentrations of ethylene glycol. The kit was tested in the laboratory with various antifreeze solutions. It was also tested on the antifreeze in approximately 90 military vehicles selected at random at Aberdeen Proving Ground, Maryland.

These preliminary studies show that the kit would have some value as a test item in the field. Its value would be limited by its accuracy range and interference by fluorescent dyes and discolored solutions.

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The kit consists of a plastic strip 3-1/4 inch by 1/4 inch with a dry reagent pad 1/4-inch square attached to one end. The reagent pad is chemically impregnated so that it changes color when dipped into various concentrations of ethylene glycol. The kit was tested in the laboratory with various antifreeze solutions. It was also tested on the antifreeze in approximately 90 military vehicles selected at random at Aberdeen Proving Ground, Maryland.

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I. INTRODUCTION

Prior to 1968, it was Army policy to determine the freezing point of antifreeze solutions in the field by means of a hydrometer type freezing point tester. A study conducted in 1968 and reported in CCL Report No. 245 compared all antifreeze freezing point testers and resulted in the recommendation that the Prestone Vu-Chek Antifreeze and Battery Tester replace the specific gravity hydrometer as the standard instrument for determining freezing points of glycol antifreeze solutions in military vehicles. This refractometer is accurate, self-contained, sturdy, rapid, easy to use, and easy to keep clean. Hydrometers were found to be relatively inaccurate, difficult to read and use correctly, and hard to clean. Subsequently, the Vu-Chek refractometer was placed in the Federal Supply system (FSN 6830-105-1418) and is being widely used.

The Ames Division of Miles Laboratories, Elkhart, Indiana, had previously developed a test kit for the determination of potential corrosion in antifreeze solutions. This kit consisted of a plastic strip with an impregnated reagent pad attached to one end (Ref. 5). Using this principal, and in the interest of supplying a simple device for measuring freezing point which could be carried in each vehicle, they impregnated the pad with a chemical which changes color at various concentrations of ethylene glycol. By making use of a color chart which correlates glycol concentration with freezing point, the freezing point of the antifreeze can be determined by dipping the test reagent pad into the antifreeze and matching the resulting color with the chart.

Since this type of test would be very inexpensive, it was considered advisable to evaluate it for possible inclusion in the tool kits of military vehicles.

This report includes the details and results of the preliminary evaluation of this test kit.

II. DETAILS OF TEST

A. Test Kit.

1. Composition (See Photo No. 1).

a) The test strip is a plastic strip 3-1/4 by 1/4 inch with a dry reagent pad 1/4 inch square attached to one end. The reagent pad is chemically impregnated so that it is sensitive to the concentration of ethylene glycol. It is initially yellow in color and turns to various shades of light green to light blue as the glycol concentration increases. Color charts can be established to any desired reference point. The charts which were used in the tests conducted by this Laboratory contained reference points at +10°, 0°, -10° and -30°F.

b) The strips were packaged in an amber glass or HD polyethylene bottles. A desiccant was inclosed within each bottle.

2. Instructions for Use.

a) Dip the strip in the coolant and remove immediately.

b) Match the reagent pad color to the color chart.

c) Read the freezing point indicated.

(Estimates may be made for colors between the reference colors on the chart.)

B. Tests Conducted.

1. Laboratory Tests.

Thirty ethylene glycol antifreeze solutions were prepared at concentrations which gave freezing points from +26° to -70°F. Antifreezes from six commercial and three military sources were used. Five automotive mechanical and field maintenance personnel were invited to test each solution with the test strips and give their opinion of the freezing point of the antifreeze solutions. The results of this test are tabulated in Table I.

2. Vehicle Tests.

Two technicians were stationed at one of the post facilities used for servicing military vehicles. Tests were conducted on samples from approximately 90 vehicles which came for service over a two day period. The freezing point of each sample was determined by one technician using the antifreeze and battery tester (refractometer). The second technician determined the freezing point by the test strip. Results are included in Table II. No attempt was made to obtain the vehicle history. Vehicles were chosen at random without regard to type or year.

