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EVALUATION OF VEHICLE CORROSION PREVENTIVES

TECHNICAL REPORT

By

Harry C. Muffley

December 1965

U. S. ARMY WEAPONS COMMAND

ROCK ISLAND ARSENAL

RESEARCH & ENGINEERING DIVISION

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EVALUATION OF VEHICLE CORROSION PREVENTIVES

By

Harry C. Muffley
Laboratory Branch

DA # 1C024401A109 AMS Code 5025.11.803

ABSTRACT

31 commercially available vehicle corrosion preventives were evaluated in the laboratory in order to establish requirements and test methods to define a satisfactory material for preserving vehicles. Seven compounds that showed promise as a result of laboratory tests were field tested. The field test indicated that certain types of materials will provide adequate protection for extended periods of time. The materials showed varying degrees of abrasion resistance in the wheel wells. This was not considered serious as periodic touch up of these areas could be accomplished on a routine maintenance basis.

Based on this work a purchase description was written describing an acceptable compound. Three materials evaluated met the requirements of the purchase description. A companion document defining the spray equipment used was also prepared. These documents will serve as a guide for the user in obtaining the proper preservative, instructions on how to clean the vehicle, the method of application and the proper type of spray equipment for use on an individual basis.

FOREWORD

The work reported here was performed under DA Project # 1CO24401A109, AMS Code 5025.11.803, Corrosion Preventives and Specialty Compounds, under the problem "Investigation of Vehicle Corrosion Preventives." The purpose of the program was to evaluate commercially available vehicle corrosion preventives both in the laboratory and in the field and to develop a technique for preserving vehicles.

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PROBLEM

To investigate the availability of vehicle corrosion preventives suitable for use in protection of underbodies, rocker panels, door panels, recesses, etc., of vehicles.

To develop test methods and requirements which would define a desirable product. To conduct a field test utilizing the products and establish an accepted procedure of application. In cooperation with the standardization activity, provide a list of potential qualified suppliers and specification information as required.

BACKGROUND

The corrosion of vehicles is a problem all are concerned with as automobile owners. The average motorist is usually unaware of corrosion taking place until rust spots and then holes appears in the car body. Every vehicle has certain areas which are vulnerable to corrosion. Gore[1] states, "That rusting commences at the time a car is manufactured and continues to its final destruction in a junk yard."

The corrosion of vehicles is costly to both the private individual and the government. This deterioration in some areas has been estimated to cost $100 per car per year.[2] It is well known that the "trade-in value" of old cars is influenced considerably by the external appearance. Corrosion can devaluate a car as much as $200 to $300 depending upon the degree of deterioration.[3] On an annual basis, vehicle corrosion represents a loss of millions of dollars to car owners.[4] This loss is reflected in body replacement parts, down time, work delay and overtime pay, all due to body rust out.

Usually a fleet operator expects to average six years of service from a passenger car and seven years from light trucks.[5,6] The Army Materiel Command has a directive indicating that sedans are to be retired at the end of six years or 72,000 miles and two and a half to four ton trucks eight years or 84,000 miles whichever occurs first.[7] In many cases, the truck bodies are completely rusted in as little as two years.[6]

The results of corrosion are seen quite often but what is it? A simple definition by Evans[8] states, "Corrosion is the destruction of a metal or alloy by chemical change, electrochemical change or physical dissolution, with the metal passing from the elementary to the combined state." Corrosion usually occurs in the presence of moisture and an excess of oxygen. The reaction is accelerated by the addition of a contaminant, such as salt.

In a study made by the Navy, Doran and Horgan[9] observed that much of the corrosion that occurred was due to improper application of primer, paint and undercoating which were intended to provide protection. This reference stressed the importance of the processing techniques in preserving a vehicle. It was apparent that the processing and the coating material are interdependent and must be considered simultaneously.

This implies that the coatings in use are either not applied correctly, or not applied to areas which need to be protected. It also implies that the technique of application requires reconsideration of the properties of the compound as related to ease of application with suitable equipment.

Underbody coatings which have been used for many years as defined in Specification TT-C-520a[10] are heavy mastic type materials consisting of a mixture of asphalts, asbestos fibers and filler.

