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HOW STEEL PRIMER PAINTS PERFORMED AT EXPOSURE POINTS ACROSS CANADA

by

JOHN HARRIS

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COMPORTEMENT DES PEINTURES D'IMPRESSION POUR L'ACIER EXPOSEES AUX ELEMENTS EN DIVERSES REGIONS DU CANADA

SOMMAIRE

Cinq genres de peintures d'impression et un enduit antirouille (wash primer) ont été appliqués sur des panneaux d'acier en vue d'observer leur comportement dans différentes conditions climatiques. Les panneaux ainsi enduits ont été exposés jusqu'à 10 ans de suite aux éléments dans les stations en plein air que la Division des recherches en bâtiment possède dans les diverses régions du Canada. Six panneaux ont été préparés pour chaque station d'essai, trois de ces panneaux étant recouverts d'un émail gris à base de résine alkyde. Les panneaux ont été enlevés à intervalles réguliers pour être examinés en laboratoire. On a vérifié leur aspect général, la quantité de saletés accumulées et le degré de lustre, de poudrage, de rouille et de cloquage. Le rapport décrit le comportement des différents types de peintures ainsi que la préparation des panneaux et la formulation des peintures employées.

How steel primer paints performed at exposure points across Canada

By JOHN HARRIS

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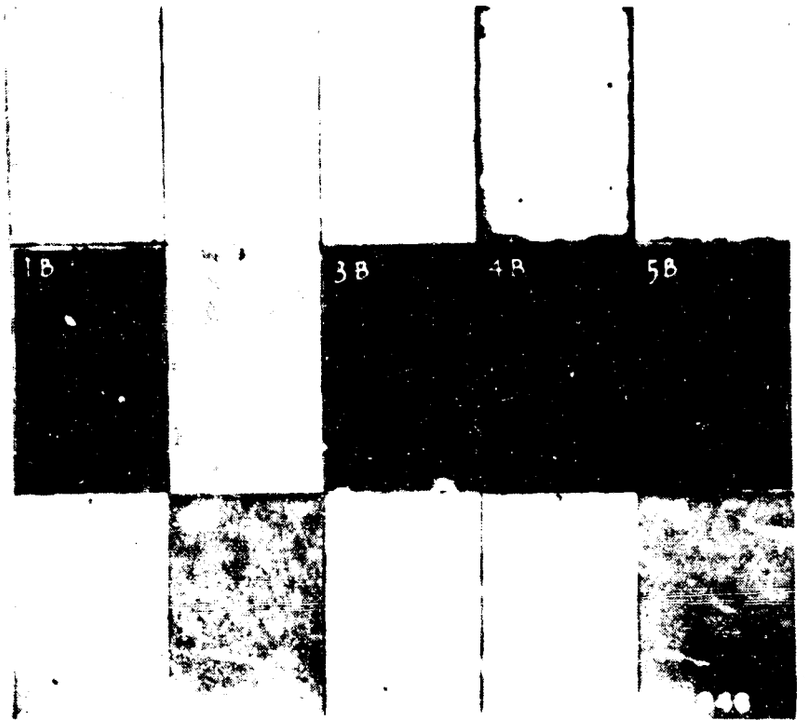

FIGURE 1. Conditions of exposed panels of red lead-linseed oil after 8 years at site 4 and 10 years at the other sites. (A-top coated B-primer.)

