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MINES BRANCH INVESTIGATION REPORT IR 62-28

COMPILATION OF TEST RESULTS AND STATISTICAL DATA ON PHASE III OF GALVANIZING RESEARCH PROJECT NF-16

by

J. J. SEBISTY & R. H. PALMER

PHYSICAL METALLURGY DIVISION

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SUMMARY

For record purposes, experimental test results and other data on Phase III of Galvanizing Research Project NF-16 have been collected in the appendices which make up this report. This phase of the project, which was conducted by the Mines Branch under the auspices of the Canadian Zinc Research and Development Committee, was concerned with study of the galvanizing behaviour of a series of commercially-produced steel sheet materials. Work involved in preparation and testing of the experimental coatings made, was carried out in the period, October 1, 1959 to February 23, 1961.

The information included comprises test work done at the Mines Branch, Ottawa, Ontario, accelerated corrosion tests made by The Steel Company of Canada, Limited, Hamilton, Ontario, and statistical evaluation studies done by The Consolidated Mining and Smelting Company of Canada, Limited, Trail, B.C.

Discussion of this phase of the galvanizing project and of the results contained herein, is to be covered in a separate research report which will be issued at a later date.

*Senior Scientific Officer, Physical Metallurgy Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

**Research Metallurgist, Canadian Zinc Research and Development Committee.

CONTENTS

APPENDIX I

GALVANIZING DATA, EXPERIMENTAL COATING PROPERTIES AND RELATED TESTS

by

J.J. Sebisty and R.H. Palmer

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INTRODUCTION

The results of experimental work conducted by the Physical Metallurgy Division, Mines Branch on the third phase of Galvanizing Research Project NF-16 are given in this appendix. In this phase, the galvanizing behaviour of a series of commercial steel sheet materials was investigated and assessed by tests on the laboratory-prepared coatings made. Miscellaneous related tests carried out included examination of the mechanical properties, microstructure and pickling behaviour of the steel base materials.

The data given in this section comprise the following:

Table 1. Steel grade, composition and mechanical properties.

Table 2. Experimental galvanizing conditions.

Table 3. Typical galvanizing melt log.

Table 4. Typical galvanizing log.

TABLE 1

Steel Grade, Composition and Mechanical Properties*

Steel No.	Grade of Steel and Condition	Gauge	C %	P %	S %	Mn %	Si %	Cu %	Cr %	Ni %	Al %	V %	UTS kpsi	YS 0.2% offset kpsi	Ratio YS to UTS	El. % in 2 in.	Rockwell Hardness 30T	Rockwell Hardness R_b	Erichsen** Cup Depth - in.
1	Galvanizing grade, as-received	24	0.05	0.010	0.026	0.30	<0.01	-	-	-	0.007	-	45.6	35.7	0.78	36.6	45.7	44	0.331
2	Galvanizing grade, cold rolled-5% reduction												50.1	45.3	0.90	26.7	65.3	73	0.294
3	Galvanizing grade, cold rolled-15% reduction												49.6	47.6	0.96	15.6	69.0	78	0.278
4	Armco iron, as-received	24	0.019	0.010	0.017	0.03	0.03	-	-	-	-	-	-	-	-	-	41.0	38	0.382
5	Armco iron, cold rolled-15% reduction												-	-	-	-	61.8	67	0.296
6	Aluminum-killed, as-received	24	0.12	0.009	0.024	0.28	0.07	-	-	-	0.060	-	45.0	27.1	0.60	39.8	42.0	39	0.413
7	Aluminum-killed, cold rolled-15% reduction												50.4	48.0	0.95	21.6	63.2	70	0.315
8	Hot-rolled normalized, as-received	14	0.04	0.003	0.024	0.26	0.01	-	-	-	0.006	-	51.7	41.4	0.80	38.0	56.3	60	-
9	Hot-rolled normalized, cold rolled-15% reduction												62.1	61.0	0.98	11.1	71.0	81	-
10	Full hard, as-received	24	0.06	0.019	0.025	0.31	<0.01	-	-	-	0.004	-	103.0	99.2	0.96	2.0	81.0	99	0.200
11	Bottle top, as-received	24	0.15	0.012	0.028	0.58	0.02	-	-	-	0.002	-	52.1	37.4	0.72	34.3	52.8	54	0.386
12	Bottle top, cold rolled-15% reduction												59.8	59.9	1.0	8.9	71.8	82	0.294
13	Alloy steel A, as-received	14	0.09	0.025	0.029	0.49	0.38	0.27	0.29	0.32	-	-	72.4	55.9	0.77	30.6	70.8	81	-
14	Alloy steel B, as-received	14	0.15	0.006	0.020	1.10	0.03	0.36	-	-	0.05 sol 0.01 insol	0.08	83.8	64.4	0.77	25.6	77.4	92	-
15	Alloy steel C, as-received	16	0.08	0.075	0.031	0.38	0.29	0.31	0.45	0.30	-	-	67.9	53.8	0.79	29.7	70.9	81	-

*Tensile and hardness values are averages of six or more determinations.

**Diameter of ball and die orifice: 0.875 in. and 1.0 in., respectively.

TABLE 2

Experimental Galvanizing Conditions*

Bath No.	Fe %	Al %	Pb %	Immersion Time, sec	Steel Dipping** Sequence
Experiment "A"					
1	0.03	0.15	0.3	35	11,14,13,9,6,1,4,15,8,10,3,7,12,2,5
2	"	0.15	0.3	60	5,3,6,11,2,15,8,7,13,9,1,14,10,4,12
3	"	0.075	0.3	60	8,9,3,2,14,1,5,11,15,10,13,12,4,6,7
4	"	0.0	0.3	10	7,4,2,12,1,13,15,3,14,9,5,6,10,11,8
5	"	0.075	0.3	35	1,8,10,12,3,14,2,6,9,15,4,13,7,5,11
6	"	0.0	0.3	35	13,7,15,3,9,4,2,5,12,1,11,8,6,10,14
7	"	0.15	0.3	10	8,2,4,3,14,7,13,10,6,5,9,11,12,15,1
8	"	0.0	0.3	60	5,6,10,2,12,1,15,11,7,14,8,4,13,3,9
9	"	0.075	0.3	60	1,10,14,4,8,2,6,12,5,7,9,3,15,11,13
10	"	0.075	0.3	35	13,8,7,9,11,15,1,2,10,3,12,5,6,4,14
11	"	0.15	0.3	10	3,14,11,15,10,1,13,9,8,4,2,5,6,7,12
12	"	0.075	0.3	10	12,6,14,13,15,1,11,4,8,10,3,7,2,9,5
13	"	0.15	0.3	60	10,7,5,2,8,1,3,13,6,14,15,12,9,11,4
14	"	0.0	0.3	10	1,2,8,13,5,15,3,11,10,7,4,12,6,9,14
15	"	0.15	0.3	35	8,10,4,11,12,3,6,14,13,2,15,5,7,9,1
16	"	0.075	0.3	10	2,11,5,12,1,9,8,3,15,4,10,6,7,14,13
17	"	0.0	0.3	60	13,2,7,11,5,15,8,14,9,4,10,12,3,6,1
18	"	0.0	0.3	35	10,9,5,2,14,3,4,11,13,8,12,15,6,7,1
Experiment "B"					
19	"	0.0	1.0	240	7,4,2,12,1,13,15,3,14,9,5,6,10,11,8
20	"	0.0	1.0	120	13,7,15,3,9,4,2,5,12,1,11,8,6,10,14
21	"	0.0	1.0	60	5,6,10,2,12,1,15,11,7,14,8,4,13,3,9
22	"	0.0	1.0	240	1,2,8,13,5,15,3,11,10,7,4,12,6,9,14
23	"	0.0	1.0	60	13,2,7,11,5,15,8,14,9,4,10,12,3,6,1
24	"	0.0	1.0	120	10,9,5,2,14,3,4,11,13,8,12,15,6,7,1
25	"	0.0	0.3	240	7,4,2,12,1,13,15,3,14,9,5,6,10,11,8
26	"	0.0	0.3	120	13,7,15,3,9,4,2,5,12,1,11,8,6,10,14
27	"	0.0	0.3	240	1,2,8,13,5,15,3,11,10,7,4,12,6,9,14
28	"	0.0	0.3	120	10,9,5,2,14,3,4,11,13,8,12,15,6,7,1

*Bath temperature for all tests: 450°C (840°F).

**Four, 4 in. by 6 in. and two, 3 in. by 4 in. panels of each grade of steel were galvanized in order indicated in each bath. For tensile testing, three extra panels of each of the alloy grades, A, B and C, were galvanized in baths 2, 3, 4, 7, 8 and 12.

TABLE 3

Typical Galvanizing Melt Log

Mines Branch	NON-FERROUS SECTION	Project: NF-16
Physical Metallurgy Division	GALVANIZING MELT LOG	Date: June 8, 1960

Melt No. KN (Bath No. 13)

Charge 36 lb

Metal	Composition	Form	Amount
Zn	99.99%	ingot	30 lb, 3 oz
Pb	99.99%	sheet	47.7 g
Zn-Fe master	0.30% Fe	shot	1590 g
Zn-Al master	4.0% Al	shot	620 g

Procedure	Time	Temp	Remarks
Furnace on	8.30 am		
Zinc charged	8.35 am		
Alloying: Pb	8.35 am		
Zn-Al master	10.30 am	475°C	
Zn-Fe master	10.45 am	478°C	
Zn-Al master			Extra additions made during galvanizing
Poured to ingot after galvanizing	6.30 pm		

Bath Composition	Fe %	Al %	Pb %	Remarks
Nominal	0.03	0.15	0.3	
Actual				
Start	0.028	0.155	0.30	Before galvanizing
Second sample	0.027	0.149	0.31	After dipping steels 10, 7, 5, 2
Third sample	0.028	0.145	0.29	" " " 8, 1, 3, 13
Fourth sample	0.029	0.147	0.30	" " " 6, 14, 15, 12
Final sample	0.030	0.142	0.30	" " " 9, 11, 4

TABLE 4

Typical Galvanizing Log

Mines Branch	NON-FERROUS SECTION	Project: NF-16
Physical Metallurgy Division	GALVANIZING LOG	Date: June 8, 1960

Melt No. KN (Bath No. 13)

Material Treated

60 panels, 4 in. by 6 in. (steels 1 to 15)
30 panels, 3 in. by 4 in. (steels 1 to 15)

Pickling

Sample No.	Acid Concentration	Inhibitor	Time & Temp	Rinse
All	5% H_2SO_4 solution	1/2% by volume of acid (Rodine 92)	5 min at 70°C	Scrubbed and rinsed for 1 min in cold running water. Dried in acetone

Fluxing

Sample No.	Flux Composition	Density	Time & Temp	Drying Time & Temp
All	Zinc chloride-ammonium chloride (1.27:1.35 ratio flux)	10.4° Baume	1 min at 80°C	1.5 to 2 min at 160° to 170°C

Galvanizing

Sample No.	Steel	Bath Temp °C	Immersion Speed	Immersion Time	Withdrawal Speed	Remarks
10N 1 to 4	10	450 to 452	6 fpm	60 sec	3 fpm	
7N 1 to 4	7	448 to 450	"	"	"	
5N 1 to 4	5	450 to 451	"	"	"	
2N 1 to 4	2	450 -	"	"	"	40 g Zn-Al master added
8N 1 to 4	8	448 to 450	"	"	"	
1N 1 to 4	1	450 -	"	"	"	
3N 1 to 4	3	450 to 452	"	"	"	
13N 1 to 4	13	449 to 450	"	"	"	40 g Zn-Al master added
6N 1 to 4	6	450 to 451	"	"	"	
14N 1 to 4	14	449 to 451	"	"	"	
15N 1 to 4	15	449 to 452	"	"	"	
12N 1 to 4	12	450 to 451	"	"	"	40 g Zn-Al master added
9N 1 to 4	9	450 to 452	"	"	"	
11N 1 to 4	11	450 to 451	"	"	"	
4N 1 to 4	4	449 to 452	"	"	"	

Steel Weight Loss Specimens

After galvanizing of each group of large panels, two, 3 in. by 4 in. panels of corresponding steel in each case were dipped for 60 sec by manual immersion and withdrawal (approx. 8 fpm).

TABLE 5

Chemical Composition of Galvanizing Baths*

Bath No.	Sample No.	Fe %	Al %	Pb %
Experiment "A"				
1	N	0.03	0.15	0.3
	1	0.027	0.146	0.26
	2	0.029	0.146	0.26
	3	0.029	0.154	0.26
	4	0.030	0.154	0.26
	5	0.030	0.144	0.26
2	N	0.03	0.15	0.3
	1	0.029	0.155	0.29
	2	0.030	0.149	0.29
	3	0.030	0.149	0.29
	4	0.030	0.142	0.27
	5	0.031	0.139	0.27
3	N	0.03	0.075	0.3
	1	0.030	0.077	0.31
	2	0.033	0.070	0.30
	3	0.036	0.070	0.30
	4	0.037	0.067	0.28
	5	0.040	0.067	0.29
4	N	0.03	-	0.3
	1	0.030	-	0.33
	2	0.030	-	0.34
	3	0.030	-	0.33
	4	0.031	-	0.33
	5	0.032	-	0.34
5	N	0.03	0.075	0.3
	1	0.029	0.073	0.31
	2	0.032	0.070	0.31
	3	0.034	0.067	0.31
	4	0.036	0.068	0.28
	5	0.037	0.065	0.28
6	N	0.03	-	0.3
	1	0.030	-	0.30
	2	0.032	-	0.32
	3	0.030	-	0.33
	4	0.032	-	0.33
	5	0.033	-	0.34

TABLE 5 (Cont'd.)