The spray guns in use which are suitable for the application of this type of material will only cover large exposed areas. Neither the process nor the product are applicable to inner cavities of vehicles as discussed by Gore[1] and Sandler.[11] Parts of the vehicle that rapidly corrode from the inside are the quarter panels, rocker panels, fender beads, headlight eyebrows, door pillars, door panels, floor pans, body panels of trucks, etc., where the accumulation of dirt, salt and water form a chemically active "poultice" in direct contact with the body steel.[12]

A survey made a few years ago showed that automobiles operated in cities using de-icing salts suffered more corrosion than autos in cities not using de-icing salts.[3,13] Calcium chloride which is more corrosive than sodium chloride, is now being mixed with salt for the more drastic removal of ice and snow at temperatures of zero degrees F and below.[14]

In some municipalities where corrosion of vehicles is due specifically to de-icing salts, chemical inhibitors are mixed with salt in an attempt to reduce or eliminate the corrosive effect. Reports, however, indicate that the findings are not conclusive.[13,15,16]

To combat this condition, the automotive industry to some extent uses zinc enriched primer, galvanized steel, deep dip paint baths and rust proof dips of the bodies.[1,11] Some attempts have been made by the industry to "design out" corrosion inviting areas[11] by eliminating pockets which may trap moisture and by locating vent holes to promote evaporation or permit drainage.

These corrections have not been effective either because they have not been used widely or may be too costly. The alternative was to resort to simple or more direct methods in order to resolve the problem. One method was to wash the vehicle frequently. However, many fleet operators literally "washed their vehicles to pieces,"[17] particularly during the winter months. Vehicles which were washed indoors and allowed to stand overnight in a heated garage in a high relative humidity, were exposed to ideal conditions for corrosion.

The other method was to "undercoat" the car. Miller[3] complained that when the American public have their cars undercoated, they do it to prevent them from rusting, however, this is a popular misconception. He states that in many cases, they are getting a sound deadener and vibration dampener with little or no protection from corrosion. Many of the underbody coatings currently used crack[3] or peel after 18 months of driving. The area where the film is cracked, permits the water to come in contact with the metal. This type of attack of the metal is serious because it spreads between the undercoating and the metal and is difficult to detect until considerable damage has been done.[9] Some of the deficiencies attributed to underbody coating may be due to poor application of the material[9] or careless preparation of the vehicle prior to applying the coating.[11] The Air Force has a publication describing the processing of vehicles for storage and shipment which states that special care must be exercised in applying TT-C-520 to insure secure bonding to the surface as loose areas will become moisture retaining trouble spots.[18]

In the last few years, corrosion preventive coatings that will effectively retard or eliminate corrosion, thus extending the life of the vehicle, have been appearing on the market.[4] These materials represent an assortment of compounds, including grease, petrolatum, wax, emulsion, modified asphaltic, resin phosphate and neoprene type materials. All of these have the advantage that they can be "fogged" into the inner cavities of vehicles. Their one minor deficiency is that they provide a comparatively soft film which can be abraded from the wheel wells of the vehicle. A few companies have conducted field tests on some of the various types of materials and have reported the results in the literature.[5,12,17]

The majority of the compounds found on the market are applied by means of a airless spray gun. The advantages of the airless spray equipment[19] include the following: There is (a) a minimum of overspray, (b) uniform coverage, (c) reduced air consumption, (d) cleaner operation, and (e) a minimum of maintenance. Many companies have detailed procedures for applying the coatings to the vehicles to insure that the inner cavities are reached.[1,5,20,21,22].

As a result of the great number of compounds available, there are also a great number of laboratory tests to determine the properties of these varied types of materials. Several reports[3,4,12,23] as well as correspondence from the leading suppliers were reviewed for test information. Some of the more common tests used were adhesion at high and low temperature, corrosion resistance in 5 and 10% salt spray and salt water immersion, resistance to solvent vapor wash, penetration and creep properties, sprayability, flash point, abrasion resistance, consistency, settling and toxicity.

With this information available, organizations which have a need to protect their vehicles have already prepared documents for their own use. These are referenced as they apply to industry,[2,5,24] City of Detroit[25] and Federal Post Office.[26]

It was necessary that the Army have a similar document to protect the large number of vehicles under its command.

The Rock Island Arsenal Laboratory initiated a program on vehicle corrosion preventives in an attempt to sort out the multitude of claims and evaluate the products commercially available. It was anticipated that the outcome of this investigation would be the development of test methods and requirements that would define a desirable product.

A field test was also included which would provide the experience needed in order to define the equipment and establish an acceptable procedure for application. The ultimate goal was the development of product and processing specifications with a list of possible suppliers.

APPROACH AND RESULTS

Types of Materials

Inquiries were sent to various suppliers. This resulted in 31 compounds being submitted for evaluation as vehicle corrosion preventives. These materials were classified into the following groups:

1. Grease type - may consist of a calcium soap type containing corrosion inhibitors and resin or inorganic thickened.

2. Petrolatum type - contains various soaps, corrosion inhibitors and solvent to provide the desired consistency.

3. Wax type - solvent cut-back compound containing corrosion inhibitors.

4. Modified asphaltic type - some contain bentonite clay filler, powdered silicate, organic resins and corrosion inhibitors.