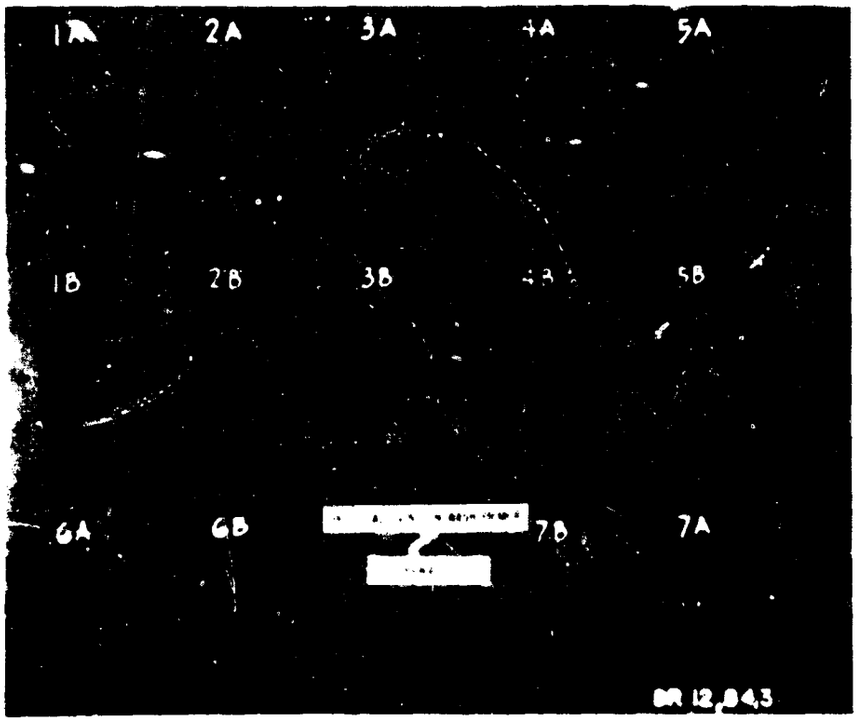

FIGURE 2. Condition of exposed panels of red lead-vinyl and wash primer after 8 years at site 4 and 10 years at other sites.

● Serious damage to steel results from atmospheric corrosion, particularly in coastal and industrial areas. To reduce this loss of metal, large quantities of paint are applied annually to steel used for various purposes by the construction industry. Problems encountered on occasion have resulted in failure of the coating. The cause of failure in several instances has been attributed to an improper selection for the particular conditions of service. When the initial outdoor testing programs of the former Associate Committee on Corrosion Research and Prevention were planned, the evaluation of paint systems for the protection of steel received first consideration.

Priming or shop coats of paints on steel play an important role in the ultimate performance of the paint system. In addition to providing a good surface for the top coat, they protect the cleaned steel from rusting, until subsequent top coats can be applied. Frequently, the lapse of time between coats may be several months. The protection provided is achieved through the use of several different types of rust-inhibitive pigments. An outdoor exposure program was planned to obtain a better understanding of how primers of different composition performed under different atmospheric conditions.

To assist in this work, the outdoor test sites of the Division of Building Research were used[1]. These sites, at various locations across Canada, provided a wide range of climatic conditions. Two of the sites, Halifax and Montreal, are roof sites and the others at Ottawa, Saskatoon, Norman Wells, N.W.T., York Redoubt (near Halifax) and Rocky Point, B.C., are well-exposed land areas. The Halifax roof site provided the most severe exposure, and deterioration of the materials set out here was extremely rapid. This is because of the influence

TABLE I
PAINTS USED FOR EXPOSURE PANELS

Type	Formula Code No.
Red Lead — Linseed Oil	NRP 5 RLL
Red Lead — Vinyl	NRP 11 RLV
Red Iron Oxide — Alkyd	NRP 48 ROA
Red Iron Oxide (high) — Zinc Chromate — Alkyd	NRP 34 ROHCA
Red Iron Oxide — Zinc Chromate — Alkyd	NRP 49 ROCA
Alkyd Enamel — Grey	NRP 35 AE
Wash Primer	NRP 12 WP

DATE OF EXPOSURE AT SITES — III

Site No.	Date of Exposure
1—Ottawa	23 June 1953
2—Saskatoon	11 August 1953
3—Montreal	9 October 1953
4—Halifax	30 June 1953
5—York Redoubt	1 July 1953
7—Rocky Point	8 June 1954
6—Norman Wells	9 September 1953

TABLE II
FILM THICKNESSES OF PAINT COATINGS (Mils)

1st Coat		2nd Coat		1st & 2nd Coats	3rd Coat		1, 2 & 3 Coats	4th Coat		1, 2, 3 & 4 Coats
PAINT	THICKNESS	PAINT	THICKNESS	TOTAL THICKNESS	PAINT	THICKNESS	TOTAL THICKNESS	PAINT	THICKNESS	TOTAL THICKNESS
RLL	—	RLL	—	3.2	—	—	—			
RLL	—	RLL	—	3.2	AE	0.8	4.0			
WP	0.1	RLV	—	—	RLV	—	3.8			
WP	0.1	RLV	—	—	RLV	—	3.8	AE	1.1	4.9
ROA	—	ROA	—	1.0	—	—	—			
ROA	—	ROA	—	1.0	AE	1.0	2.0			
ROHCA	1.5		—			—	—			
ROHCA	1.5	AE	0.9	2.4	—	—	—			
ROCA	—	ROCA	—	1.3	—	—	—			
ROCA	—	ROCA	—	1.3	AE	1.0	2.3			

of the chimney on the roof, which gave this site the highest level of SO_2 and large quantities of soot.