Chemical Composition of Galvanizing Baths*

Bath No.	Sample No.	Fe %	Al %	Pb %
7	N	0.03	0.15	0.3
	1	0.030	0.152	0.30
	2	0.028	0.148	0.29
	3	0.028	0.147	0.31
	4	0.028	0.146	0.28
	5	0.029	0.147	0.30
8	N	0.03	-	0.3
	1	0.030	-	0.32
	2	0.031	-	0.33
	3	0.030	-	0.31
	4	0.033	-	0.31
	5	0.035	-	0.32
9	N	0.03	0.075	0.3
	1	0.029	0.071	0.31
	2	0.032	0.069	0.31
	3	0.032	0.069	0.29
	4	0.033	0.066	0.29
	5	0.033	0.065	0.28
10	N	0.03	0.075	0.3
	1	0.030	0.072	0.29
	2	0.033	0.069	0.31
	3	0.033	0.069	0.31
	4	0.036	0.070	0.30
	5	0.036	0.072	0.31
11	N	0.03	0.15	0.3
	1	0.029	0.148	0.31
	2	0.029	0.140	0.29
	3	0.028	0.139	0.32
	4	0.028	0.140	0.31
	5	0.027	0.145	0.31
12	N	0.03	0.075	0.3
	1	0.029	0.078	0.29
	2	0.032	0.072	0.29
	3	0.033	0.070	0.30
	4	0.035	0.074	0.30
	5	0.036	0.079	0.31

TABLE 5 (Cont'd.)

Chemical Composition of Galvanizing Baths*

Bath No.	Sample No.	Fe %	Al %	Pb %
13	N	0.03	0.15	0.3
	1	0.028	0.155	0.30
	2	0.027	0.149	0.31
	3	0.028	0.145	0.29
	4	0.029	0.147	0.30
	5	0.030	0.142	0.30
14	N	0.03	-	0.3
	1	0.029	-	0.31
	2	0.031	-	0.31
	3	0.032	-	0.28
	4	0.031	-	0.28
	5	0.033	-	0.29
15	N	0.03	0.15	0.3
	1	0.031	0.156	0.30
	2	0.030	0.145	0.30
	3	0.029	0.144	0.30
	4	0.030	0.143	0.30
	5	0.028	0.144	0.30
16	N	0.03	0.075	0.3
	1	0.028	0.073	0.31
	2	0.030	0.069	0.31
	3	0.032	0.074	0.28
	4	0.035	0.078	0.31
	5	0.036	0.076	0.32
17	N	0.03	-	0.3
	1	0.033	-	0.32
	2	0.035	-	0.32
	3	0.035	-	0.31
	4	0.035	-	0.29
	5	0.035	-	0.29
18	N	0.03	-	0.3
	1	0.030	-	0.32
	2	0.031	-	0.32
	3	0.031	-	0.31
	4	0.031	-	0.32
	5	0.032	-	0.33

TABLE 5 (Cont'd)

Chemical Composition of Galvanizing Baths*

Bath No.	Sample No.	Fe %	Al %	Pb %
Experiment "B"				
19	N	0.03	-	1.0
	1	0.026	-	1.02
	2	0.027	-	1.05
	3	0.029	-	1.08
	4	0.031	-	1.11
	5	0.032	-	1.13
20	N	0.03	-	1.0
	1	0.029	-	1.07
	2	0.028	-	1.07
	3	0.028	-	1.07
	4	0.028	-	0.99
	5	0.029	-	1.12
21	N	0.03	-	1.0
	1	0.027	-	0.95
	2	0.028	-	0.99
	3	0.028	-	0.97
	4	0.030	-	0.94
	5	0.031	-	0.94
22	N	0.03	-	1.0
	1	0.029	-	1.00
	2	0.030	-	1.05
	3	0.030	-	1.05
	4	0.029	-	1.05
	5	0.032	-	1.08
23	N	0.03	-	1.0
	1	0.026	-	0.93
	2	0.028	-	0.99
	3	0.028	-	1.02
	4	0.029	-	1.04
	5	0.030	-	1.06
24	N	0.03	-	1.0
	1	0.027	-	1.02
	2	0.030	-	1.04
	3	0.031	-	1.05
	4	0.031	-	1.07
	5	0.033	-	1.11

TABLE 5 (Cont'd.)

Chemical Composition of Galvanizing Baths*

Bath No.	Sample No.	Fe %	Al %	Pb %
25	N	0.03	-	0.3
	1	0.029	-	0.32
	2	0.033	-	0.34
	3	0.032	-	0.33
	4	0.031	-	0.33
	5	0.033	-	0.33
26	N	0.03	-	0.3
	1	0.029	-	0.31
	2	0.031	-	0.33
	3	0.029	-	0.33
	4	0.030	-	0.32
	5	0.032	-	0.34
27	N	0.03	-	0.3
	1	0.029	-	0.32
	2	0.030	-	0.32
	3	0.033	-	0.34
	4	0.035	-	0.34
	5	0.036	-	0.34
28	N	0.03	-	0.3
	1	0.030	-	0.31
	2	0.033	-	0.32
	3	0.033	-	0.31
	4	0.033	-	0.33
	5	0.033	-	0.34

* N - Nominal composition.
1, 5 - Sample at start and end of run, respectively.
2, 3 & 4 - Samples taken after dipping 16, 32 and 48 large panels, respectively.

TABLE 6

Spectrographic Analyses of Chill-Cast Bath Samples*

Bath No.	Disc** Sample	Pb %	Cd %	Cu %	Fe %	Mn %	Cr %	Ni %	Al %
19	KU 1	0.81	0.0003	0.0008	0.032	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	KU 2	0.93	0.0003	0.0014	0.035	0.0004	ND <0.0001	0.0003	ND <0.001
20	KV 1	0.95	0.0003	0.0007	0.033	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	KV 2	1.11	0.0003	0.0013	0.036	0.0006	0.0001	0.0003	TR <0.001
21	KW 1	0.99	0.0003	0.0009	0.028	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	KW 2	1.17	0.0003	0.0017	0.033	0.0007	0.0001	0.0003	0.001
22	KX 1	0.81	0.0003	0.0006	0.031	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	KX 2	1.02	0.0003	0.0012	0.034	0.0004	ND <0.0001	0.0003	ND <0.001
23	KY 1	1.00	0.0003	0.0009	0.026	ND <0.0001	ND <0.0001	0.0001	ND <0.001
	KY 2	1.04	0.0003	0.0016	0.032	0.0007	0.0001	0.0003	ND <0.001
24	KZ 1	0.99	0.0003	0.0008	0.029	ND <0.0001	ND <0.0001	0.0001	ND <0.001
	KZ 2	1.06	0.0003	0.0014	0.030	0.0005	0.0001	0.0003	ND <0.001
25	LA 1	0.31	0.0003	0.0004	0.031	ND <0.0001	ND <0.0001	0.0001	ND <0.001
	LA 2	0.33	0.0003	0.0013	0.033	0.0006	0.0001	0.0003	ND <0.001
26	LB 1	0.30	0.0003	0.0007	0.030	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	LB 2	0.32	0.0003	0.0014	0.033	0.0007	0.0001	0.0003	TR <0.001
27	LC 1	0.32	0.0003	0.0005	0.032	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	LC 2	0.33	0.0003	0.0018	0.031	0.0006	0.0002	0.0003	ND <0.001
28	LD 1	0.30	0.0003	0.0008	0.034	ND <0.0001	ND <0.0001	ND <0.0001	ND <0.001
	LD 2	0.33	0.0003	0.0015	0.033	0.0005	0.0001	0.0002	ND <0.001

*Si % and V % in all samples: ND <0.001%
Ag % in all samples: 0.0002%
Ca % in all samples: Tr

**Baths sampled at start and end of each galvanizing run.

TABLE 7

Coating Test Results for Typical Series of Specimens* (As-received Steel Grades)

Bath No.	Steel No.	Coating Wt. oz/sq ft - sheet	Iron Content mg/sq ft	Iron Content g/m²	Steel Wt. Loss g/m²	Alloy Thickness mm x 10-3	Proportion of Alloy %	Ductility	Adherence	Spangles (or grains) per in.²	Spangle Contrast	Brightness	Roughness	Aluminum in Coating %
5	1	1.35	1903	20.5	20.5	17.5	61.2	2.5	5.0	128	1.5	2.0	1.0	0.25
5	1	-	-	-	20.4	-	-	-	-	128	1.5	2.0	1.0	-
10	1	1.33	1874	20.2	19.7	17.5	62.3	2.5	5.0	128	1.5	2.0	1.0	0.25
10	1	1.32	1818	19.6	19.7	-	-	-	5.0	128	1.5	2.0	1.0	0.26
5	4	1.40	1846	19.9	20.9	18.1	61.1	2.5	5.0	128	1.5	2.0	1.5	0.20
5	4	1.40	1846	19.9	20.4	-	-	-	5.0	128	1.5	2.0	1.0	-
10	4	1.36	1832	19.7	19.4	17.8	61.8	2.5	5.0	128	1.5	2.0	1.5	0.27
10	4	-	-	-	19.7	-	-	-	-	128	1.5	2.0	1.0	0.29
5	6	1.41	1960	21.1	20.6	20.0	65.6	2.5	4.5	128	2.0	2.0	1.5	0.23
5	6	1.47	1903	20.5	21.0	-	-	-	5.0	128	2.0	2.0	1.5	-
10	6	1.39	1789	19.3	20.4	19.8	67.3	2.5	5.0	128	2.0	2.0	1.5	0.28
10	6	-	-	-	21.2	-	-	-	-	128	2.0	2.0	1.5	0.28
5	8	1.63	2953	31.9	20.6	25.9	74.2	-	-	128	2.0	2.0	2.5	0.25
5	8	1.66	2939	31.7	20.6	-	-	-	-	90	2.0	2.0	2.5	-
10	8	1.65	3053	32.9	19.7	25.6	73.4	-	-	90	2.0	2.0	2.5	0.25
10	8	-	-	-	18.8	-	-	-	-	128	2.0	2.0	2.5	0.24
5	10	1.48	2016	21.7	25.6	17.5	56.0	2.5	5.5	256	2.0	2.0	1.0	0.23
5	10	-	-	-	24.6	-	-	-	-	256	2.0	2.0	1.0	-
10	10	1.50	2215	23.9	24.1	17.5	56.0	2.5	5.5	256	2.0	2.0	1.0	0.24
10	10	1.45	2116	22.8	24.4	-	-	-	5.5	256	2.0	2.0	1.0	0.27
5	11	1.35	2059	22.2	24.4	17.4	60.4	2.5	5.0	362	2.0	2.0	1.0	0.21
5	11	1.37	2144	23.1	24.5	-	-	-	5.0	362	2.0	2.0	1.0	-
10	11	1.35	2343	25.2	23.8	17.5	61.2	2.5	5.0	362	2.0	2.0	1.0	0.28
10	11	-	-	-	24.2	-	-	-	-	362	2.0	2.0	1.0	0.29
5	13	0.91	1164	12.5	20.9	5.3	27.5	-	-	256	2.5	2.0	2.0	0.19
5	13	-	-	-	20.4	-	-	-	-	256	2.5	2.0	2.0	-
10	13	0.90	1264	13.6	21.0	4.5	23.1	-	-	256	2.5	2.0	1.5	0.23
10	13	0.94	1179	12.7	20.9	-	-	-	-	256	2.5	2.0	2.0	0.22
5	14	1.91	2485	26.8	18.5	23.5	53.2	-	-	256	3.0	3.0	4.0	0.19
5	14	-	-	-	18.6	-	-	-	-	256	3.0	3.0	4.0	-
10	14	1.59	1463	15.8	18.8	22.8	66.8	-	-	256	3.0	3.0	4.0	0.22
10	14	1.63	1647	17.7	19.7	-	-	-	-	256	3.0	3.0	4.0	0.21
5	15	1.06	866	9.3	32.2	10.5	46.7	-	-	256	3.0	2.0	2.5	0.20
5	15	-	-	-	31.4	-	-	-	-	256	3.0	2.0	2.5	-
10	15	1.06	866	9.3	32.2	10.0	46.0	-	-	256	3.0	2.0	2.5	0.24
10	15	1.00	880	9.5	32.0	-	-	-	-	181	3.0	2.0	2.5	0.25

*Alloy thickness values are averages of twenty measurements on single samples.
For ductility, adherence and surface appearance rating codes, see Table 9.