5. Emulsion type - may be water or asphaltic containing polymers and corrosion inhibitors.

6. Resin phosphate type - blend of inorganic and organic compounds, corrosion inhibitors, resins and petroleum solvent.

7. Nooprene type - neoprene blended with selected asphaltic material, coal tar and gilsonite.

A few materials were not classified due to lack of information from the suppliers. These materials were placed in a miscellaneous group. Each product was assigned to a group and given a vehicle corrosion preventive number (VCP#) as follows:

Grease type 1, 2, 3, 4, 5, 6, 7 and 8.

Petrolatum type 9, 10, 11, 12, 13, 14 and 15.

Wax type 16, 17, 18 and 19.

Asphaltic type 20 and 21.

Emulsion type 22, 23 and 24.

Resin Phosphate type 25, 26 and 27.

Neoprene type 28.

Miscellaneous materials 29, 30 and 31.

Laboratory Evaluation

Laboratory tests employed in the evaluation of the samples were divided into two parts. The first part covered the examination of the materials "as received" in the container. The tests utilized to characterize the compounds appear in Table I with the range of results found on each type of material.

The results indicate the following:

1. All the products are solvent "cutbacks" as indicated by the volatility test. Solid material can vary from 35% to as high as 82%.

2. The flash and fire point values indicate that the products can be formulated to specify a minimum of 100°F to satisfy government safety requirements.

3. The viscosity values, using a Brookfield Viscometer, indicated that this property was related to percent solvent used in a product and to the type of base material involved. This value would be specially significant when sprayability would be determined.

4. The copper strip corrosion test on the majority of the materials provided a 1A rating, indicating no corrosive effects produced by the material itself. Certain materials had a rating of 1B to 2C, however, this was not considered objectionable.

5. The low temperature storage test was included since its application and use would be in cold weather geographical areas.

The tests of the "as received" product would be used to identify the material. Actually, no performance requirement is involved here.

The second phase of the laboratory tests concerned the "as applied" factors. Tests on the materials "as applied" were to help establish what could be expected from the material in actual use and the nature of the coating after the solvent is evaporated. The tests and range of results appear in Table II. These tests were selected to evaluate the coating after they are applied and are in position to protect the item.

The low temperature flexibility test (where a coated sheet metal specimen is bent over a mandrel) was designed to eliminate products which become brittle and hard at low temperature. Eighteen of the materials passed this requirement.

The salt spray test is an indication of the protective quality. Twelve of the materials provide protection for over 500 hours. The scratch part of this test was used

TABLE I

TEST RESULTS OF MATERIALS "AS RECEIVED"

Tests	Type Compound			
	Grease	Petrolatum	Wax	Asphaltic
Compounds Evaluated	8	7	4	2
Condition in Container	Homogenous to separating	Homogenous to separating	Homogenous to separating	Homogenous
Flash Point, ^{o}F	105 - 300	77 - 170	77 - 225	110 - 130
Fire Point, ^{o}F	110 - 310	85 - 215	77 - 265	125 - 150
Viscosity, cp, $77^{o}F$	1,485,000 - 172,800	1,320,000 - 4,600	145,800 - 26	1,220 - 480
Volatility, %	18 - 45	21 - 46	30 - 65	37 - 44
Chlorinated Solvent	Negative	Negative	Negative	Negative
Water Content, %	0.0 - 4.6	0.0 - 1.8	0.0 - Trace	0.0
Copper Corrosion	1A - 1B	1A - 2C	1A	1A
Neut. No.	1.79 Acid - 1.04 Base	1.88 Acid - 37.99 Base	0.03 Acid - 0.62 Acid	0.45 Acid - 1.07 Acid
Sulfated Residue, %	1.2 - 21.1	0.4 - 25.8	0.0 - 4.03	0.01 - 0.10
Low Temp. Stability, $-20^{o}F$	Homogenous	Homogenous	Homogenous - Separating	Homogenous

TABLE I (Continued)

TEST RESULTS OF MATERIALS "AS RECEIVED"

Tests	Type Compound			
	Emulsion	Resin Phosphate	Neoprene	Miscellaneous
Compounds Evaluated	3	3	1	3
Condition in Container	Homogenous	Homogenous	Homogenous	Homogenous to separating
Flash Point, °F	110 - none	90 - 185	Flammable at 77	105 - 240
Fire Point, °F	120 - none	100 - 190	77	115 - 260
Viscosity, cp, 77°F	3,600 - 560	15,000 - 2,300	1,300	160,000 - 720,000
Volability, %	49 - 53	46 - 48	62	38.5 - 49.1
Chlorinated Solvent	Negative	Negative	Negative	Negative
Water Content, %	0.0 - 53	0.0 - 1.0	0.0	Trace - 2.63
Copper Corrosion	1A	1A	1A	1A - 1B
Neut. No.	0.49 Acid - 17.3 Acid	0.28 Acid - 11.17 Base	1.01 Acid	0.08 Acid - 1.59 Acid
Sulfated Residue, %	0.01 - 2.01	18 - 19	9.09	0.36 - 25.62
Low Temp. Stability, -20°F	Homogenous - Separating	Homogenous	Homogenous	Homogenous