Five priming paints and a wash primer were selected for testing. They included a red lead and linseed oil, a red lead and vinyl, a red iron-oxide and alkyd, two variations of red iron-oxide and zinc chromate with alkyd and a zinc chromate, vinyl-phosphoric acid type of wash primer. A grey alkyd enamel was used as a top coat. The formulations for the primers and the enamel are included in Appendix A. The paints are shown in Table I with the code used for their identification.

The panels were made from cold-rolled, SAE 1010 steel of 20-gauge stock cut to a 6x9-in. size. They were first cleaned by solvent and rags and then scrubbed with a brush, soap and warm water to remove oil and dirt. After rinsing and drying, the panels were then vapor degreased and treated with a metal conditioner and rust remover of the phosphoric acid type similar to CGSB specification 31-GP-107. Six panels were coated with each of the priming paints. Subsequently, three of the six primed panels were top coated with the grey alkyd enamel.

The paints were applied by dipping. The priming paints were applied in two coats, except ROHCA which was used as one coat. Because of differences in application properties of the primers, different thicknesses were obtained. The vinyl priming paint (RLV) was applied over a thin base coat of wash primer. The grey alkyd enamel was applied to a film thickness of about 1.0 mil. The dry film thickness of the various coatings is recorded in Table II.

A uniform thickness of film was obtained between panels with the same coating. The edges of the panels were protected by dipping them into the same paint as that used for the final coat on the panel surface. The various coatings were identified through the code letters shown in Table I. Prior to coating, these letters were

FIGURE 3 The condition of panels of red oxide-alkyd after four years at site 4 and 10 years at the other sites

RECORD OF GLOSS ON WASHED PANELS—IV

PAINT	Site No.	Gloss Units — Length of Exposure (years) 1	2	3	4	5
Red Lead	1	1.2	2.0	2.0	0.2	
in Linseed Oil	2	3.4	2.5	1.5	0.2	
(RLL)	3	4.1	3.0	0.1	0.2	
	4	Nil	Nil	1.4	0.2	
	5	1.1	Nil	1.5	0.2	
	6	3.4	2.0	1.5	—	
	7	2.5	7.3	0.25	—	
Wash Primer (WP)	1	11.7	4.0	2.0	0.7	
Red Lead	2	11.5	20.0	5.0	0.9	
in Vinyl (RLV)	3	11.1	16.0	0.3	0.8	
	4	—	22.0	16.5	0.8	
	5	13.2	22.0	8.3	0.8	
	6	10.3	14.0	11.6	—	
	7	17.3	5.2	1.0	—	
Red Lead in	1	41.8	4.0	2.0	0.5	
Linseed Oil (RLL)	2	81.3	46.4	21.0	0.5	
Alkyd Enamel (AE)	3	76.9	45.0	2.4	1.6	
	4	7.0	17.0	3.7	0.6	
	5	42.3	22.0	1.5	0.2	
	6	85.8	64.0	42.0	—	3.0
	7	59.7	1.6	0.2	—	
Wash Primer (WP)	1	45.2	5.0	3.0	0.4	
Red Lead in Vinyl (RLV)	2	77.9	56.7	19.0	0.5	
Alkyd Enamel (AE)	3	77.6	43.0	2.8	2.0	
	4	8.5	15.0	3.3	0.5	
	5	43.6	25.0	1.6	0.2	
	6	85.3	57.0	39.0	—	3.1
	7	55.6	6.6	0.2	—	
Red Iron Oxide	1	38.1	4.0	2.0	0.4	
- Alkyd (ROA)	2	59.7	41.3	15.0	0.4	
Alkyd Enamel (AE)	3	62.7	38.0	1.9	1.4	
	4	5.1	10.0	2.5	0.3	
	5	38.3	21.0	1.5	0.2	
	6	70.4	52.0	35.0	—	3.4
	7	50.6	2.2	0.2	—	

stamped on all panels, together with the site number and replication number.

The coated panels were aged in the laboratory under standard conditions of 73F and 50 ± 5% R.H. for a minimum of two weeks. Preparation of the panels was completed by June 1953, and the panels were set out at all of the sites except at Rocky Point, B.C., during that summer. The Rocky Point site did not become available until June 1954. For exposure, the panels were mounted at an angle of 45 deg to the horizontal facing south. The exposure dates for the various sites are given in Table III.

All of the panels were removed from their respective exposure racks at approximately yearly intervals for the first four years and returned to the paint research laboratory of DBR for examination. After the first four years of exposure, examination at two-year intervals was begun. The panels were examined for general appearance, amount of dirt collection and degree of gloss, chalking, rusting and blistering.