TABLE 8

Average Coating Test Results*

Bath No.	Steel No.	Coating Wt. oz/sq ft-sheet	Iron Content mg/sq ft	Iron Content g/m^2	Steel Wt. Loss g/m^2	Alloy Thickness mm x 10^{-3}	Proportion of Alloy %	Ductility	Adherence	Spangles (or grains) per in.^{2}	Spangle Contrast	Brightness	Smoothness	Aluminum in Coating %	Lead in Coating %
Experiment "A"															
1, 15	1	0.50	241	2.6	4.4	1.5	14.2	1.0	1.0	128	3.5	1.0	1.5	0.60	-
	2	0.49	241	2.6	4.5	1.5	14.0	1.0	1.0	128	3.5	2.0	1.5	0.61	-
	3	0.50	204	2.2	3.9	1.1	10.1	1.0	1.0	128	3.5	1.5	1.5	0.65	-
	4	0.49	222	2.4	5.4	1.5	14.2	1.0	1.0	128	3.5	1.5	1.9	0.60	-
	5	0.52	232	2.5	4.8	1.5	13.3	1.0	1.0	128	3.5	2.0	1.8	0.52	-
	6	0.52	170	1.8	5.4	0.8	6.9	1.0	1.0	128	3.5	2.0	2.0	0.67	-
	7	0.55	213	2.3	6.1	0.8	6.2	1.0	1.0	128	3.5	2.0	2.0	0.65	-
	8	0.61	324	3.5	5.9	1.5	11.6	-	-	128	3.5	2.0	3.1	0.60	-
	9	0.72	565	6.1	7.2	2.5	16.2	-	-	128	3.5	2.0	3.4	0.64	-
	10	1.27	2115	22.8	25.5	16.1	59.2	2.0	4.5	181	2.0	2.0	1.5	0.56	-
	11	0.54	334	3.6	6.8	1.5	13.2	1.0	1.0	362	3.5	2.0	1.6	0.63	-
	12	0.56	287	3.1	8.0	1.1	9.1	1.0	1.0	362	3.5	2.0	1.5	0.57	-
	13	0.79	842	9.1	18.2	0.8	4.5	-	-	256	3.5	1.5	3.0	0.57	-
	14	0.77	574	6.2	11.7	1.9	11.7	-	-	256	3.5	2.0	4.0	0.57	-
	15	2.26	2640	28.5	33.4	19.4	39.8	-	-	362	3.0	3.0	1.6	0.48	-
2, 13	1	0.59	315	3.4	5.4	2.6	17.7	1.3	1.0	128	3.5	2.0	1.9	0.63	-
	2	0.59	278	3.0	5.2	1.5	11.8	1.0	1.0	128	3.5	2.0	2.0	0.72	-
	3	0.53	232	2.5	4.8	1.5	13.8	1.0	1.0	119	3.5	2.0	2.0	0.66	-
	4	0.73	380	4.1	6.3	2.5	16.1	1.0	1.1	128	3.5	2.0	2.0	0.56	-
	5	0.53	259	2.8	4.8	1.5	13.4	1.0	1.1	128	3.5	1.0	2.0	0.73	-
	6	0.74	370	4.0	6.1	2.5	15.9	1.0	1.1	109	3.5	2.0	2.0	0.68	-
	7	0.70	352	3.8	6.2	2.5	16.6	1.0	1.0	109	3.5	2.0	2.0	0.77	-
	8	0.63	436	4.7	5.8	4.3	17.4	-	-	100	3.5	2.5	3.5	0.68	-
	9	0.97	965	10.4	9.2	5.8	26.6	-	-	90	3.5	2.5	3.4	0.58	-
	10	1.63	2545	27.5	30.8	21.0	60.0	2.5	4.6	90	2.0	2.0	1.0	0.61	-
	11	0.83	741	8.0	9.8	3.8	22.3	1.0	1.0	362	3.5	2.0	2.0	0.61	-
	12	1.02	861	9.3	12.7	5.4	25.2	1.0	1.0	362	3.5	2.0	1.8	0.60	-
	13	0.96	1019	11.0	21.4	2.0	9.9	-	-	181	3.5	2.0	3.0	0.60	-
	14	0.90	704	7.6	11.9	4.7	23.1	-	-	181	3.5	2.0	4.0	0.67	-
	15	1.73	1158	12.5	44.9	7.5	20.2	-	-	181	3.0	3.0	1.5	0.51	-
3, 9	1	1.66	2458	26.5	25.3	23.2	66.4	3.0	5.5	50	1.4	1.8	1.0	0.27	-
	2	1.63	2478	26.7	25.7	22.9	66.2	3.0	5.5	45	1.4	1.5	1.0	0.27	-
	3	1.64	2403	25.9	25.2	23.0	66.0	3.0	5.5	35	1.4	1.8	1.0	0.27	-
	4	1.78	2365	25.5	26.1	23.9	63.2	3.0	6.0	112	1.6	2.0	1.0	0.25	-
	5	1.66	2310	24.9	25.2	23.4	66.0	3.0	6.0	64	1.5	2.0	1.0	0.28	-
	6	1.88	2460	26.5	25.7	24.5	62.5	3.0	5.3	50	1.5	2.0	1.5	0.26	-
	7	1.91	2618	28.2	26.5	24.3	60.3	3.0	5.3	45	1.5	2.0	1.3	0.25	-
	8	2.06	3640	39.2	28.8	33.3	75.8	-	-	83	2.5	2.3	2.5	0.27	-
	9	2.08	3462	37.3	28.5	33.0	75.1	-	-	83	2.5	2.5	2.5	0.27	-
	10	1.91	2858	30.8	31.1	26.2	65.0	3.0	6.0	109	1.9	2.0	1.0	0.26	-
	11	1.70	2762	29.8	26.3	24.3	67.5	3.0	5.5	181	2.0	2.0	1.0	0.28	-
	12	1.69	2700	29.1	26.2	24.2	67.6	3.0	5.5	200	2.0	2.0	1.0	0.29	-
	13	1.01	1558	16.8	22.7	6.1	28.3	-	-	181	2.5	2.0	2.0	0.25	-
	14	2.20	2865	30.9	26.3	33.0	71.1	-	-	256	3.0	3.0	4.0	0.27	-
	15	2.14	2062	22.2	42.5	11.8	28.5	-	-	181	3.0	3.0	2.5	0.27	-
4, 14	1	1.41	1605	17.3	15.3	15.5	52.0	2.5	5.5	23	2.0	3.0	1.5	-	0.18
	2	1.32	1532	16.5	15.5	15.4	55.4	2.0	5.3	23	2.0	3.0	1.5	-	-
	3	1.31	1458	15.7	14.9	15.6	55.6	2.0	5.3	23	2.0	3.0	1.5	-	-
	4	1.35	1578	17.0	15.2	16.2	56.4	2.5	5.5	23	2.0	3.0	1.5	-	-
	5	1.36	1568	16.9	15.1	16.2	56.5	2.0	5.5	23	2.0	3.0	1.5	-	-
	6	1.41	1642	17.7	15.5	16.0	59.9	2.3	5.5	32	2.5	3.0	1.5	-	0.17
	7	1.40	1745	18.8	15.8	18.8	63.5	2.5	5.5	32	2.5	3.0	1.5	-	-
	8	1.63	2262	24.4	13.1	18.6	53.8	-	-	23	2.5	4.0	2.0	-	0.20
	9	1.67	2338	25.2	13.5	18.8	53.0	-	-	23	2.5	4.0	2.0	-	0.19
	10	1.43	1708	18.4	19.5	17.5	57.9	2.0	5.6	32	2.5	3.0	1.5	-	0.17
	11	1.32	1699	18.3	16.5	15.4	55.2	2.5	5.5	18	2.5	3.0	1.5	-	-
	12	1.34	1485	16.0	16.0	14.3	50.3	2.5	5.4	18	2.5	3.0	1.5	-	-
	13	2.03	2815	30.3	23.7	25.4	58.6	-	-	16	3.5	3.8	1.5	-	0.21
	14	2.08	2660	28.7	18.2	25.0	56.3	-	-	16	3.5	4.5	3.0	-	0.20
	15	1.64	2460	26.5	20.9	25.0	72.1	-	-	8	2.0	4.0	1.5	-	0.18

TABLE 8 (Cont'd.)

Average Coating Test Results*

Bath No.	Steel No.	Coating Wt. oz/sq ft - sheet	Iron Content mg/sq ft	Iron Content g/m^2	Steel Wt. Loss g/m^2	Alloy Thickness mm x 10^{-3}	Proportion of Alloy %	Ductility	Adherence	Spangles (or grains) per in.^{2}	Spangle Contrast	Brightness	Smoothness	Aluminum in Coating %	Lead in Coating %
5, 10	1	1.33	1865	20.1	20.1	17.5	61.8	2.5	5.0	128	1.5	2.0	1.0	0.25	-
	2	1.33	1865	20.1	19.8	17.4	62.5	2.5	5.0	128	1.5	2.0	1.0	0.24	-
	3	1.31	1838	19.8	19.6	17.2	62.3	2.5	5.0	128	1.5	2.0	1.0	0.26	-
	4	1.39	1838	19.8	20.1	18.0	61.5	2.5	5.0	128	1.5	2.0	1.3	0.25	-
	5	1.32	1800	19.4	20.4	17.5	62.0	2.5	5.0	128	1.5	2.0	1.3	0.26	-
	6	1.42	1882	20.3	20.8	19.9	66.5	2.5	4.8	128	2.0	2.0	1.5	0.26	-
	7	1.47	1882	20.3	20.3	19.8	67.5	2.5	4.5	119	2.0	2.0	1.0	0.25	-
	8	1.65	2985	32.2	19.9	25.8	73.8	-	-	109	2.0	2.0	2.5	0.25	-
	9	1.63	2922	31.5	20.6	24.6	71.4	-	-	128	2.0	2.0	2.5	0.24	-
	10	1.48	2118	22.8	24.7	17.5	56.0	2.5	5.5	256	2.0	2.0	1.0	0.25	-
	11	1.36	2180	23.5	24.2	17.5	60.8	2.5	5.0	362	2.0	2.0	1.0	0.26	-
	12	1.33	2162	23.3	24.0	16.7	58.9	2.5	5.0	362	2.0	2.0	1.0	0.27	-
	13	0.92	1198	12.9	20.8	4.9	25.3	-	-	256	2.5	2.0	1.9	0.21	-
	14	1.71	1865	20.1	18.9	23.2	62.5	-	-	256	3.0	3.0	4.0	0.21	-
	15	1.04	872	9.4	32.0	10.3	46.4	-	-	237	3.0	2.0	2.5	0.23	-
6, 18	1	1.79	2142	23.1	22.1	18.9	49.8	3.0	5.5	16	2.3	3.0	1.5	-	0.16
	2	1.58	1985	21.4	21.7	17.4	52.4	3.0	5.5	16	2.4	3.0	1.5	-	-
	3	1.55	1920	20.7	21.1	16.9	51.1	2.5	5.5	16	2.4	3.0	1.5	-	-
	4	1.78	2118	22.8	21.9	19.3	51.0	2.5	5.5	16	2.5	3.0	1.5	-	-
	5	1.66	2035	21.9	21.0	19.6	55.9	2.5	5.5	16	2.5	3.0	1.5	-	-
	6	1.99	2382	25.7	24.9	23.5	55.3	2.8	5.5	16	2.6	3.0	1.5	-	0.35
	7	1.92	2403	25.9	26.9	22.9	56.2	2.5	5.5	18	2.6	3.0	1.5	-	-
	8	1.98	2638	28.4	17.6	23.7	56.0	-	-	16	2.5	3.5	2.0	-	0.20
	9	2.14	2710	29.2	20.1	23.9	52.5	-	-	15	2.5	3.5	1.8	-	0.19
	10	1.82	2258	24.3	28.2	22.7	58.5	2.0	5.5	16	2.6	3.0	1.5	-	0.16
	11	1.79	2262	24.4	24.8	22.6	59.4	2.5	5.5	16	2.6	3.0	1.5	-	-
	12	1.59	2105	22.7	24.1	19.0	56.1	2.5	5.5	16	2.6	3.0	1.5	-	-
	13	2.50	3838	41.3	38.5	36.5	69.6	-	-	16	3.0	3.0	1.5	-	0.36
	14	2.87	3135	33.8	25.1	27.2	44.8	-	-	16	3.5	3.0	3.0	-	0.18
	15	2.53	3480	37.5	39.9	42.4	79.0	-	-	8	2.0	4.0	1.5	-	0.15
7, 11	1	0.43	189	2.0	4.4	0.8	8.1	1.0	1.0	155	3.5	1.0	1.5	0.48	-
	2	0.40	161	1.7	3.6	0.8	8.7	1.0	1.0	155	3.5	1.0	1.5	0.47	-
	3	0.42	170	1.8	3.7	0.8	8.3	1.0	1.0	181	3.5	1.0	1.5	0.49	-
	4	0.44	170	1.8	3.0	0.8	8.1	1.0	1.0	155	3.5	1.3	2.0	0.51	-
	5	0.45	180	1.9	3.5	0.8	7.9	1.0	1.0	155	3.5	1.0	2.0	0.47	-
	6	0.48	161	1.7	4.7	0.8	7.4	1.0	1.0	181	3.5	2.0	2.0	0.48	-
	7	0.52	142	1.5	4.5	0.8	6.8	1.0	1.0	181	3.5	2.0	2.0	0.47	-
	8	0.57	269	2.9	4.0	0.8	6.2	-	-	128	3.5	2.0	3.4	0.54	-
	9	0.71	482	5.2	5.8	1.5	10.2	-	-	181	3.5	2.5	3.0	0.49	-
	10	0.78	1040	11.2	19.2	6.6	40.0	1.5	3.0	355	2.5	2.0	1.5	0.45	-
	11	0.50	269	2.9	5.2	0.8	7.2	1.0	1.0	362	3.5	2.0	1.6	0.49	-
	12	0.45	418	4.5	7.9	0.8	8.1	1.0	1.0	362	3.5	2.0	1.5	0.51	-
	13	0.94	890	9.6	15.9	0.8	3.8	-	-	256	3.5	2.0	3.0	0.47	-
	14	0.94	566	6.1	7.9	1.5	7.7	-	-	256	3.5	2.0	4.0	0.49	-
	15	1.27	992	10.7	15.0	11.0	37.0	-	-	256	3.5	2.0	2.0	0.44	-
8, 17	1	2.05	2550	27.5	29.8	22.2	50.9	3.0	6.0	18	2.9	3.0	1.5	-	0.14
	2	1.81	2383	25.7	27.6	21.5	55.9	3.0	6.0	15	2.9	3.0	1.3	-	-
	3	1.76	2350	25.3	26.7	21.0	56.0	3.0	6.0	16	2.9	3.0	1.4	-	-
	4	1.92	2505	27.0	28.1	25.9	64.0	3.0	6.0	14	2.8	3.0	1.5	-	-
	5	1.84	2450	26.4	26.2	25.6	65.5	3.0	6.0	16	2.8	3.0	1.5	-	-
	6	2.44	2980	32.1	32.6	29.2	56.6	3.0	6.0	32	3.0	3.0	1.6	-	0.13
	7	2.20	2840	30.6	31.5	28.9	61.9	3.0	6.0	32	3.0	3.0	1.8	-	-
	8	2.34	3380	36.4	31.0	25.8	51.6	-	-	9	2.5	3.5	1.8	-	0.17
	9	2.46	3360	36.2	27.4	25.6	49.0	-	-	9	2.5	3.0	1.8	-	0.15
	10	2.11	2675	28.8	31.8	27.2	61.1	2.0	6.0	13	3.0	3.0	1.5	-	0.13
	11	2.07	2643	28.5	30.6	23.8	54.1	3.0	6.0	16	3.0	3.0	1.5	-	-
	12	1.89	2420	26.1	30.2	21.8	55.8	3.0	6.0	16	3.0	3.0	1.5	-	-
	13	3.24	5060	54.5	49.9	62.3	90.0	-	-	16	3.0	3.3	1.5	-	0.14
	14	2.93	3315	35.7	37.2	31.1	50.6	-	-	16	3.5	3.3	3.0	-	0.16
	15	3.95	4890	52.7	46.0	67.3	78.5	-	-	11	2.3	3.5	1.5	-	0.14

TABLE 8 (Cont'd.)