TABLE II

TEST RESULTS OF MATERIALS "AS APPLIED"

Tests	Type Compound			
	Grease	Petrolatum	Wax	Asphaltic
Compounds Evaluated	8	7	4	2
Color	Tan-Black	Brown-Black	Brown	Black
Fire Resistance	8 Pass	7 Pass	4 Pass	2 Pass
Low Temp. Flex., -10°F	4 Pass-4 Fail	5 Pass-2 Fail	4 Pass	2 Fail
High Temp. Flow, °F	150 - 500	150 - 500	150 - 170	250 - 300
Salt Spray Resistance 168 Hours	4 Pass-4 Fail	7 Pass	4 Pass	1 Pass-1 Fail
500 Hours	8 Fail	4 Pass-3 Fail	4 Pass	2 Fail
Scratch	8 Undercut	Partly healed to healed	Partly healed to healed	2 Undercut
Acid & Alkali Resistance HCl	4 Pass-4 Fail	5 Pass-2 Fail	1 Pass-3 Fail	1 Pass-1 Fail
H_2SO_4	2 Pass-6 Fail	4 Pass-3 Fail	1 Pass-3 Fail	2 Fail
NaOH	7 Pass-1 Fail	7 Pass	4 Pass	2 Pass
Condition to Touch	Tacky to Dry	Tacky to Dry	Slight Tacky to Dry	Dry
Creep	Very little to complete	Very little to complete	Complete	Complete
Rust Removal	Negative	Negative	Negative	Negative

TABLE II (Continued)

TEST RESULTS OF MATERIALS "AS APPLIED"

Tests	Type Compound: Emulsion	Resin Phosphate	Neoprene	Miscellaneous
Compounds Evaluated	3	3	1	3
Color	Brown-Black	Amber-Tan	Black	Amber-Black
Fire Resistance	3 Pass	3 Pass	Pass	3 Pass
Low Temp. Flex., -10°F	1 Pass-2 Fail	3 Pass	Fail	1 Pass-2 Fail
High Temp. Flow	260 - 500	300 - 500	500	175 - 500
Salt Spray Resistance				
168 Hours	3 Fail	3 Pass	Pass	1 Pass-2 Fail
500 Hours	3 Fail	1 Pass-2 Fail	Pass	1 Pass-2 Fail
Scratch	3 Undercut	Undercut to Partly healed	Partly healed	2 Undercut - 1 Healed
Acid & Alkali Resistance				
HCl	1 Pass-2 Fail	1 Pass-2 Fail	Fail	1 Pass-2 Fail
H_2SO_4	1 Pass-2 Fail	3 Fail	Fail	1 Pass-2 Fail
NaOH	1 Pass-2 Fail	2 Pass-1 Fail	Pass	1 Pass-2 Fail
Condition to Touch	Dry	Slight Tacky - Dry	Dry	Dry
Creep	Complete	Very little to complete	Complete	Very little to complete
Rust Removal	Negative	Negative	Negative	Negative

to observe whether the product would heal the scratch or permit corrosion to undercut the coating. The products tested gave results ranging from healing the scratch to undercutting the compound.

The creep test was a method in which two metal plates were riveted together and coated. The extent that the coating would creep between the plates was observed. This capability was considered desirable. The compounds varied from very little creep to completely covering both mating surfaces.

Rust removal was tested only because some claims were made that some of the products removed rust. None did this.

These represent the most important tests which could reflect the actual performance of the product in use. There are other tests which could be included but the intent was to develop a minimum number of tests to serve the purpose.

Field Test

At this point, a field test was scheduled. In selecting materials for the field test program, several properties were considered essential for a desirable product. Since the primary purpose of a vehicle corrosion preventive compound is to prevent corrosion, this property was given the greatest emphasis. The 20% salt spray and acid and alkali resistance tests were used to establish this property.

From the viewpoint of applying the material to a vehicle, other properties were important. The material selected also should have a consistency such that it could be applied by means of airless spray equipment. It should provide adequate uniform coverage in corners, crevices and enclosed areas. The material should be safe from a fire hazard and toxicity standpoint.

The condition of the dry coating after application should not be messy so as to be objectionable to mechanics who may have to maintain the vehicle.

It was also desirable that as many of the types which appeared applicable should be included in the field test. Tables III and IV describe the products selected, giving the properties of the products "as received" and "as applied."