Gloss. Gloss was measured by means of a glossmeter on one of the panels (No. 3 of each set) after it had been washed lightly to remove dirt and loose chalk. Original gloss readings were not taken but can be assumed to be between 85 and 90 gloss units except for the red iron oxide-alkyd (ROA), the red iron-oxide, zinc chromate-alkyd (ROCA), and the red iron-oxide (high), zinc chromate-alkyd (ROHCA), as these paints were without appreciable gloss at the start. The gloss values are recorded in Table IV. Gloss values for most of the other panels are not reported after four years as by this time no appreciable gloss remained. The panels at site No. 6 were exposed with the faces down during the fourth year, and consequently there are no observations reported for this site for that period. Subsequent gloss readings on these panels must be interpreted accordingly.

Rating of Sites from Gloss Results— The residual gloss at the end of each interval for panels top coated with enamel was used to classify the test sites in order of severity in respect of loss of gloss. The gloss readings for each site of all the top-coated panels as shown in Table IV were added together. Four-year totals were used in obtaining a severity rating for all of the sites except Norman Wells and Rocky Point. For these two sites, readings of the first three years only were used. The sites were then arranged in the order of highest to lowest summated gloss values. This ranking is shown in Table V, which also includes the exposure time required for the gloss to drop below 40 units and below 10 units.

Chalking. The panels were examined for chalking and the number of years was recorded that were required for the first signs of chalking to appear. A numerical system was used to rate the degree of chalking. A value of 10 represented very marked chalking, whereas a value of 0 indicated that no change had taken place. Intermediate values were assigned of 1, 2 and 5, respectively, for a trace, slight or medium chalking. The first appearance of chalking and the degree of chalking of the different primers, with and without a top coat, at each of the sites are shown in Table VI.

The years of exposure required for the first signs of chalking and the degree at that time for all the paints at each site were added up separately. The site for which the sum of the years was lowest provided the atmospheric conditions for the most rapid rate of chalking. Also, it would be expected that that site would show the highest value for the sum of the ratings of degree of chalking for all the paints. The sums of the chalking ratings for the entire exposure period at

each site are given in Table VII. The ranking of the test sites is with respect to their rate of chalking as shown in Table VIII.

From these tabulations it is observed that, with respect to chalking, the atmospheric conditions at Norman Wells are comparatively mild to those at Ottawa and Rocky Point. Because of the special conditions at Halifax (as mentioned previously), this site has not been included in Table VIII. The ranking of the sites based on the first appearance of chalking is given in Table IX.

The panels were also examined for the appearance of rust. Site No. 4 at Halifax again provided the most severe environment with respect to the development of rust. Because the atmosphere where the specimens were located on the roof at this site was so aggressive, the manner in which rusting developed is shown separately in Table No. X.

Rusting was evident on six of the ten sets of exposed panels by the end of one year. Most of the panels that had been primed only were removed because of complete failure by the end of four years. The exceptions to this were the primed panels of red lead—linseed oil and the two primers, red lead-linseed and red lead-vinyl, that were top coated with the alkyd enamel.

There was little development of rusting and blistering with any of the paints at any of the other sites during this interval until about the sixth year. By this time, as is indicated in Table XI, a few rust blisters, slight rusting or no rusting was observed with the different paint systems at these sites. At site No. 4, however, at the end of six years, the following test panels only were judged still in good condition: the red lead-linseed oil primer panels and the panels top coated with the alkyd enamel over the red lead-linseed oil and red lead-vinyl primers.

The condition with regard to rusting of panels remaining after eight and ten years of exposure has been recorded in Table XII. From this tabulation it is seen that, after eight years of exposure at the Halifax site, no panels of primers only remain. By the end of eight years, it is also observed that red - lead primer was eroded away completely at Ottawa, Montreal and York Redoubt near Halifax. All of the other primers gave a considerably improved performance at these and the remaining