Average Coating Test Results*

Bath No.	Steel No.	Coating Wt. oz/sq ft - sheet	Iron Content mg/sq ft	Iron Content g/m²	Steel Wt. Loss g/m²	Alloy Thickness mm x 10⁻³	Proportion of Alloy %	Ductility	Adherence	Spangles (or grains) per in.²	Spangle Contrast	Brightness	Smoothness	Aluminum in Coating %	Lead in Coating %
12, 16	1	0.97	1225	13.2	13.1	11.4	55.4	2.0	3.5	128	1.5	2.0	1.0	0.21	-
	2	1.02	1300	14.0	11.7	11.0	50.5	1.5	3.4	128	1.5	2.0	1.0	0.21	-
	3	1.02	1225	13.2	12.2	11.2	51.9	1.5	3.4	128	1.5	2.0	1.0	0.23	-
	4	1.03	1290	13.9	12.5	11.5	52.8	1.5	3.9	119	1.5	2.0	1.5	0.21	-
	5	1.04	1262	13.6	12.6	10.6	48.4	1.5	3.8	128	1.5	2.0	1.5	0.22	-
	6	0.86	1262	13.6	12.3	11.4	62.4	1.5	3.5	128	2.0	2.0	1.5	0.23	-
	7	0.73	1058	11.4	10.7	11.0	69.3	1.8	3.5	140	2.0	2.0	1.0	0.26	-
	8	1.11	2330	25.1	10.3	14.9	64.9	-	-	237	2.0	2.5	2.5	0.23	-
	9	1.20	2295	24.7	10.6	14.5	56.7	-	-	256	2.0	2.3	2.5	0.24	-
	10	1.07	1346	14.5	16.5	11.4	49.6	2.0	5.0	362	2.0	2.0	1.3	0.23	-
	11	1.04	1540	16.6	13.9	11.0	50.0	1.5	3.6	355	1.5	2.0	1.0	0.21	-
	12	1.03	1503	16.2	14.6	10.4	47.7	1.5	3.5	362	1.5	2.0	1.0	0.21	-
	13	0.84	1040	11.2	18.1	3.1	17.3	-	-	256	2.5	2.0	2.0	0.19	-
	14	0.88	1160	12.5	13.0	9.3	50.3	-	-	256	3.0	3.0	4.0	0.20	-
	15	2.27	2200	23.7	16.6	20.0	41.6	-	-	362	3.0	3.0	2.5	0.18	-
Experiment "B"															
19, 22	1	2.75	4270	46.0	47.4	43.0	72.4	3.8	8.0	6	3.0	2.5	1.5	-	0.36
	2	2.67	4120	44.3	47.7	42.9	75.8	3.5	8.0	6	3.0	2.0	1.3	-	-
	3	2.84	4303	46.4	46.5	43.4	71.7	3.5	8.0	6	3.0	2.0	1.5	-	-
	4	2.87	4100	44.2	48.6	41.2	68.0	3.8	8.0	5	3.0	2.0	1.3	-	-
	5	2.80	4085	44.1	46.3	41.4	69.6	3.5	8.0	5	3.0	2.0	1.5	-	-
	6	3.40	4910	52.9	49.3	46.5	65.0	3.5	8.0	6	3.0	2.0	2.0	-	0.40
	7	3.31	4750	51.2	52.0	48.3	69.6	3.5	8.0	6	3.0	2.0	1.5	-	-
	8	3.04	4460	48.0	47.6	40.7	63.2	-	-	2	3.5	2.3	2.0	-	0.49
	9	3.08	4435	47.8	47.3	40.7	62.3	-	-	2	3.5	3.5	1.8	-	0.45
	10	2.84	4330	46.7	46.9	40.5	67.5	3.3	8.0	4	3.0	2.3	1.5	-	0.40
	11	2.83	4640	50.0	48.7	40.4	67.0	3.5	8.0	14	3.0	2.3	1.5	-	-
	12	2.58	4220	45.5	47.6	41.2	75.1	3.5	8.0	13	3.0	2.0	1.4	-	-
	13	7.98	11190	120.5	131.2	162.9	96.3	-	-	21	3.0	5.0	2.0	-	0.36
	14	4.14	5440	58.6	59.1	52.2	59.0	-	-	3	3.5	3.0	3.5	-	0.49
	15	7.78	10900	117.4	118.6	154.5	93.5	-	-	6	2.5	4.0	1.5	-	0.33
20, 24	1	2.33	3265	35.2	36.7	30.2	61.3	3.3	6.5	3	3.0	2.5	1.5	-	0.42
	2	2.11	3080	33.2	37.9	29.8	67.4	3.3	6.5	2	3.0	2.0	1.5	-	-
	3	2.08	2955	31.8	36.5	29.5	67.7	3.0	6.5	2	3.0	2.0	1.5	-	-
	4	2.44	3275	35.3	36.8	32.6	62.7	3.0	6.5	3	3.0	2.3	1.5	-	-
	5	2.16	3018	32.5	32.7	31.3	68.5	3.0	6.5	2	3.0	2.3	1.5	-	-
	6	2.83	3750	40.4	40.1	36.2	60.4	3.3	6.5	2	3.0	2.0	2.0	-	0.50
	7	2.60	3620	39.0	39.7	36.0	65.5	3.0	6.5	2	3.0	2.0	1.5	-	-
	8	2.67	3538	38.1	34.6	34.2	60.2	-	-	2	3.5	3.3	2.0	-	0.51
	9	2.66	3715	40.0	36.5	34.5	61.1	-	-	2	3.5	3.5	1.5	-	0.47
	10	2.29	3200	34.5	38.8	30.8	63.5	3.0	6.5	2	3.0	2.0	1.5	-	0.45
	11	2.39	3740	40.3	37.9	30.7	60.9	3.0	6.5	8	3.0	2.5	1.5	-	-
	12	2.15	3575	38.5	37.2	30.6	67.5	3.0	6.6	8	3.0	2.0	1.5	-	-
	13	4.74	7050	76.0	75.8	99.2	98.9	-	-	6	3.0	5.0	1.5	-	0.36
	14	3.64	4510	48.6	46.2	45.9	59.7	-	-	2	3.5	3.0	3.5	-	0.53
	15	4.41	6400	68.9	79.2	84.9	89.5	-	-	2	2.5	4.3	1.5	-	0.35
21, 23	1	2.05	2535	27.3	28.4	23.9	55.0	3.0	6.0	8	3.0	3.0	1.6	-	0.47
	2	1.78	2440	26.3	26.8	22.6	59.7	3.0	6.0	8	3.0	3.0	1.5	-	-
	3	1.80	2358	25.4	26.9	22.8	59.7	3.0	6.0	8	3.0	3.0	1.5	-	-
	4	2.17	2618	28.2	27.5	25.1	54.5	3.0	6.0	6	3.0	3.0	1.5	-	-
	5	1.93	2415	26.0	26.6	24.8	61.1	3.0	6.0	6	3.0	3.0	1.5	-	-
	6	2.46	3005	32.4	31.5	29.7	57.1	3.0	6.0	6	3.0	3.0	2.0	-	0.49
	7	2.20	2830	30.5	32.6	28.3	60.5	3.0	6.0	6	3.0	3.0	1.5	-	-
	8	2.39	2865	30.9	23.9	25.8	51.3	-	-	4	3.0	3.0	2.0	-	0.49
	9	2.41	2935	31.6	27.4	25.3	49.3	-	-	4	3.0	3.5	2.0	-	0.47
	10	2.08	2878	31.0	30.3	25.6	57.9	2.5	6.0	7	3.0	3.0	1.5	-	0.45
	11	2.07	2710	29.2	30.3	23.4	53.6	3.0	6.0	16	3.0	3.0	1.5	-	-
	12	1.81	2430	26.2	28.2	21.6	56.1	3.0	6.0	16	3.0	3.0	1.5	-	-
	13	3.34	4990	53.8	52.4	55.9	79.9	-	-	4	3.0	4.7	1.5	-	0.42
	14	3.18	3790	40.8	40.8	35.4	52.5	-	-	4	3.5	3.3	3.5	-	0.51
	15	3.07	4280	46.2	47.1	52.8	80.4	-	-	3	2.5	3.3	1.5	-	0.33

TABLE 8 (Cont'd)

Average Coating Test Results*

Bath No.	Steel No.	Coating Wt. oz/sq ft - sheet	Iron Content mg/sq ft	Iron Content g/m²	Steel Wt. Loss g/m²	Alloy Thickness mm x 10⁻³	Proportion of Alloy %	Ductility	Adherence	Spangles (or grains) per in.²	Spangle Contrast	Brightness	Smoothness	Aluminum in Coating %	Lead in Coating %
25, 27	1	2.80	4340	46.8	47.9	41.3	69.0	3.5	8.0	16	3.0	2.5	1.5	-	0.11
	2	2.73	4250	45.8	46.8	41.2	71.0	3.5	8.0	16	3.0	2.3	1.5	-	-
	3	2.84	4200	45.3	47.5	41.2	70.1	3.5	8.0	18	3.0	2.5	1.5	-	-
	4	3.03	4290	46.3	48.7	42.7	67.2	3.5	8.0	12	3.0	2.5	1.5	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	3.41	4800	51.7	51.9	47.4	65.4	3.3	7.9	35	3.0	3.0	1.8	-	0.13
	7	3.22	5030	54.2	52.1	48.3	70.2	3.0	8.0	42	3.0	2.5	1.5	-	-
	8	3.18	4600	49.6	45.9	45.0	66.8	-	-	10	3.0	3.0	1.5	-	0.15
	9	3.23	4460	48.2	47.3	45.1	65.4	-	-	10	3.0	3.0	1.5	-	0.15
	10	2.85	4035	43.5	47.6	41.4	68.9	3.0	8.0	14	3.0	3.0	1.5	-	0.11
	11	2.93	4810	51.8	50.3	41.3	66.8	3.0	7.9	45	3.0	3.0	1.5	-	-
	12	2.60	4190	45.2	50.1	39.3	71.1	3.0	7.8	36	3.0	2.5	1.5	-	-
	13	7.86	11040	119.1	121.5	163.9	98.3	-	-	15	3.0	3.7	2.0	-	0.10
	14	4.15	5230	56.4	61.1	51.1	56.2	-	-	8	3.0	3.0	3.5	-	0.18
	15	7.63	10750	115.8	123.7	160.5	99.0	-	-	10	3.0	4.5	1.5	-	0.10
26, 28	1	2.39	3220	34.7	36.6	30.7	60.5	3.0	6.6	39	2.6	3.0	1.5	-	0.13
	2	2.35	3265	35.2	36.3	30.6	60.9	3.0	6.5	42	2.6	3.0	1.5	-	-
	3	2.23	3210	34.6	36.5	30.7	65.5	3.0	6.6	23	2.6	3.0	1.5	-	-
	4	2.40	3250	35.0	38.5	32.2	63.1	3.0	6.5	16	2.6	3.0	1.5	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	2.83	3665	39.5	40.1	36.5	60.7	3.0	6.5	39	3.0	3.0	2.0	-	0.13
	7	2.53	3665	39.5	39.5	35.8	66.9	3.0	6.5	42	3.0	3.0	1.5	-	-
	8	2.85	3880	41.8	36.2	34.1	56.7	-	-	10	3.0	3.0	1.5	-	0.15
	9	2.82	3638	39.2	38.2	34.3	57.1	-	-	8	3.0	3.0	1.5	-	0.15
	10	2.35	3490	37.6	37.8	32.4	64.7	3.0	6.8	18	3.0	3.0	1.5	-	0.12
	11	2.41	3790	40.9	39.7	30.7	60.4	3.0	6.5	18	3.0	3.0	1.5	-	-
	12	2.14	3662	39.5	37.5	30.3	67.6	3.0	6.5	18	3.0	3.0	1.5	-	-
	13	4.88	7410	80.0	78.6	99.9	96.8	-	-	18	3.0	4.5	2.0	-	0.12
	14	3.63	4265	46.0	50.2	44.2	49.9	-	-	8	3.0	3.0	3.5	-	0.17
	15	4.67	6525	70.4	71.9	91.4	91.3	-	-	8	2.5	3.0	1.5	-	0.12

*Each value shown is average of three determinations except for ductility (average of two determinations) and alloy thickness (average of twenty measurements on single samples).
Ductility and adherence tests and lead analyses were made on samples indicated only.
For ductility, adherence and surface appearance rating codes, see Table 9.