III. RESULTS OF TESTS

An examination of Table I will show that of those values which fall within the freezing point range of the test, only 6.6% of the recorded values deviate from the refractometer freezing point by more than 10°F.

In the vehicle survey 9.6% of the values which could be measured deviated from the refractometer freezing point more than 10°F. In the majority of the cases where deviation over 10°F. was recorded, rust masked the color change of the test strip. In addition, 16.8% of the antifreezes samples contained so much rust that it was impossible to determine the color of the strip.

IV. DISCUSSION AND CONCLUSIONS

The results of the two tests conducted during this study shows that the test strip would have application when used to test clean antifreeze solutions. If the solutions are rusty the results are masked. Cooling systems of military vehicles which are properly maintained in line with requirements spelled out in TB 750-651, dated January 1971, should not contain rust, so the strip would give a rapid and inexpensive estimation of the freezing point of the antifreeze. If the freezing point test strip was used in conjunction with the corrosion test strip, field maintenance personnel could readily detect improper antifreeze coolant. The ±10°F. accuracy found in the tests conducted in this study would limit the usefulness of the freezing point strip and would be the governing factor concerning its military application.

The fluorescent dye used in the Arctic Antifreeze (MIL-A-11755) also masks the color change of the strip, so it would not have application in areas where the Arctic antifreeze is used.

V. REFERENCES

1. TB 750-651, "Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems", 22 January 1971.

2. Military Specification MIL-A-46153, "Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package", 19 October 1970.

3. Military Specification MIL-A-11755, "Antifreeze, Arctic Type", 20 September 1967.

4. CCL Report No. 245, "Evaluation of Antifreeze Freeze Point Testers", January 1968.

5. CCL Report No. 289, "Evaluation of an Antifreeze Corrosion Test Kit", February 1971.

APPENDIX A

TABLE I

Comparison of Refractometer Freeze Point Values With Dipstick Values - Non-Technical Personnel

Antifreeze	Color	Conc.	Sample No.	Refractometer Freeze Pt., °F.	Operator No. 1	2	3	4	5
Commercial A	Blue-green	10%	1	+26	+10	+10	+'	+10	+10
		30%	2	+ 3	0	0	.)	+ 5	- 5
		50%	3	-35	-20	-20	-30	-30	-30
Commercial B	Fluorescent Green	20%	4	+15	+10	+15	+ 5	+ 5	+ 5
		40%	5	-12	-15	-25	-20	-25	-20
		60%	6	-50	-30	-30	-30	-30	-30
Commercial C	Blue-green	50%	7	-35	-30	-20	-30	-30	-30
		30%	8	+ 4	0	+ 5	0	+ 2	+10
		10%	9	+24	+10	+10	+10	+15	+10
Commercial D	Blue-green	60%	10	-50	-30	-30	-30	-45	-30
		40%	11	-11	-12	- 5	-20	-12	-10
		20%	12	+15	+ 5	+10	+10	+11	+10
Commercial E	Green	30%	13	+ 2	- 5	- 5	- 5	0	0
		10%	14	+24	+1'	+10	+10	+15	+10
		50%	15	-3'	-30	-27	-30	-40	-30
Commercial F	Blue-green	40%	16	-13	-13	-22	-10	- 5	- 5
		20%	17	+15	+ 6	+12	+15	+10	+10
		60%	18	-50	-30	-32	-30	-35	-30
MIL-A-46153	Blue-green	10%	19	+24	+10	+ 9	+10	+ 8	+20
		20%	20	+15	+ 6	+ 8	+10	+ 2	+10
		30%	21	+ 5	- 3	- 7	0	- 5	- 5
		40%	22	-11	-15	-14	-20	-12	- 5
		50%	23	-32	-30	-26	-30	-32	-20
		60%	24	-50	-30	-30	-30	-30	-30
O-A-548 Type I + Inhibitor	Blue-green	20%	25	+15	+ 8	+13	+10	+15	+10
		10%	26	+23	+10	+16	+20	+20	+20
		30%	27	+ 4	- 2	- 3	-10	0	- 5
O-A-548 Type I	Blue-green	60%	28	-50	-30	-27	-40	-30	-30
		50%	29	-28	-25	-15	-2(	-30	-20
		40%	30	-10-	-12	- 7	-15	-20	- 5

NOTE: Some operators preferred to estimate values between those listed in the dipstick chart.