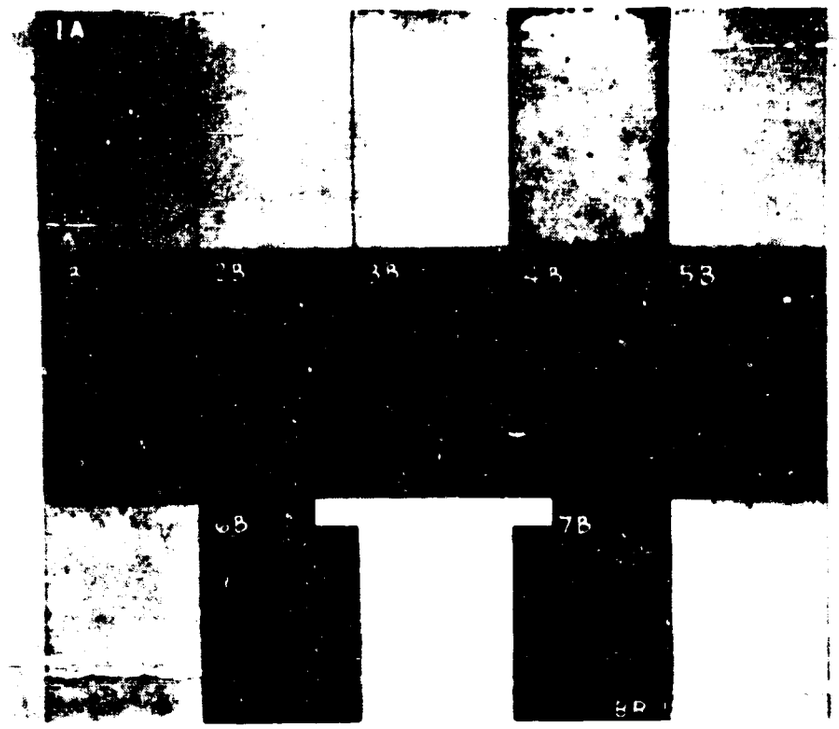

FIGURE 4. Condition of exposed panels of red oxide-high zinc chromate alkyd after the same period as those in Fig. 3.

RECORD OF GLOSS ON WASHED PANELS—IV (continued)

PAINT	Site No.*	Gloss Units Lengths of Exposure (years)				
		1	2	3	4	5
Red Iron Oxide	1	50.8	5.0	5.0	0.4	
- Zinc Chromate	2	67.5	48.9	19.0	0.5	
- Alkyd (ROCA)	3	71.6	38.0	2.4	1.7	
Alkyd Enamel (AE)	4	7.1	13.0	0.6	0.7	
	5	45.1	25.0	1.5	0.2	
	6	77.0	36.0	48.0	—	4.0
	7	56.5	2.2	0.2	—	
Red Iron Oxide	1	50.1	6.0	2.0	0.4	
- Zinc Chromate	2	78.1	46.6	21.0	0.5	
- Alkyd (ROHCA)	3	77.8	44.0	0.3	1.8	
Alkyd Enamel (AE)	4	6.5	16.0	3.4	Nil	
	5	46.8	22.0	1.9	0.25	
	6	87.7	61.0	51.0	—	4.8
	7	59.0	1.6	0.2	—	

*Site 1—Ottawa, Site 2—Saskatoon, Site 3—Montreal, Site 4—Halifax, Site 5—York Redoubt, Site 6—Norman Wells, Site 7—Rocky Point.

GLOSS RENTENTION RANKING OF TEST SITES—V

Rank	Site	Summated Gloss	Years for Gloss to fall below 40 Units	Years for Gloss to fall below 10 Units
1 (best)	Norman Wells (6)	891.2	3+	5
2	Saskatoon (2)	701.8	3	4
3	Montreal (3)	592.9	3	3
4	York Redoubt (5)	340.2	1+	3
5	Rocky Point (7)	296.6	1+	1+
6	Ottawa (1)	266.1	1+	1+
7	Halifax (4)	120.8	1	1

FIGURE 5. Exposed panels of red oxide-zinc chromate in alkyd after four years at site 4 and 10 years at others.

NUMBER OF YEARS FOR CHALKING TO APPEAR—VI

PAINT	Site 1	2	3	4	5	6	7
RLL	1(5)*	1(2)	1(2)	1(5)	1(5)	2(1)	1(5)
WP RLV	2(1)	3(2)	6(1)	4(0)	6(1)	5(1)	2(1)
ROA	6(0)	4(1)	6(0)	6(0)	4(2)	5(0)	5(0)
ROHCA	3(1)	3(1)	3(1)	4(0)	4(1)	5(1)	3(1)
ROCA	3(1)	3(1)	4(1)	4(0)	6(0)	5(0)	5(0)
RLL AE	2(5)	2(1)	3(2)	4(3)	3(3)	5(2)	2(1)
WP RLV AE	2(5)	2(1)	3(2)	4(3)	3(2)	5(2)	2(1)
ROA AE	2(5)	2(1)	3(2)	4(2)	4(2)	5(2)	2(1)
ROHCA AE	2(5)	2(1)	3(2)	4(3)	4(2)	5(2)	2(1)
ROCA AE	2(5)	2(1)	3(2)	4(2)	4(3)	5(2)	2(1)
Total	25(33)	24(12)	35(15)		39(21)	47(13)	26(12)

*The degree of chalking is shown in brackets according to the numerical values given in the following scale: no change 0, trace 1, slight 2, medium 5, very marked 10.