TABLE 9

Ductility, Adherence and Surface Appearance Rating Codes

Coating Ductility

Rating: 1 = Excellent, no cracking
2 = Good, network of fine cracks
3 = Fair, general cracking, with coating broken into small blocks
4 = Poor, wide separation of medium size blocks
5 = Very poor, general peeling of coating in large blocks

Coating Adherence

Based on minimum bend radius causing flaking (90° bend plus 180° reverse bend)

Rating: 1 = 0.050 in. bend radius
2 = 0.070 in. bend radius
3 = 0.100 in. bend radius
4 = 0.144 in. bend radius
5 = 0.192 in. bend radius
6 = 0.252 in. bend radius
7 = 0.320 in. bend radius
8 = 0.400 in. bend radius

Spangle Contrast of Coating

Rating: 1 = Good, spangles well defined
2 = Moderate, spangles well defined
3 = Low or no contrast. Spangles outlined only
4 = No contrast (no spangles)

Coating Brightness

Rating: 1 = 0 to 1.25 photometer units
2 = 1.5 to 2.75 photometer units
3 = 3.0 to 5.5 photometer units
4 = 6.0 to 11.0 photometer units
5 = 11.5 + photometer units

Coating Roughness

Rating: 1 = Very smooth
2 = Moderately smooth
3 = Fine to moderately rough sandpaper-like texture
4 = Rough texture or uneven surface

TABLE 10

Steel Weight Lost by Pickling*
(mg/sample and per cent on 3 in. by 4 in. sample)

Steel No.	Grade of Steel and Condition	Pickling Time, min	55°C (130°F)	70°C (160°F)	85°C (185°F)
1	Galvanizing grade, as-received	2.5	2.6 (0.007)	2.8 (0.008)	3.4 (0.009)
	" " "	5.0	3.2 (0.009)	3.3 (0.009)	3.5 (0.010)
	" " "	7.5	4.5 (0.012)	5.1 (0.014)	6.1 (0.016)
	" " "	10.0	6.2 (0.017)	8.0 (0.022)	9.6 (0.026)
3	Galvanizing grade, cold rolled - 15% reduction	2.5	1.9 (0.006)	1.8 (0.006)	2.6 (0.008)
	" " "	5.0	2.2 (0.007)	2.4 (0.008)	3.1 (0.010)
	" " "	7.5	3.6 (0.011)	4.6 (0.014)	5.6 (0.018)
	" " "	10.0	5.1 (0.015)	5.3 (0.017)	6.5 (0.020)
4	Armco iron, as-received	2.5	0.9 (0.002)	1.0 (0.002)	1.3 (0.003)
	" " "	5.0	1.7 (0.004)	2.2 (0.005)	2.8 (0.007)
	" " "	7.5	2.4 (0.006)	2.7 (0.006)	3.0 (0.008)
	" " "	10.0	3.1 (0.008)	3.5 (0.009)	4.7 (0.012)
5	Armco iron, cold rolled - 15% reduction	2.5	0.7 (0.002)	0.8 (0.002)	1.1 (0.003)
	" " " "	5.0	1.6 (0.004)	1.9 (0.006)	1.8 (0.006)
	" " " "	7.5	2.3 (0.005)	2.4 (0.007)	3.1 (0.009)
	" " " "	10.0	2.6 (0.008)	3.1 (0.009)	4.0 (0.012)
6	Aluminum-killed, as-received	2.5	4.0 (0.011)	4.1 (0.011)	4.4 (0.012)
	" " "	5.0	4.7 (0.012)	5.9 (0.016)	8.9 (0.024)
	" " "	7.5	5.4 (0.014)	7.7 (0.021)	16.0 (0.042)
	" " "	10.0	6.8 (0.018)	9.9 (0.026)	18.2 (0.048)
7	Aluminum-killed, cold rolled - 15% reduction	2.5	1.8 (0.006)	2.0 (0.006)	2.1 (0.006)
	" " " "	5.0	2.4 (0.007)	2.3 (0.008)	4.3 (0.012)
	" " " "	7.5	2.9 (0.009)	3.5 (0.010)	5.6 (0.016)
	" " " "	10.0	5.3 (0.016)	6.8 (0.018)	7.0 (0.020)
8	Hot-rolled normalized, as-received	2.5	565.0 (0.500)	677.1 (0.604)	687.3 (0.594)
	" "	5.0	678.5 (0.609)	679.7 (0.600)	683.6 (0.602)
	" "	7.5	680.0 (0.601)	675.7 (0.611)	696.1 (0.591)
	" "	10.1	683.1 (0.604)	689.3 (0.614)	698.1 (0.606)
9	Hot-rolled normalized, cold rolled - 15% reduction	2.5	508.4 (0.511)	533.0 (0.559)	533.7 (0.547)
	" " "	5.0	490.8 (0.502)	534.0 (0.562)	538.0 (0.553)
	" " "	7.5	497.6 (0.511)	533.1 (0.556)	537.9 (0.552)
	" " "	10.0	531.5 (0.549)	532.6 (0.556)	544.2 (0.559)

TABLE 10 (Cont'd)

Steel Weight Lost by Pickling*
(mg/sample and per cent on 3 in. by 4 in. sample)

Steel No.	Grade of Steel and Condition	Pickling Time, min	55°C (130°F)	70°C (160°F)	85°C (185°F)
10	Full hard, as-received	2.5	4.8 (0.012)	6.1 (0.015)	6.3 (0.016)
	" " "	5.0	7.6 (0.019)	8.4 (0.021)	8.7 (0.024)
	" " "	7.5	9.3 (0.023)	11.3 (0.028)	12.3 (0.032)
	" " "	10.0	10.7 (0.027)	14.1 (0.036)	17.0 (0.044)
11	Bottle top, as-received	2.5	5.9 (0.015)	6.7 (0.018)	6.9 (0.019)
	" " "	5.0	6.2 (0.016)	8.7 (0.023)	9.8 (0.026)
	" " "	7.5	7.2 (0.019)	10.8 (0.029)	11.0 (0.029)
	" " "	10.0	9.1 (0.024)	12.6 (0.034)	12.7 (0.034)
12	Bottle top, cold rolled - 15% reduction	2.5	3.3 (0.010)	3.6 (0.011)	4.6 (0.014)
	" " "	5.0	4.2 (0.013)	4.6 (0.014)	6.0 (0.018)
	" " "	7.5	5.6 (0.018)	5.9 (0.018)	7.0 (0.021)
	" " "	10.0	6.4 (0.020)	7.1 (0.022)	8.4 (0.026)
13	Alloy Steel A, as-received	2.5	323.2 (0.279)	353.7 (0.304)	403.0 (0.346)
	" " "	5.0	343.2 (0.295)	373.2 (0.320)	497.7 (0.426)
	" " "	7.5	347.3 (0.299)	434.7 (0.374)	589.5 (0.506)
	" " "	10.0	363.3 (0.312)	516.5 (0.446)	720.4 (0.618)
14	Alloy Steel B, as-received	2.5	11.4 (0.010)	17.7 (0.016)	30.4 (0.027)
	" " "	5.0	20.9 (0.018)	36.1 (0.032)	38.2 (0.034)
	" " "	7.5	24.0 (0.021)	39.0 (0.034)	44.8 (0.039)
	" " "	10.0	27.5 (0.024)	44.5 (0.039)	64.4 (0.057)
15	Alloy Steel C, as-received	2.5	10.0 (0.011)	22.9 (0.025)	56.3 (0.060)
	" " "	5.0	16.3 (0.018)	34.9 (0.037)	129.5 (0.138)
	" " "	7.5	21.9 (0.024)	40.4 (0.043)	342.2 (0.365)
	" " "	10.0	26.4 (0.028)	59.1 (0.063)	598.4 (0.637)

*Acid solution as given in Galvanizing Log, Table 4.
Values are averages of two determinations; figures in brackets represent weight loss per cent.

TABLE 11

Mechanical Properties of Alloy Steels After Galvanizing*

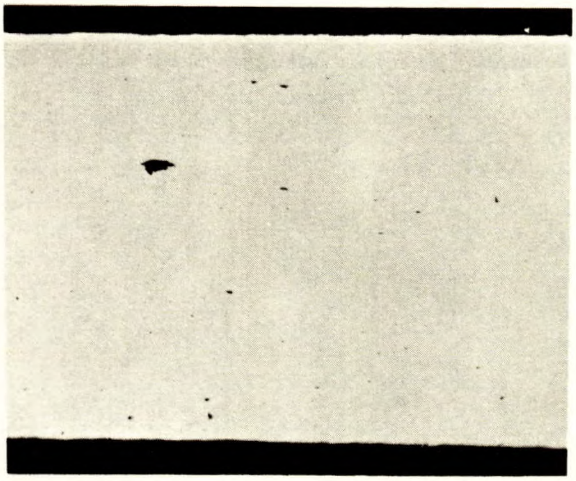
Steel No. and Grade	Bath No.	Al %	Pb %	Immersion Time, sec	UTS kpsi	YS 0.2% offset kpsi	Ratio YS to UTS	El. % in 2 in.
13. Alloy Steel A								
(a) as-received	-	-	-	-	72.4	55.9	0.77	30.6
(b) galvanized	4	0.0	0.3	10	72.0	60.9	0.85	29.8
"	8	0.0	0.3	60	70.0	60.9	0.87	29.0
"	12	0.075	0.3	10	72.8	62.0	0.85	28.2
"	3	0.075	0.3	60	74.0	63.6	0.86	28.6
"	7	0.15	0.3	10	73.1	61.9	0.85	31.1
"	2	0.15	0.3	60	73.9	62.9	0.85	30.2
14. Alloy Steel B								
(a) as-received	-	-	-	-	83.8	64.4	0.77	25.6
(b) galvanized	4	0.0	0.3	10	81.7	69.3	0.85	25.0
"	8	0.0	0.3	60	80.8	68.0	0.84	24.9
"	26	0.0	1.0	120	83.4	71.3	0.86	24.6
"	27	0.0	1.0	240	83.7	70.8	0.84	22.8
"	12	0.075	0.3	10	82.8	70.4	0.85	24.9
"	3	0.075	0.3	60	83.4	70.0	0.84	25.4
"	7	0.15	0.3	10	82.9	69.7	0.84	25.5
"	2	0.15	0.3	60	82.7	69.0	0.84	25.3
15. Alloy Steel C								
(a) as-received	-	-	-	-	67.9	53.8	0.79	29.7
(b) galvanized	4	0.0	0.3	10	68.0	57.5	0.85	24.9
"	8	0.0	0.3	60	66.6	57.5	0.87	25.6
"	26	0.0	1.0	120	64.6	56.2	0.87	25.2
"	27	0.0	1.0	240	63.2	55.5	0.88	24.8
"	12	0.075	0.3	10	66.5	57.8	0.87	25.0
"	3	0.075	0.3	60	67.2	58.1	0.87	26.5
"	7	0.15	0.3	10	68.4	59.8	0.87	25.0
"	2	0.15	0.3	60	66.1	56.0	0.85	25.5

*As-received values are averages of 36 tests.
Galvanized values are averages of 6 to 12 tests.

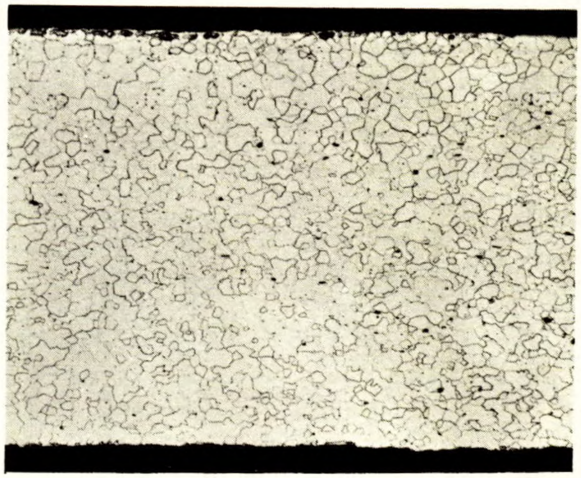
METALLOGRAPHIC AND SURFACE EXAMINATION OF STEELS

Photomicrographs illustrating the grain structure and typical inclusion distribution of the various steels in the as-received condition are given in Figures 1 to 9 which follow. Grain size measurements are indicated.

The surface roughness of the complete series of steels prior to galvanizing was measured and the Talysurf traces obtained are reproduced in Figures 10 to 16. Accompanying photomacrographs illustrate the surface texture in each case.



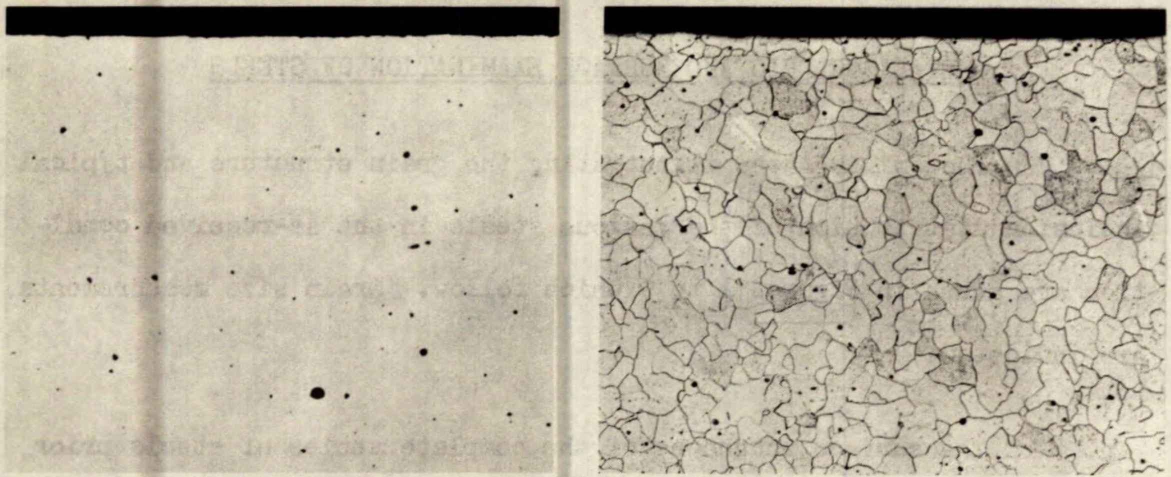
as-polished



etched (2% nital)