TABLE III

PROPERTIES OF COMPOUNDS SELECTED FOR FIELD TEST "AS RECEIVED"

Tests	Type Compound						
	Grease	Petrolatum			Wax		Asphaltic
Code No.	1	9	10	11	16	19	20
Condition in Container	Bleeds	Bleeds	Homogenous	Homogenous	Bleeds	Homogenous	Homogenous
Flash Point, °F	115	170	77	120	95	205	110
Fire Point, °F	120	215	85	125	125	215	125
Viscosity, cp, 77°F	1,485,000	204,466	261,200	1,320,000	145,800	2,080	1,220
Volatility, %	40	22	36	46	30	65	44
Chlorinated Solvent	Negative	Negative	Negative	Negative	Negative	Negative	Negative
Water Content, %	0.9	0.0	0.0	1.8	0.0	0.0	0.0
Copper Corrosion	1A	1A	1A	2C	1A	1A	1A
Neut. No.	0.89 Acid	0.52 Acid	5.67 Base	37.99 Base	0.62 Acid	0.20 Acid	1.07 Acid
Sulfate Residue, %	3.75	0.44	5.91	7.16	4.03	0.21	0.01
Low Temp. Stability, -20°F	Homogenous	Homogenous	Homogenous	Homogenous	Homogenous	Separated	Homogenous

TABLE IV

PROPERTIES OF COMPOUNDS SELECTED FOR FIELD TEST "AS APPLIED"

Tests	Type Compound						
	Grease	Petrolatum			Wax		Asphaltic
Code No.	1	9	10	11	16	19	20
Color	Brown	Brown	Brown	Black	Brown	Brown	Black
Fire Resistance	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Low Temp. Flex., -10°F	Fail	Pass	Pass	Pass	Pass	Pass	Fail
High Temp., °F	180	150	300	500	150	170	300
Salt Spray Resistance 168 Hours	Pass	Pass	Pass	Pass	Pass	Pass	Pass
500 Hours	Fail	Fail	Fail	Pass	Pass	Pass	Fail
Scratch	Undercut	Partly Healed	Partly Healed	Healed	Healed	Healed	Undercut
Acid & Alkali Resistance HCl	Pass	Pass	Pass	Fail	Pass	Fail	Fail
H_2SO_4	Pass	Pass	Pass	Fail	Pass	Fail	Fail
NaOH	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Condition to Touch	Slight Tacky	Tacky	Dry	Dry	Slight Tacky	Dry	Dry
Creep	Very little	Very little	Little	Very little	Creeps (1/2)	Complete	Creeps (1/2)
Rust Removal	Negative	Negative	Negative	Negative	Negative	Negative	Negative

Table IV shows that VCP 16 was most promising and that VCP 20 appeared inadequate when one observes the data on low temperature flexibility, salt spray resistance, scratch test and acid and alkali resistance.

The other products had various deficiencies. In any event, it was hoped the field test would help establish any correlation between the bench test and field performance.

The field test consisted of contacting appropriate personnel at the motor pools of agencies located at Rock Island Arsenal, Rock Island, Illinois and the Army Tank Automotive Command at Warren, Michigan and arranging to process a number of their regularly used vehicles. The authority to conduct the test included all aspects of the test, such as, cleaning, inspecting, applying the coating and reinspecting at scheduled intervals.

The following compounds and vehicles were used at the field test sites:

Compound	Rock Island Arsenal	Detroit Arsenal
1		Carryall '63 Pickup '63 Panel '63
9	Sedan '63 Pickup '63 Carryall '60	Station Wagon '63 Pickup '63 Sedan '63
10	Pickup '63 Sedan '57 Sedan '63	Carryall '63 Station Wagon '63 Sedan '63
11		Sedan '63 Sedan '61 Pickup '63
16	Sedan '63 Sedan '63 Sedan '63	Pickup '63 Sedan '63 Station Wagon '63
19		Sedan '63 Sedan '63 Panel '63
20		Sedan '63 Sedan '63 Station Wagon '63

In processing vehicles for the field test, every effort was made to treat all the vehicles in a uniform manner. A stepwise procedure was followed which indicated when to make inspections, how to clean the vehicle and apply the vehicle corrosion preventive.[27] In conjunction with this procedure, a set of data sheets were used to record observations at the various stages. A brief outline of the procedure is as follows:

1. Receive vehicle (General information on vehicle recorded as to make, model number, miles, etc.)

2. Inspect vehicle.

3. Clean vehicle by scraping fender bead and remove large accumulation of mud, then steam clean and rinse with hot water.