SUMMATION OF CHALKING RATINGS—VII

PAINT	Site 1	2	3	4	5	6	7
RLL	25	25	27	33	28	7	23
WP RLV	3	4	1	0	1	1	4
ROA	0	1	0	0	2	0	0
ROCA	1	1	2	0	0	0	0
ROHCA	4	3	5	0	1	1	3
RLL AE	11	9	7	3	9	2	9
WP RLV AE	11	9	7	3	10	2	9
ROA AE	11	9	7	2	7	2	9
ROCA AE	11	9	7	2	8	2	9
ROHCA AE	11	6	7	3	4	2	9
Total	88	76	70	46	70	19	75
				58*		24*	94*

*The totals shown are based on five years of exposure at all of the sites except numbers 4, 6 and 7. For comparison purposes, values at these sites have been converted from four to five years.

sites. The panels top coated with the alkyd enamel were in excellent condition at all of the sites except Halifax by the end of eight years. By this time, the red-lead panels with the enamel top coat were showing signs of serious failure. At the end of ten years, rusting was in evidence in varying degrees on all of the panels as shown in Table XII.

The primers of red lead-linseed oil and the red lead-vinyl with the wash primer and a top coat of grey alkyd enamel gave best performance, (see Figures 1 and 2). These two paint systems provided good protection against corrosion for a number of years at the Halifax site after the other paints under test had failed. There was little to choose between the other paint systems exposed at the other sites. This is indicated in Figures 3, 4 and 5. All of them gave a good performance for about eight years. (In the figures A indicates top coated panels; B indicates primer.)

The change in gloss of those panels having a high initial gloss is attributable to the particular site conditions rather than to the paint system. The Ottawa site had the most severe atmosphere of all the sites (excluding Halifax) from the point of view of chalking. The Norman Wells and Saskatoon sites were the mildest in this regard.

The Ottawa site was also the most severe for chalking of the grey alkyd enamel. The red-lead primer not top coated showed a high degree of chalking after one year of exposure at all of the sites except Norman Wells and Saskatoon. Of all of the primers, the red iron oxide - alkyd primer showed the highest resistance to chalking.

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REFERENCE

1. Gibbons, E. J. Outdoor Exposure Sites of the National Research Council. Chemistry in Canada Vol. 12, No. 3, March 1960, p. 44. NRC 5593.

TABLE VIII

RANKING DERIVED FROM TABLE VII

(Excluding Site 4)

Rank	Site	Total of all Ratings, 5-year basis
1 (Best)*	Norman Wells (6)	24
2	York Redoubt (5)	70
3	Montreal (3)	70
4	Saskatoon (2)	76
5	Ottawa (1)	88
6	Rocky Point (7)	94

* Lowest rate of chalking.

TABLE IX

RANKING BASED ON FIRST APPEARANCE OF CHALKING

(Excluding Site 4)

Rank	Site	Total Years	Total Ratings
1 (Best)*	Norman Wells (6)	52	13
2	York Redoubt (5)	39	21
3	Montreal (3)	35	15
4	Rocky Point (7)	28	12
5	Saskatoon (2)	24	12
6	Ottawa (1)	25	33

* Lowest rate of chalking.

Occurrence of Rust After Six Years' Exposure—XI

Paint	Site	Observation
RLL	4	Dense rust due to the paint having eroded away.
ROA	1	A few rust blisters.
	3	A few rust blisters.
	5	A few rust blisters.
ROCA	7	Slight rust stain.
ROHCA	5	A few rust spots.
WP RLV AE	1	2½-in. blister patches with rust.
	4	Marked rust blister around edges and a few in the middle
ROA AE	5	A few small blisters.
RLL AE	4	A few #9 rust spots.

NOTE: All site 4 panels not included in this table had been removed at the end of 4 years. All panels from other sites not included in this table did not show any rusting.