Figure 1. X100

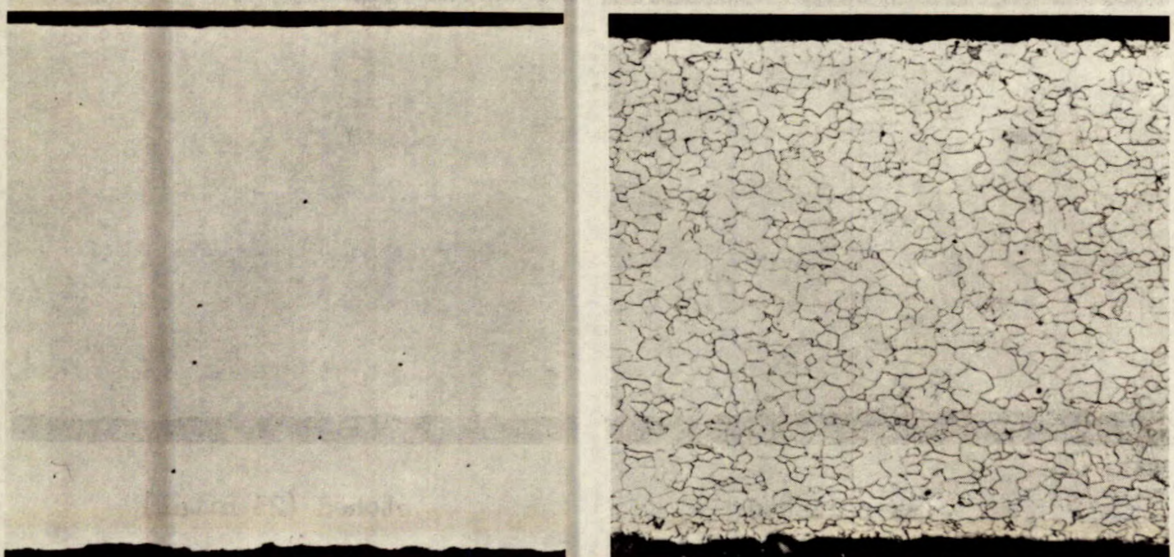
Typical inclusion distribution and grain structure of galvanizing grade steel, as-received (No. 1). Fine equiaxed grains (ASTM grain size number 8), low inclusions.



as-polished etched (2% nital)

Figure 2. X100

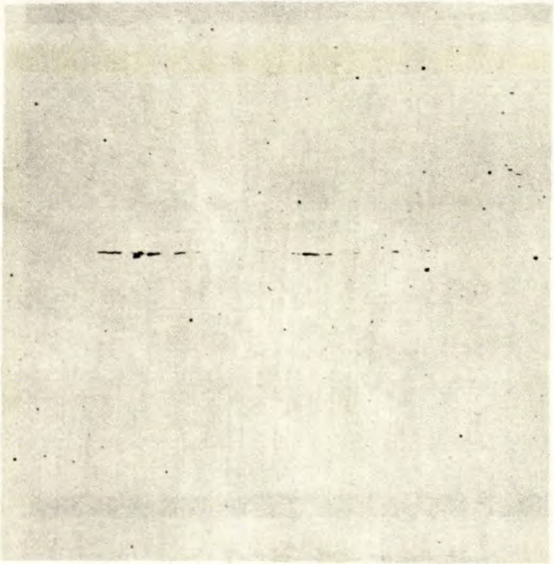
Typical inclusion distribution and grain structure of Armco iron sheet, as-received (No. 4). Medium equiaxed grains (ASTM grain size number 5), low inclusions.



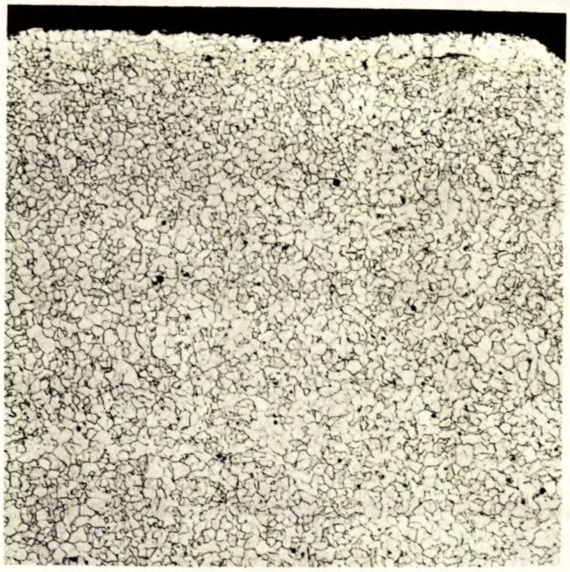
as-polished etched (2% nital)

Figure 3. X100

Typical inclusion distribution and grain structure of aluminum-killed steel, as-received (No. 6). Fine pancake grains (ASTM grain size number 7), low inclusions.



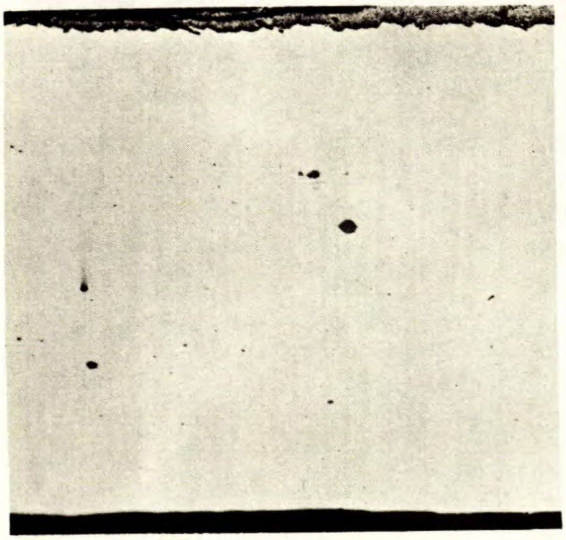
as-polished



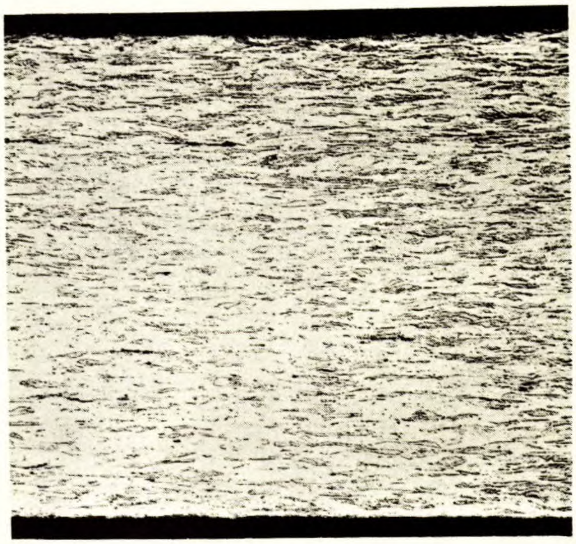
etched (2% nital)

Figure 4. X100

Typical inclusion distribution and grain structure of hot rolled normalized steel, as-received (No. 8). Fine equiaxed grains (ASTM grain size number 8), low inclusions.



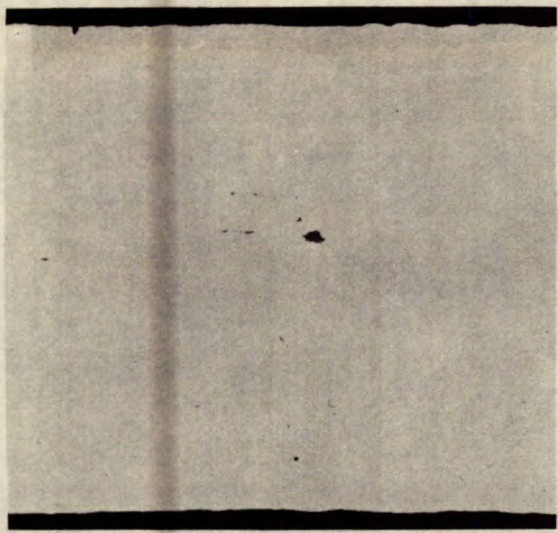
as-polished



etched (2% nital)

Figure 5. X100

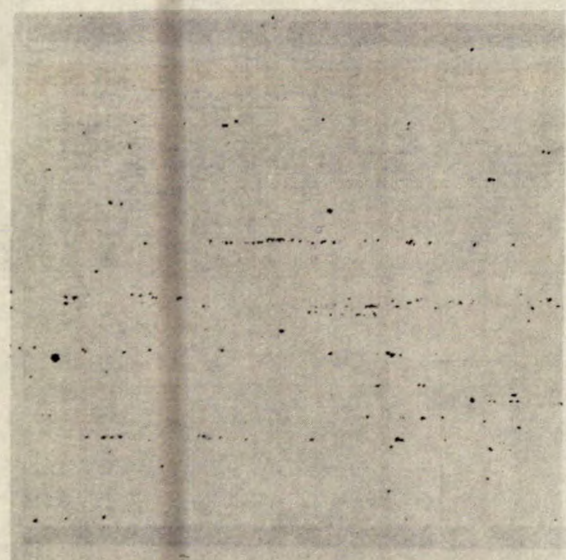
Typical inclusion distribution and grain structure of full-hard steel, as-received (No. 10). Elongated grains, low inclusions.

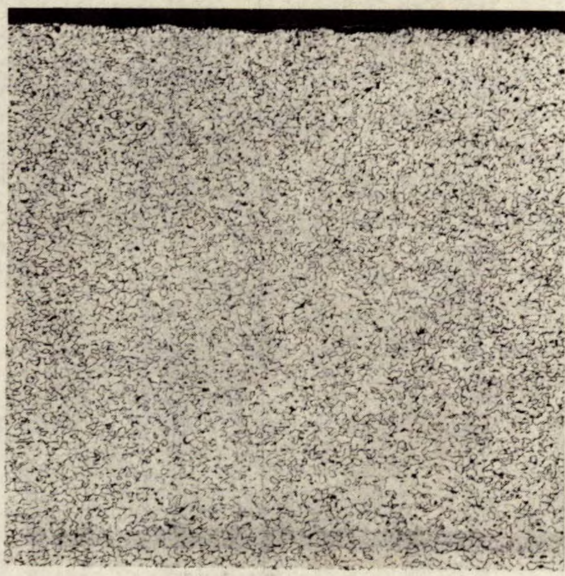


as-polished etched (2% nital)

Figure 6. X100

Typical inclusion distribution and grain structure of bottle-top steel, as-received (No. 11). Very fine equiaxed grains (ASTM grain size number 9), low inclusions.

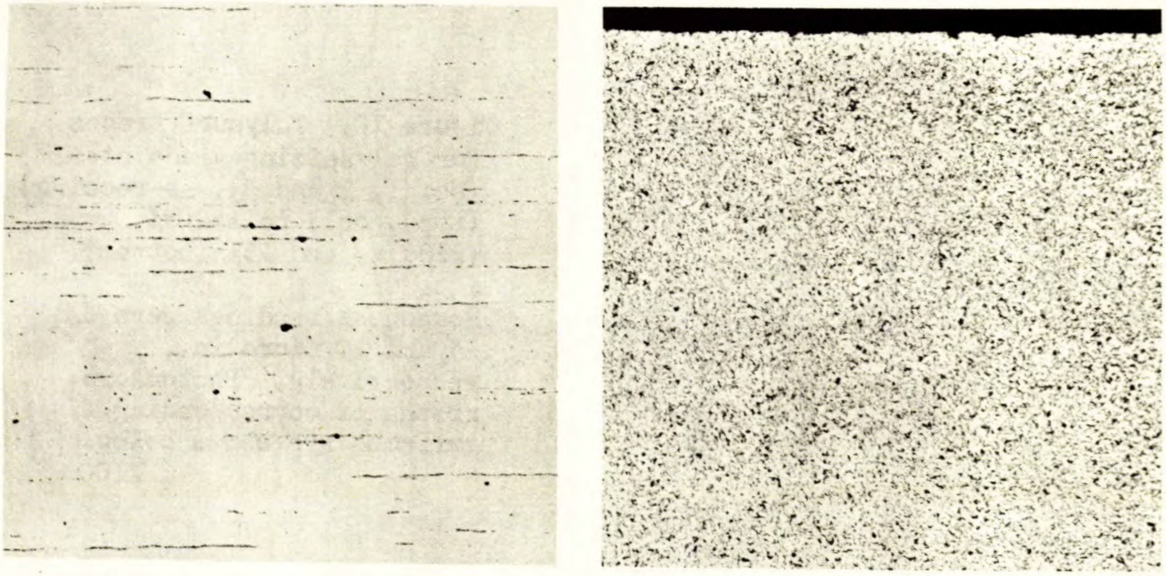




as-polished etched (2% nital)

Figure 7. X100

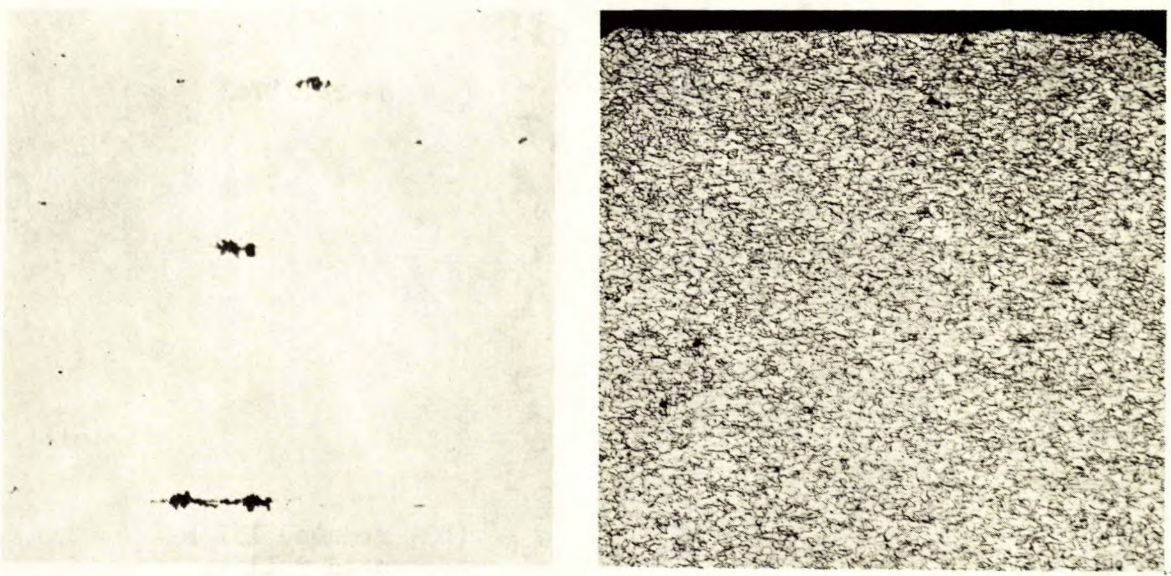
Typical inclusion distribution and grain structure of Alloy Steel A (No. 13). Very fine equiaxed grains (ASTM grain size number 10), low inclusions.



as-polished etched (2% nital)

Figure 8. X100

Inclusion distribution and grain structure of Alloy Steel B (No. 14). Very fine, equiaxed grains (ASTM grain size number 10). Note elongated stringer-type inclusions.



as-polished etched (2% nital)

Figure 9. X100

Typical inclusion distribution and grain structure of Alloy Steel C (No. 15). Fine equiaxed grains (ASTM grain size number 8).