4. Inspect vehicle for cleanliness.

5. Inspect vehicle before applying coating to see if it is dry.

6. Apply coating.

7. Inspect vehicle for coverage.

8. Inspect vehicle just prior to release to service.

9. Inspect vehicle soon after first winter season.

10. Inspect vehicle in the fall prior to the second winter season.

11. Inspect vehicle soon after second winter season.

The tools and equipment used in treating the vehicles were as follows:

Cleaning Procedure

Screw driver	Wire brush
Putty knife	Steam nozzle
Plastic bags to cover brake drums	

Application Procedure

Center punch	5/8 inch drift
Hammer	Long straight wand
3/4 inch hole saw	Short curved wand
Electric drill	Roto clean nozzle
Plastic plugs	Plastic bags to cover brake drums
Airless spray gun (24:1 ratio pump)	

Many improvised tools may be used at the discretion of the processor.

The areas treated with the vehicle corrosion preventive were the same as those emphasized and described in the literature.[28] The various designs of vehicle bodies and understructures make a rigid procedure impractical. Experience with the various types of vehicles will determine the best procedure for a particular vehicle.

The areas treated were as follows:

1. Front fender wells, headlight areas, eyebrows, underside of fenders (particularly the fender beads), baffles and supporting members.

2. Floor pan and body floor support - All the underside of vehicles, boxed in sections, etc.

3. Rocker panels - Drain holes were enlarged with a 5/8 inch drift to gain access to this area.

4. Rear fenders and quarter panels - These were treated the same as the front fenders. Access to part of the rear fender may be possible through the trunk.

5. Center door pillars - Holes were drilled for access and treatment. Holes were sealed with plastic plugs.

6. Doors - Upholstery was loosened and the lower portion of door treated.

7. Tail and back-up light area - if not accessible from underneath, it may be reached through the trunk.

8. Miscellaneous - There were many areas treated that are not mentioned specifically. In the different types of vehicles, there were areas unique to the model, such as the tailgate of station wagons, the rear doors of panels trucks, the double paneled area in the cargo area of trucks, etc.

The performance of each compound when applied appears in Table V.

Nine vehicles were processed at the Illinois area during December 1963. In Michigan, 21 vehicles were processed during the period 12-25 January 1964.

Inspections were made in the spring of 1964 after

TABLE V

APPLICATION PERFORMANCE

Type Compound	Code No.	Air Pressure Used to Apply, psig	Remarks
Grease	1	65	Easily applied, covers well
Petrolatum	9	55	Easily applied, covers well
Petrolatum	10	55	Easily applied, covers well
Petrolatum	11	55	Easily applied, covers well
Wax	16	60	Easily applied, covers well
Wax	-	40	Messy to apply, covers well
Asphaltic	20	30	Messy to apply, drips

the first winter season, in the fall of 1964 prior to the second winter season and in the spring of 1965. During the time that elapsed from the initiation of the field test to the first inspection 34.4 and 31.1 inches of snow fell as shown in Table VI, in the Rock Island Arsenal and the Army Tank Automotive Center area, respectively, as reported in the Local Climatological Data Sheets published by the U. S. Weather Bureau[29] for these areas. In the interval between the second and final inspection 47.6 and 48.2 inches of snow fell bringing the total snow fall for the entire test period to 82.0 and 79.3 inches, respectively. This indicates the second winter season was more severe than the first. The difference between areas was not significant.

The final inspection of the coatings revealed that all of the compounds were adhering well and providing satisfactory protection to surfaces of inner cavities. However, the compounds applied to seams, cracks and corners on the underside of the vehicle were beginning to show variation in the amount of protection provided. Table VII is an appraisal of the general condition of the underside of the vehicle coated with the different materials. The two wax type, compounds 16 and 19, and one of the petrolatum type, compound 10, appear to be providing better protection than the other materials due to the fact that they penetrated the seams and cracks in the metal, thus providing protection to these mating surfaces. The asphaltic type material 20, provided less protection while the remaining two petrolatum 9 and 11 and the grease type 1 provided the least amount of protection to the seams and cracks in the metal on the underside. In any case the vehicles that were coated were in better condition than two sedans observed as controls. These vehicles were of the same make, year and model as the sedans used in the field test. The two cars were undercoated with the mastic type material but were not treated with a vehicle corrosion preventive. Considerable rust was observed on the underside of these sedans particularly at the seams and cracks.

As for abrasion resistance, the vehicle corrosion preventives showed varying degress of abrasion resistance on the underside of the vehicle where dirt, water and sand could be thrown against the surfaces when the car was moving. In the wheel wells, the softer materials were removed more extensively than the harder products. No rust was evident in the wheel wells at the second inspection made in the fall of 1964. However, rust had formed in this area on many of the vehicles by the time the final inspection was made in the spring of 1965. It is likely that a thin protective film was retained for awhile which