TABLE II

Refractometer Freeze Point Versus Dipstick Freeze Point

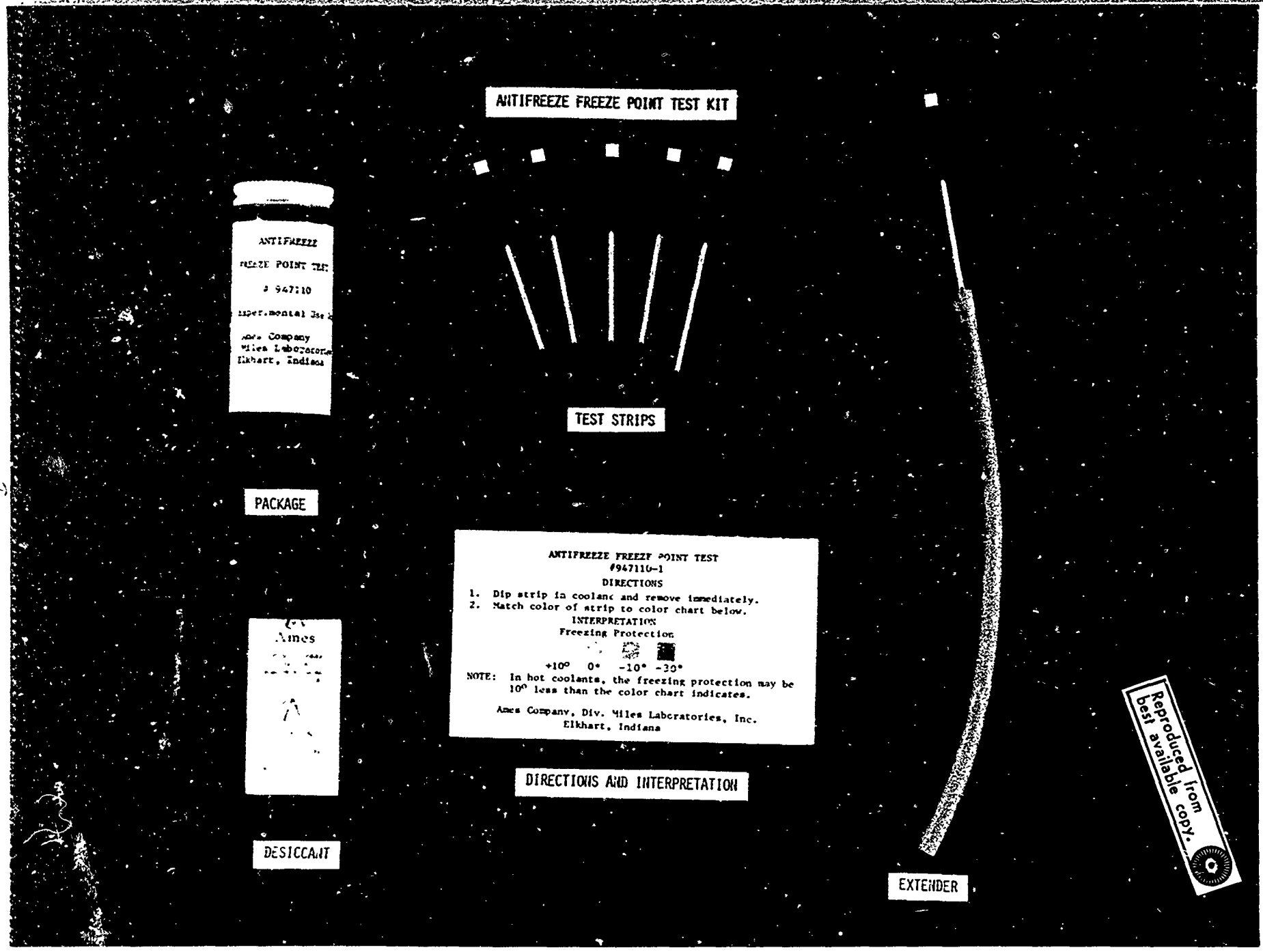
Vehicle No.	Refractometer Freeze Point, °F.	Dipstick Freeze Point, °F.
752	- 5	-10
228	-48	<-30
632	-21	-10
375	- 1	- 5
802	- 3	+ 5
324	-14	-10
Fork Lift	<-50	<-30
134	+23 (Rusty)	+10
871	-10	-10
265	-29 (Rusty)	-10
806	-34	<-30
433	-25	-30
771	<-50 (Rusty)	Brown
852	+10 (Rusty)	Brown
38	-30 (Rusty)	Brown
679]	-10 (Rusty)	>+10
978	-18	-25
318	-15	-25
807	-21	-30
842	-20	-30
596	-45	<-30
623	<-50	<-30
432	-40	<-30
669	+25	>+10
874	<-50	<-30
866	+18	>+10
600	-20 (Rusty)	-20
868	<-50	<-30
564	-30 (Rusty)	Brown
353	- 5	-10
541	-10 (Rusty)	Brown
189	+24	>+10
43	+32 (Rusty)	Brown
169	- 8	-10
539	<-50	<-30
241	+32 (Rusty)	>+10
2519	-35	<-30
869	0 (Rusty)	-10
621	+ 8	+ 5
995	<-50	<-30
664	<-50	<-30
559	-27	-30
645	<-50	<-30