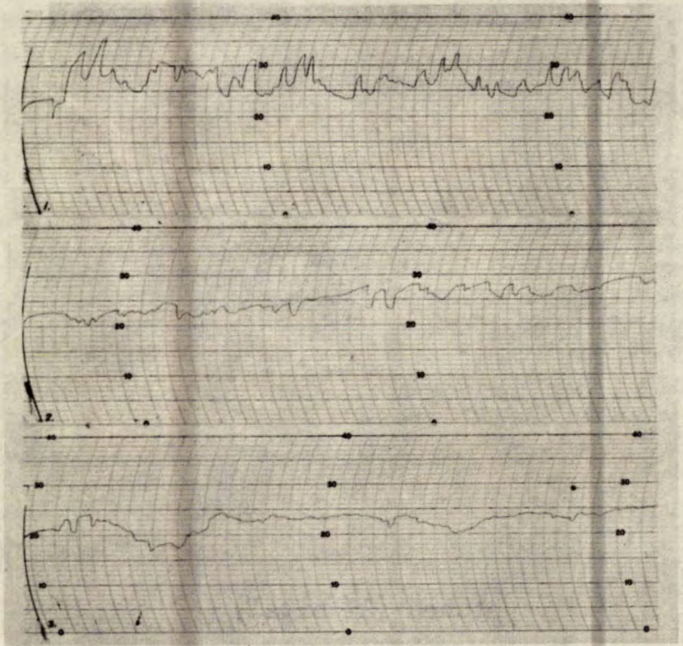
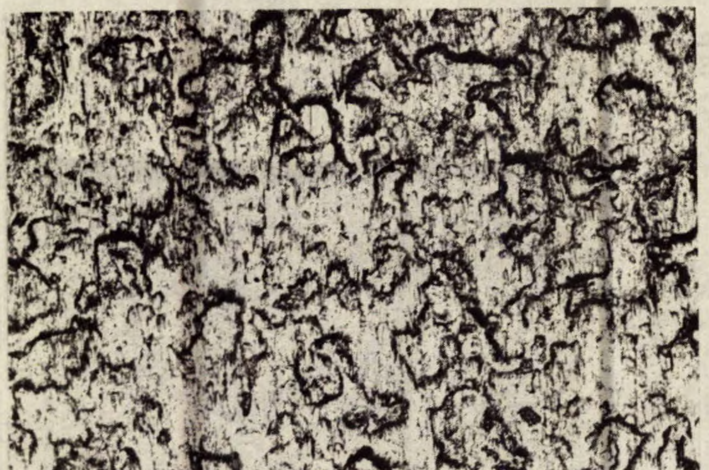
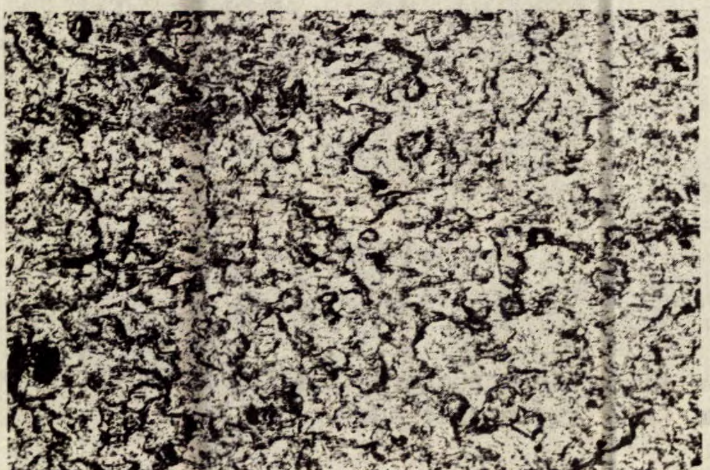


Figure 10. Talysurf traces for galvanizing grade steel (No. 1, 2 and 3), as-received (top), cold rolled 5% (middle) and 15% (bottom).

Roughness readings were 44, 25 and 20 micro in., respectively. Photomacrographs of corresponding surfaces are shown below.
X100



(a) as-received



(b) reduced 15% by cold rolling

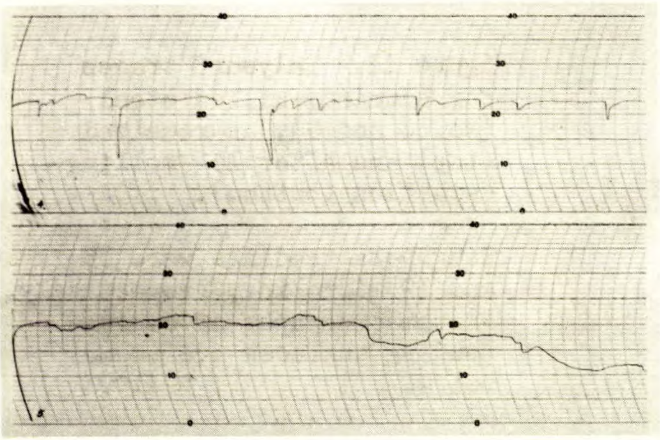
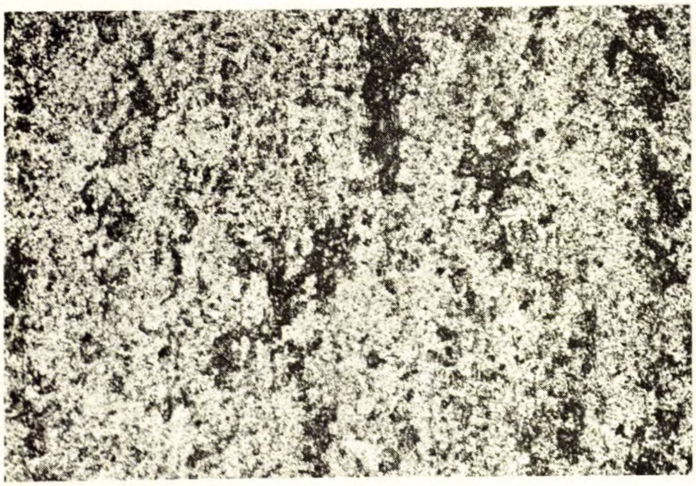
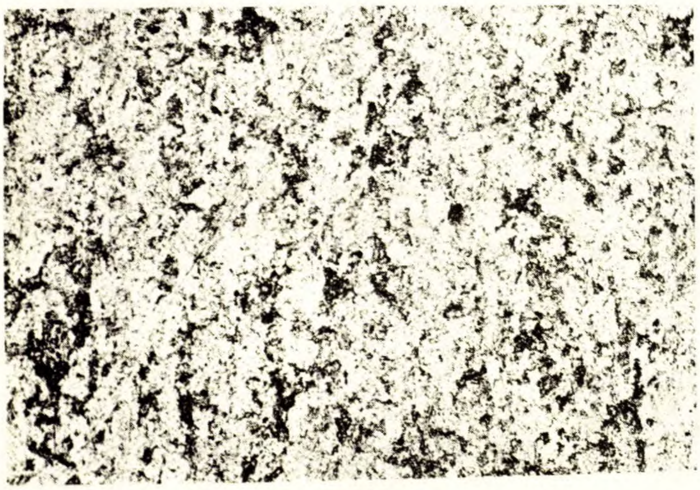


Figure 11. Talysurf traces for Armco iron sheet (No. 4 and 5), as-received (top) and after 15% rolling reduction (bottom).

Roughness readings were 20 and 18 micro in., respectively. Photomacrographs of corresponding surfaces are shown below. X100



(a) as-received



(b) reduced 15% by cold rolling

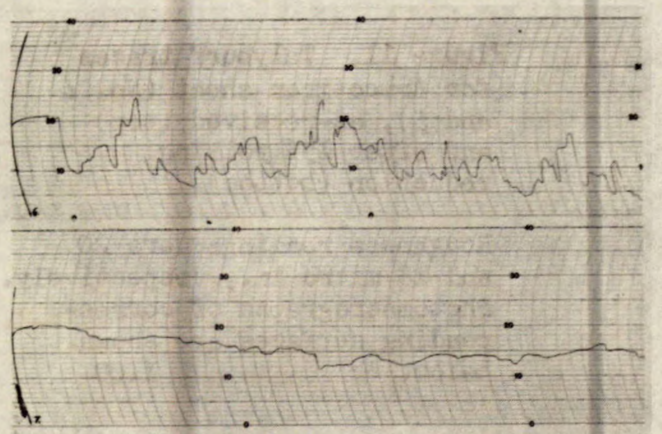
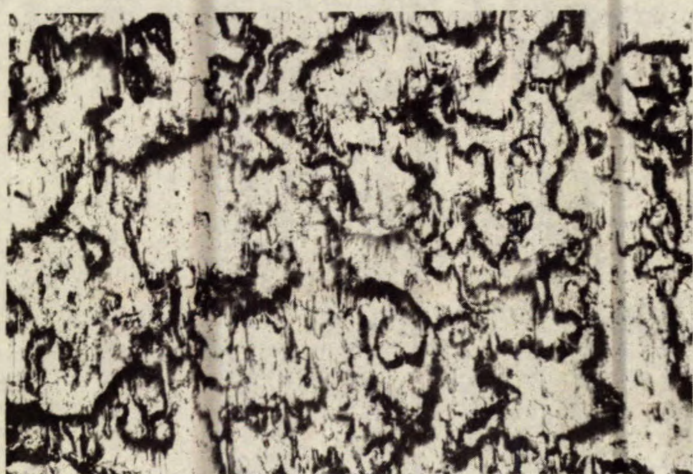
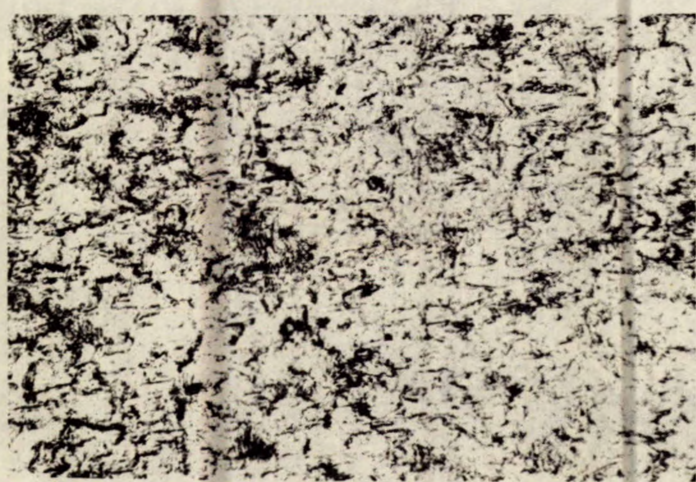


Figure 12. Talysurf traces for aluminum-killed steel (No. 6 and 7), as-received (top) and after 15% rolling reduction (bottom).

Roughness readings were 75 and 19 micro in., respectively. Photomacrographs of corresponding surfaces are shown below. X100



(a) as-received



(b) reduced 15% by cold rolling

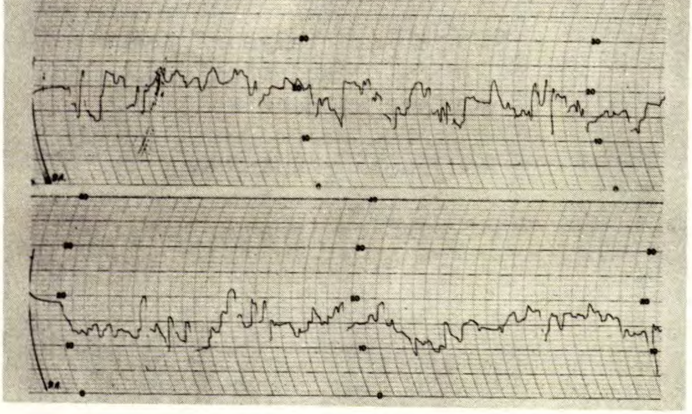


Figure 13. Talysurf traces for hot-rolled normalized steel (No. 8 and 9), as-received and pickled (top) and after 15% rolling reduction and pickling (bottom).

Roughness readings were 52 and 42 micro in., respectively. Photomacrographs of corresponding surfaces are shown below. X100

(a) as-received and pickled

(b) reduced 15% by cold rolling and pickled

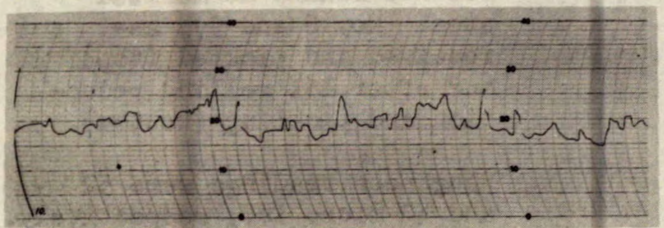


Figure 14. Talysurf trace for full hard steel (No. 10), surface as-received.