TABLE VI

LOCAL CLIMATOLOGICAL DATA

	Moline Airport Total Water Equivalent (in.)	Moline Airport Snow Fall (in.)	Detroit Airport Total Water Equivalent (in.)	Detroit Airport Snow Fall (in.)
Dec. 1963	0.94	9.7	1.37	10.3
Jan. 1964	1.59	5.3	2.18	5.3
Feb.	0.73	5.5	0.52	5.1
Mar.	4.02	13.9	2.62	9.2
Apr.	6.37	T	4.65	1.2
May	2.68	0	1.68	0
June	3.89	0	2.35	0
July	5.31	0	2.37	0
Aug.	2.41	0	5.87	0
Sept.	3.98	0	2.12	0
Oct.	0.01	0	0.50	T
Nov.	3.40	2.1	0.81	2.6
Dec.	1.27	11.7	1.74	7.4
Jan. 1965	4.08	10.2	3.74	7.1
Feb.	.97	7.4	2.49	15.8
Mar.	2.52	16.2	3.02	12.9
Apr.	7.92	0	3.04	2.4
May	4.04	0	2.16	0
Total Snow Fall During Test		82.0		79.3

TABLE VII

APPRAISAL OF VEHICLES IN FIELD TEST

Compound Number	Type Compound	Vehicle 1	Vehicle 2	Vehicle 3
		ATAC		
16	Wax	Good	Good	Good
19	Wax	Good	Fair	Good
9	Petrolatum	Poor	Very Poor	Fair
10	Petrolatum	Good	Good	Fair
11	Petrolatum	Very Poor	Poor	Very Poor
1	Grease	Very Poor	Very Poor	Very Poor
20	Asphalt	Fair	Good	Fair
Control	Conventional Underbody Coating	Very Poor	Very Poor	-
		RIA		
16	Wax	Good	Good	Good
9	Petrolatum	Good	Fair	*
10	Petrolatum	Good	*	*

*Vehicle was disposed of before final inspection.

was eventually worn away before the last inspection was made. This suggests that periodic reapplication of the coating in areas subjected to abrasion should be accomplished on a routine maintenance basis.

DISCUSSION

The evaluation of vehicle corrosion preventives in the field is a time consuming procedure. However, if a correlation can be established between laboratory tests and field test performance, predictions from the results of certain significant tests could aid in the selection of satisfactory compounds. Some tests are more informative than others when considering the environmental conditions the coatings are expected to encounter. For example, it is obvious the coatings are going to come in contact with salt solutions on the highway. Therefore, the salt spray resistance test was considered one of the more significant tests in order to establish the protection a compound will provide. Other tests that reflect performance in the field are creep, low temperature flexibility and high temperature flow which identify the products in the condition "as applied" to metal panels.

The correlation of bench tests with field performance leave much to be desired when considering the underside of the vehicle that is exposed to abrasion. The many variables encountered in preparing the vehicle for treatment, the treatment of the vehicle and the environment each vehicle was exposed to no doubt contributes to this inconsistency. The one wax type material, 16, was the exception providing good results in the bench tests and showing good performance in the field. The rest of the materials included in the field test showed various deficiencies in the bench tests. Of this group two materials, 10 and 19, provided reasonably good protection in the field test.

The part of the program which was highly informative and found to be very important was the actual processing of the vehicle. The manner in which the vehicles were cleaned and the coatings applied has a direct bearing on the useful life of the compound. The satisfactory application of the compounds to the surfaces of the intercavities requires the use of airless spray equipment. Thus, it became apparent that the processing and the coating material are interdependent and must be considered simultaneously.

CONCLUSIONS

Pertinent information has been obtained in the course of evaluating the products "as received," "as applied" and in conducting the field test to include three inspections.

The work has shown that a number of types of products will do the "job" and a tentative set of requirements can be suggested. For material which may be suitable, Table VIII lists requirements and test methods which would define or characterize the product "as received."

Table IX lists tentative requirements and test methods to establish the performance expected of a satisfactory product.

These requirements were used as a basis for the preparation of a purchase description entitled "Corrosion Preventive Compound, Cold Application (For Motor Vehicles)" RIA PD-687.[30] An appendix to this purchase description describes the detailed procedures concerning the cleaning of the vehicle and the application of the preservative material. A companion document entitled "Spray Outfits, Airless, Vehicle Corrosion Preventive and Paints" RIA TE PD-36[31] defines the spray equipment used in applying the compounds.

These documents will serve as a guide for the user in obtaining the proper preservative, instructions on how to clean the vehicle, the method of application, and the proper type of spray equipment for use on an individual basis. A project has been authorized for converting RIA PD-687 into a limited coordinated military specification during FY66.

RECOMMENDATIONS

The following recommendations are submitted:

1. All new motor vehicles acquired by Rock Island Arsenal be treated with a vehicle corrosion preventive before being put into service. It is particularly important that all trucks and buses be treated since replacement parts for these vehicles are more costly.

2. All areas of the vehicle subjected to abrasion be touched up periodically, preferably just before the start of the winter season.

3. Vehicles that are operated in areas exposed to marine atmospheres should be completely treated with a vehicle corrosion preventive.