TABLE X

DEVELOPMENT OF RUSTING AT SITE NO. 4

PAINT	LENGTH OF EXPOSURE			
	1 year	2 years	3 years	4 years
RLL	None	None	None	None
WP RLV	None	Few rust spots on one panel	Few rust spots on one panel	Large blisters around edge and at centre of one panel
ROA	Medium dense #9 blisters	Dense #8-9 rust nodules with pitting	Dense #8 rust blisters	Medium dense #8 rust nodules
ROCA	Very few very small rust nodules	Few very small rust nodules	Few #9 rust blisters	Few #9 rust nodules
ROHCA	Medium dense microscopic rust nodules	Medium dense #9-9 rust nodules	Few #9 rust blisters	Medium dense #9 rust blisters
RLL AE	Few #9 blisters	Very few rust nodules		Few small rust spots
WP RLV AE	None	None	None	None
ROA AE	Few #9 blisters	Dense very small rust nodules	Medium dense #8 rust blisters	Dense #6 rust blisters
ROCA AE	Medium dense #9 blisters	Dense very small rust nodules	Few #9 rust blisters and few #6 rust blisters	Dense #6 rust blisters
ROHCA AE	None	Few small rust nodules	Dense #6-8 rust blisters	Few #6 rust blisters

Panels for the paints WP RLV, ROA, ROCA, ROHCA, ROA AE, ROCA AE, and ROHCA AE were removed at the end of four years. The proposed ASTM blister ratings system was used in this tabulation.

OCCURRENCE OF RUST AFTER 8 AND 10 YEARS' EXPOSURE — XII

Primer	Site	Exposure 8 years	Exposure 10 years
RED LEAD IN LINSEED OIL (RLL)	1	Completely rusted	No panels left
	2	No rusting	No rusting
	3	Completely rusted	No panels left
	4	No panels left	No panels left
	5	Completely rusted	No panels left
	6	Little or no rusting	Slight edge rust
	7	No rusting	Medium rust at edges
WASH PRIMER (WP) RED LEAD IN VINYL (RLV)	1	Slight rust at edge	Medium rust at edges
	2	No rusting	No rusting
	3	No rusting	Slight rust at edges
	4	No panels left	No panels left
	5	Slight rust at edges	Marked rust at edges
	6	No rusting	No rusting
	7	No rusting	Medium rusting edges
RED IRON OXIDE AND ALKYD (ROA)	1	Medium rusting	Medium rusting
	2	Trace	Trace
	3	Medium rusting	Medium rusting
	4	No panels left	No panels left
	5	Medium rusting	Medium rusting
	6	No rusting	No rusting
	7	No rusting—top side	Medium rusting
RED IRON OXIDE (HIGH) — ZINC CHROMATE — ALKYD (ROHCA)	1	No rusting	Slight rusting edge
	2	No rusting	No rusting
	3	No rusting	Medium rusting
	4	No panels left	No panels left
	5	No rusting	Medium rusting
	6	No rusting	Trace on edge
	7	Trace on back	Marked rusting
RED IRON OXIDE — ZINC CHROMATE — ALKYD (ROCA)	1	Medium rusting	Marked rusting
	2	No rusting	No rusting
	3	Trace	Marked rusting
	4	No panels left	No panels left
	5	No rusting	Marked rusting
	6	No rusting	Trace
	7	No rusting	Marked rusting

FORMULATIONS FOR THE PRIMERS AND ENAMEL (SERIES 1)

Red Iron Oxide Zinc Chromate Alkyd Priming Paint (ROCA)

NRP No. 49	% by weight
Red Iron Oxide	
Mapico 420	16.[illegible]
Zinc Chromate	
Imperial X2127	16.[illegible]
Zinc Oxide	
AZO ZZZ 22	5.27
Magnesium Silicate	
Asbestine 3X	[illegible]
Alkyd Resin Solution	
Duraplex C57, 85%	20.56
Mineral Spirits	24.8[illegible]
24% Lead Naphthenate	[illegible]
6% Cobalt Naphthenate	0.36
Anti-Skinning Agent	0.06
Ground on ball mill	
Pigment	53.82
Nonvolatile Vehicle	17.73
Solvent	28.43
Nonvolatile Matter	
Pigment	75.22
Nonvolatile vehicle	24.77
Pigment Composition	
Iron Oxide	30.40
Zinc Chromate	30.40
Zinc Oxide	9.96
Magnesium Silicate	29.21

Red Lead in Linseed Oil Priming Paint (RLL)