TABLE II - Continued

Vehicle No.*	Refractometer Freeze Point, °F.	Dipstick Freeze Point, °F.
732	+27 (Rusty)	Brown
P14	-21 (Rusty)	-10
165	<-50 (Rusty)	Brown
638	-15	- 6
219	<-50	<-30
224	-20	-22
225	-36	<-30
2572	-25	-30
79	<-50	<-30
103	-22	-10
574	-51	<-30
583	-40	-30
592	+15	+10
536	-25 (Rusty)	Brown
636	-45	<-30
54	-20	-30
74	-40	<-30
33	+28 (Rusty)	Brown
2514	<-50	<-30
794	-12	-20
204	+32 (Rusty)	Brown
953	+21	+10
235	+20	>+10
168	-16	-20
230	- 5	0
46	-16	-30
307	-50	<-30
675	+30	<+10
847	-50	<-30
617	<-50	<-30
744	+16	>+10
713	-25	-30
963	-31	<-30
544	<-50	<-30
2540	+13	+10
862	-15	-20
755	- 5	-10
298	-25	-30
678	+19	>+10
850	0	-10
631	+20 (Rusty)	Brown
651	+30 (Rusty)	Brown
286	-35	-30
305	+ 6	+10
771	<-50 (Rusty)	Brown
150	-10 (Rusty)	Brown

NOTES: Brown - impossible to interpret.
Antifreeze samples taken from Army vehicles at Aberdeen Proving Ground, Maryland.

APPENDIX B


ANTIFREEZE FREEZE POINT TEST KIT
TEST STRIPS
PACKAGE
ANTIFREEZE FREEZE POINT TEST
#947110-1
DIRECTIONS
1. Dip strip in coolant and remove immediately.
2. Match color of strip to color chart below.
INTERPRETATION
Freezing Protection
+10° 0° -10° -30°
NOTE: In hot coolants, the freezing protection may be 10° less than the color chart indicates.
Ames Company, Div. Miles Laboratories, Inc.
Elkhart, Indiana
DIRECTIONS AND INTERPRETATION
DESICCANT
EXTENDER
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