TABLE VIII

PROPOSED REQUIREMENTS OF MATERIAL "AS RECEIVED"

Tests	Test Method	Requirement
Condition in Container	TT-C-520a	No separation
Flash Point, °F	ASTM D92-57	100°F, Min.
Fire Point, °F	ASTM D92-57	105°F, Min.
Volatility, %	FED-STD 791, 3480	Requirement established on qualification
Chlorinated Solvent	Beilstein Test	Negative
Water Content, %	ASTM D95-62	0.2 Max.
Copper Corrosion	ASTM D130-56	Less than ASTM No. 3, Max.
Neutralization No.	ASTM D974-58 Modification	Requirement established on qualification
Sulfated Residue, %	ASTM D874-59	Requirement established on qualification
Low Temp Storage Stability, -20°F	Modification of MIL-C-16173C	No separation

TABLE IX

PROPOSED REQUIREMENTS OF MATERIAL "AS APPLIED"

Tests	Test Method	Requirement
Fire Resistance	TT-C-520a	Not support combustion
Low Temp. Flex. -10°F	Original	No cracking
High Temp. Flow, °F, min.	MIL-C-11796B	145
20% Salt Resistance Spray, Hours	FED-STD 791, 4001	500
Scratch	Original	No undercutting
Acid and Alkali Resistance	TT-C-520a	No corrosion
Condition to Touch	Original	Dry
Creep	Original	Complete

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31. "Spray Outfits, Airless, Vehicle Corrosion Preventive and Paints," 2 September 1965, Rock Island Arsenal Tool and Equipment Purchase Description 36.

APPENDIX A

MATERIALS EVALUATED

Code No.	Brand Name	Supplier
1	Unda Gard	Kendall Refining Co.
2	SL 7790	Shell Oil Company
3	Code 1401	Southwest Grease & Oil Co., Inc.
4	Code 1410	Southwest Grease & Oil Co., Inc.
5	Rust-O-Lene Spray Coat	Sinclair Refining Co.
6	Unda Gard FD863	Kendall Refining Co.
7	Rust Ban	Imperial Oil Limited
8	Rust-O-Lene Duro Coat	Sinclair Refining Co.
9	Rust Proof Compound L	Texaco, Inc.
10	Tectyl 820	Valvoline Oil Company
11	Nox Rust AC415	Daubert Chemical Co.
12	Rust Ban 385	Humble Oil Company
13	Ziebart No. 4	Ziebart Process Corp.
14	Nox Rust AC415M	Daubert Chemical Company
15	Tectyl TL-107	Valvoline Oil Company
16	Sundercoat	Sun Oil Company
17	Amalie Film Spray Rust Stop Undercoating	Sonneborn Chemical and Refining Corp.
18	Undercoating No. 1	Sonneborn Chemical and Refining Corp.
19	Code 380	Southwest Grease & Oil Co., Inc.
20	Ensis Fluid 264	Shell Oil Company
21	WSX 5790	Humble Oil Company
22	Pure Tect	The Pure Oil Company
23	Modified Pure Tect	The Pure Oil Company
24	Code 4500	Southwest Grease & Oil Co., Inc.
25	Rust Proofing Compound	The Standard Oil Co. (Ohio)
26	Code 4200	Southwest Grease & Oil Co., Inc.
27	OS 15479	The Lubrizol Corporation
28	Gacote NA-62	Gates Engineering Company
29	GS 15116	Gulf Research & Development Company
30	Valcote	Valvoline Oil Company
31	Quaker Coat	Quaker State Oil Refining Corporation

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13. ABSTRACT

31 commercially available vehicle corrosion preventives were evaluated in the laboratory in order to establish requirements and test methods to define a satisfactory material for preserving vehicles. Seven compounds that showed promise as a result of laboratory tests were field tested. The field test indicated that certain types of materials will provide adequate protection for extended periods of time. The materials showed varying degrees of abrasion resistance in the wheel wells. This was not considered serious as periodic touch up of these areas could be accomplished on a routine maintenance basis. Based on this work a purchase description was written describing an acceptable compound. Three materials evaluated met the requirements of the purchase description. A companion document defining the spray equipment used was also prepared. These documents will serve as a guide for the user in obtaining the proper preservative, instructions on how to clean the vehicle, the method of application and the proper type of spray equipment for use on an individual basis. (U) (Author)

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	ROLE	WT	ROLE	WT	ROLE	WT
Corrosion Preventives Vehicle Corrosion Preventives Coatings for Vehicles						

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EVALUATION OF VEHICLE CORROSION PREVENTIVES,
By Harry C. Huffley

RIA Lab. Rep. 65-3305, Dec 65, 37 p., incl. illus. tables, (DA Project No. 1C024401A109, AMS Code 5025.11.803) Unclassified report.

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