NRP No. 5	% by weight
Red Lead, 98% grade	47.87
Magnesium Silicate —	
Asbestine 3X	9.33
Diatomaceous SiO —	
Dicalite L	6.49
Aluminum Stearate	0.18
Linseed Oil raw	15.01
Linseed Oil Z2 body	9.3[illegible]
Mineral Spirits	11.3[illegible]
24% Lead Naphthenate	0.44
6% Cobalt Naphthenate	0.08
6% Manganese Naphthenate	0.08
Ground on ball mill	
Pigment	64.06
Nonvolatile Vehicle	24.48
Solvent	11.42
Nonvolatile Matter	
Pigment	72.35
Nonvolatile vehicle	27.65
Pigment Composition	
Red Lead, 98% grade	75.15
Magnesium Silicate	14.64
Diatomaceous SiO	[illegible]

Red Lead In Vinyl Priming Paint (RLV)

NRP No. 11	% by weight
Red Lead, 98% grade	22.68
Vinyl Resin —	
Vinylite VAGH	14.94
Tricresyl phosphate	1.54
Methyl Isobutyl Ketone	30.41
Toluene	30.41
Ground on ball mill	
Pigment	22.68
Nonvolatile Vehicle	16.49
Solvent	60.82
Nonvolatile Matter	
Pigment	57.90
Nonvolatile vehicle	42.09
Pigment Composition	
Red Lead, 98% grade	100.00

Wash Primer (WP)

NRP No. 12	% by weight
Part A	
Vinyl Resin —	
Vinylite XYHL	8.98
Zinc Chromate —	
Imperial 2259	8.65
Magnesium Silicate —	
Asbestine 3X	1.28
Lampblack	0.09
n-Butanol	20.04
Ethanol	60.93
Ground on ball mill	
Pigment	10.03
Nonvolatile Vehicle	8.98
Solvent	80.98
Nonvolatile Matter	
Pigment	52.78
Nonvolatile vehicle	47.21
Pigment Composition	
Zinc Chromate	86.26
Magnesium Silicate	12.77
Lampblack	0.95
Part B	
Phosphoric Acid, 85%	18.06
Ethanol	65.80
Water	[illegible].12

Red Iron Oxide (high) — Zinc Chromate — Alkyd Priming Paint (ROHCA)

NRP No. 34	% by weight
Red Iron Oxide	
Mapico 387	20.00
Zinc Chromate	
Imperial Y2087	15.00
Zinc Oxide	
AZO ZZZ 11	10.00
Magnesium Silicate	
Asbestine 3X	5.00
Alkyd Resin Solution	
Glyptal G2466 (70%)	35.00
Linseed Oil raw	6.00
Mineral Spirits	7.50
24% Lead Naphthenate	1.25
6% Cobalt Naphthenate	0.05
6% Manganese Naphthenate	0.20
Ground on ball mill	
Pigment	50.76
Nonvolatile vehicle	30.96
Solvent	18.28
Nonvolatile Matter	
Pigment	62.[illegible]
Nonvolatile Vehicle	37.88
Pigment Composition	
Iron Oxide	40.00
Zinc Chromate	30.00
Zinc Oxide	20.00
Magnesium Silicate	10.00

Grey Alkyd Enamel (AE)

NRP No. 35	% by weight
TiO_2, rutile —	
Titanox RANC	10.06
Iron Oxide, brown —	
Mapico 418	0.15
Lampblack	0.15
Alkyd Resin Solution —	
Glyptal G2475	69.45
Mineral Spirits	18.11
24% Lead Naphthenate	1.66
6% Cobalt Naphthenate	0.07
6% Manganese Naphthenate	0.33
Ground on ball mill	
Pigment	10.58
Nonvolatile Vehicle	42.54
Solvent	46.86
Nonvolatile Matter	
Pigment	19.92
Nonvolatile Vehicle	80.08
Pigment Composition	
TiO	97.03
Iron Oxide	1.45
Lampblack	1.45

Red Iron Oxide-Alkyd Priming Paint (ROA)

NRP No. 48	% by weight
Red Iron Oxide —	
Mapico 420	29.87
Magnesium Silicate —	
Asbestine 3X	14.93
Diatomaceous SiO_2 —	
Celite 110	4.97
Alkyd Resin Solution —	
Duraplex C-57 (85%)	21.16
Mineral Spirits	29.04
24% Lead Naphthenate	0.62
6% Cobalt Naphthenate	0.12
Anti-Skinning Agent	0.04
Ground on ball mill	
Pigment	49.79
Nonvolatile Vehicle	17.98
Solvent	32.21
Nonvolatile Matter	
Pigment	73.46
Nonvolatile Vehicle	26.53
Pigment Composition	
Iron Oxide	60.00
Magnesium Silicate	30.00
Diatomaceous SiO_2	10.00