Roughness reading was 38 micro in. Photomacrograph of surface is show below. X100

Full hard steel, as-received

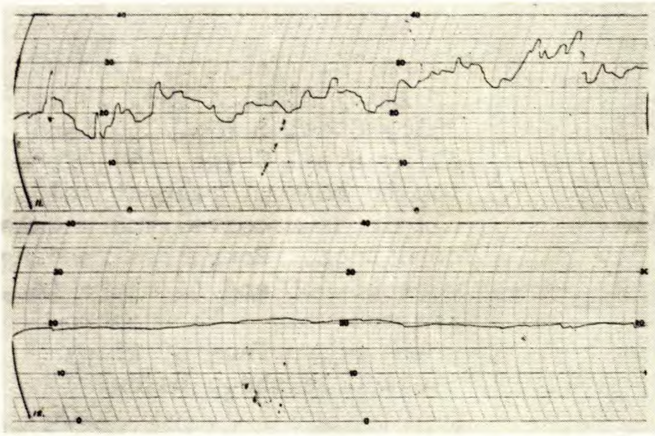
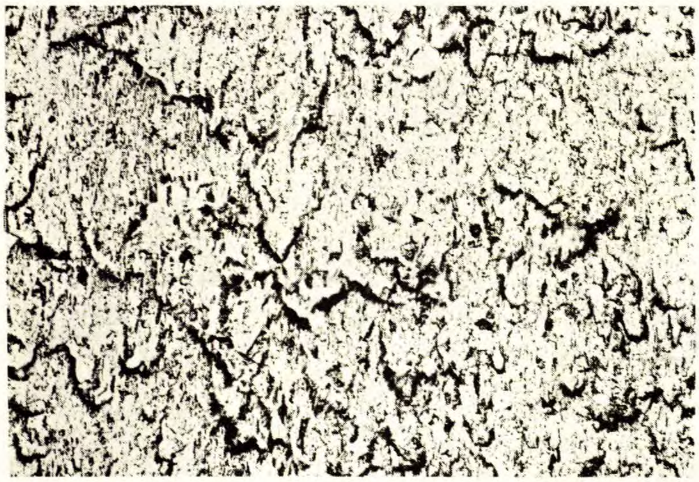
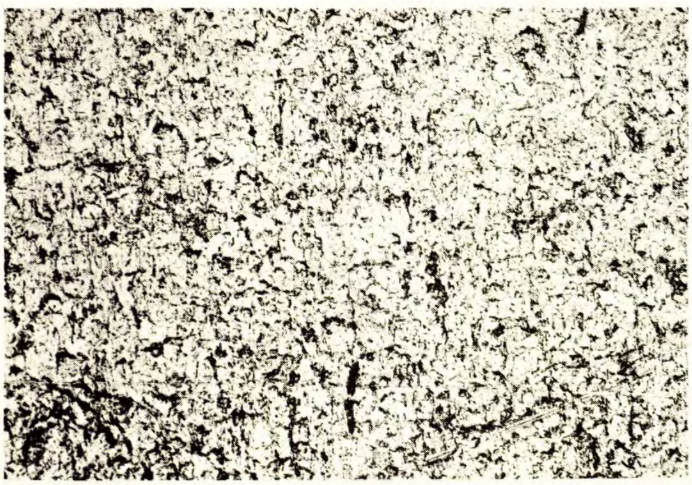


Figure 15. Talysurf traces of bottle top steel (No. 11 and 12), as-received (top) and after 15% rolling reduction (bottom).

Roughness readings were 33 and 12 micro in., respectively. Photomacrographs of corresponding surfaces are shown below. X100



(a) as-received



(b) reduced 15% by cold rolling

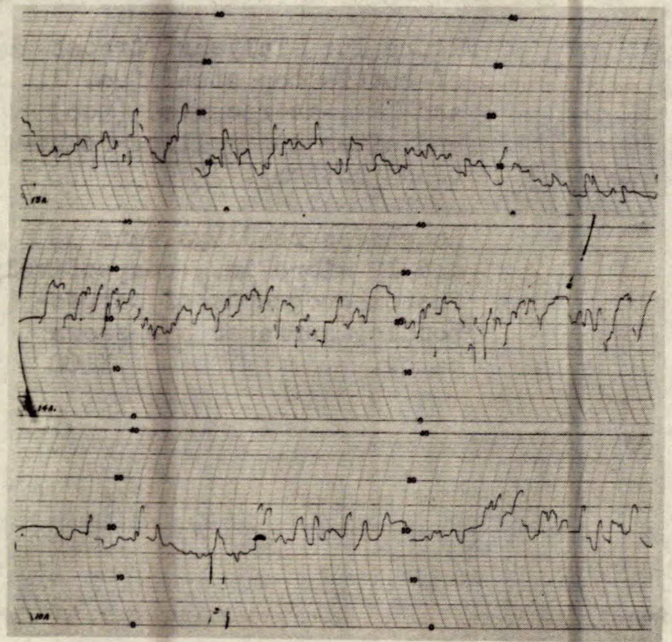
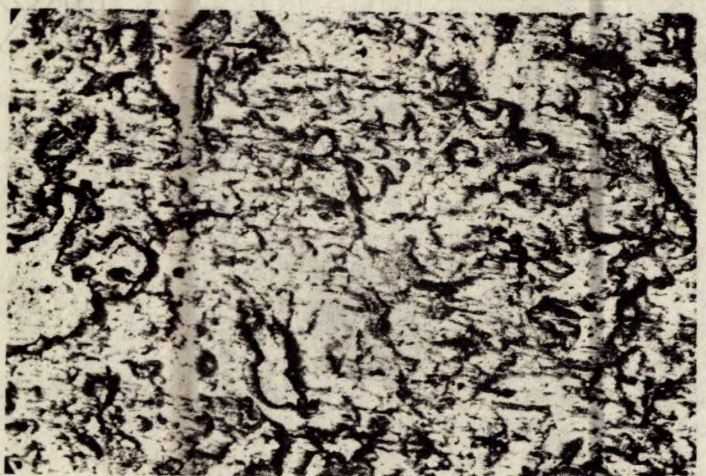


Figure 16. Talysurf traces of Alloy Steel A (No. 13), Alloy Steel B (No. 14), and Alloy Steel C (No. 15), from top to bottom, respectively, all in as-received and pickled condition. Roughness readings were 60, 60 and 44 micro in., respectively. Photomacrograph of surface of Alloy Steel C is shown below.
X100



Alloy Steel C, as-received and pickled

APPENDIX II

ACCELERATED CORROSION TEST RESULTS

by

D.B. Clay
The Steel Company of Canada, Limited, Hamilton, Ont.
January 11, 1961

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INTRODUCTION

In this appendix, results are given of humidity and water film corrosion stack tests run by The Steel Company of Canada, Limited, to determine the storage-stain susceptibility of the galvanized test panels prepared at the Mines Branch. The test procedures corresponded to those used in previous Mines Branch galvanizing investigations and are described in Mines Branch Investigation Report IR 58-149. Separate panels were used for each test and, in the case of the humidity test, the diffusivity measurements on each panel were made according to the pattern "B" distribution.

Because single panels only could be provided for this work, and for other reasons, the humidity test was run on the thin gauge materials, grades 1, 2, 3, 4, 5, 6, 7, 10, 11 and 12 and the water film test on the thick gauges remaining, i.e., grades 8, 9, 13, 14 and 15. The corrosion index values listed for the latter are estimates of the amount of the test panel showing corrosion. White and black staining were evaluated separately according to the scale below. Two index values appear together, e.g. 1_2, the upper being the index for the numbered side of a panel, the lower that of the opposite side.

Index	0	1	2	3	4
% of Surface Corroded	0	1 to 25	26 to 50	51 to 75	76 to 100

The data tabulated in this appendix are as follows:

Table 1. Humidity Test Results

Table 2. Water Film Test Results

TABLE 1

Humidity Test Results

Bath No.	Sample No.*	Weight Change mg/sample: Gain From Corrosion	Weight Change mg/sample: Loss From Corrosion	Average Diffusivity**: Before Corrosion	Average Diffusivity**: After Corrosion	Average Diffusivity**: Gain	Average Diffusivity**: % Gain
9	1 J-5	30.0	82.7	13.9	18.9	5	36
"	2 J-5	29.0	87.9	9.3	12.7	3.4	36.6
"	3 J-5	16.8	54.1	9.7	14.9	5.2	53.6
"	4 J-5	20.2	51.4	14.8	16.6	1.8	12.2
"	5 J-5	23.5	80.3	14.1	18.4	4.3	30.5
"	6 J-5	13.0	77.5	12.3	16.9	4.6	37.4
"	7 J-5	27.7	92.2	17.3	18.4	1.1	6.4
"	10 J-5	17.5	42.5	14.3	15.2	0.9	6.3
"	11 J-5	31.6	63.1	11.0	12.2	1.2	10.9
"	12 J-5	31.3	100.1	13.9	16.0	2.1	15.1
10	1 K-5	15.0	108.7	15.1	14.5	-0.6	-4
"	2 K-5	25.1	67.9	12.4	12.5	0.1	0.8
"	3 K-5	22.9	50.0	14.8	16.2	1.4	9.5
"	4 K-5	13.0	47.7	11.8	18.6	6.8	57.6
"	5 K-5	21.2	66.0	11.1	14.2	3.1	27.9
"	6 K-5	16.0	36.0	10.8	14.9	4.1	38
"	7 K-5	18.1	55.6	11.9	14.0	2.1	17.7
"	10 K-5	15.6	54.4	16.1	14.9	-1.2	-7.5
"	11 K-5	17.3	46.3	14.9	14.4	-0.5	-3.4
"	12 K-5	15.0	48.5	16.6	15.3	-1.3	-7.8
11	1 L-5	11.7	31.5	8.8	11.2	2.4	27.3
"	2 L-5	19.2	39.5	8.0	15.1	7.1	88.8
"	3 L-5	18.2	48.3	9.7	11.9	2.2	22.7
"	4 L-5	16.2	34.3	10.9	13.6	2.7	24.8
"	5 L-5	12.5	36.6	10.3	13.8	3.5	34
"	6 L-5	37.1	94.4	14.3	17.6	3.3	23.1
"	7 L-5	37.8	104.6	14.1	19.4	5.3	37.6
"	10 L-5	38.4	115.3	23.3	19.0	-4.3	-18.5
"	11 L-5	37.1	110.6	11.5	16.1	4.6	40
"	12 L-5	36.0	97.3	11.3	13.1	1.8	15.9
13	1 N-5	31.5	70.3	9.9	16.7	6.8	69.5
"	2 N-5	11.8	24.2	13.7	17.0	3.3	24.1
"	3 N-5	28.9	105.6	11.4	13.0	1.6	14
"	4 N-5	20.2	55.0	14.1	16.6	2.5	17.7
"	5 N-5	27.9	68.3	12.0	14.5	2.5	20.8
"	6 N-5	13.2	29.8	12.5	15.6	3.1	24.8
"	7 N-5	17.8	37.4	16.5	15.0	-1.5	-9.1
"	10 N-5	26.5	63.1	21.4	16.3	-5.1	-23.8
"	11 N-5	25.0	49.8	21.6	16.6	-5	-23.2
"	12 N-5	15.5	35.1	22.4	18.6	-3.8	-17
14	1 P-5	24.1	35.4	20.0	34.0	14	70
"	2 P-5	22.6	35.4	16.2	32.9	16.7	100.3
"	3 P-5	25.5	41.4	20.4	34.4	14	68.7
"	4 P-5	27.9	41.5	15.9	36.6	20.7	130
"	5 P-5	10.6	40.6	16.2	34.3	18.1	111.8
"	6 P-5	23.0	48.1	25.5	37.1	11.6	45.5
"	7 P-5	23.2	52.0	21.9	33.7	11.8	53.9
"	10 P-5	17.2	38.1	20.3	33.4	13.1	64.5
"	11 P-5	24.6	45.2	22.5	36.1	13.6	60.5
"	12 P-5	100.9	134.5	22.4	36.2	13.8	61.6

TABLE 1 (Cont'd.)

Humidity Test Results

Bath No.	Sample No.*	Weight Change mg/sample: Gain From Corrosion	Weight Change mg/sample: Loss From Corrosion	Average Diffusivity**: Before Corrosion	Average Diffusivity**: After Corrosion	Average Diffusivity**: Gain	Average Diffusivity**: % Gain
15	1 Q-5	12.8	40.4	11.4	29.5	18.1	159
"	2 Q-5	16.4	52.0	11.5	28.2	16.7	145
"	3 Q-5	11.8	31.6	10.1	22.9	12.8	127
"	4 Q-5	14.6	40.9	9.8	28.3	18.5	189
"	5 Q-5	12.3	33.5	9.8	28.0	18.2	186
"	6 Q-5	10.7	29.0	16.6	30.8	14.2	85.5
"	7 Q-5	15.6	50.9	19.7	30.2	10.5	53.4
"	10 Q-5	25.9	90.1	21.1	31.2	10.1	47.9
"	11 Q-5	12.7	59.8	16.4	28.6	12.2	74.5
"	12 Q-5	14.4	48.9	16.8	29.2	12.4	74
16	1 R-5	26.7	78.4	18.5	27.5	9	48.6
"	2 R-5	26.7	63.6	-	-	-	-
"	3 R-5	10.6	34.4	-	-	-	-
"	4 R-5	18.7	54.0	16.8	27.8	11	65.5
"	5 R-5	9.2	21.7	17.3	28.5	11.2	64.7
"	6 R-5	16.3	46.4	16.4	24.6	8.2	50
"	7 R-5	10.1	39.6	14.5	22.0	7.5	51.7
"	10 R-5	22.2	50.0	20.1	27.3	7.2	39.4
"	11 R-5	22.5	66.6	18.9	29.3	10.4	55
"	12 R-5	15.9	59.2	19.2	29.0	9.8	51
17	1 S-5	12.9	53.3	23.1	34.8	11.7	50.6
"	2 S-5	8.4	27.3	21.0	31.5	10.5	50
"	3 S-5	40.5	122.0	21.1	32.7	11.6	55
"	4 S-5	10.5	79.2	22.3	34.2	11.9	53.4
"	5 S-5	11.8	31.6	23.6	34.9	11.3	47.8
"	6 S-5	24.9	62.7	32.9	36.8	3.9	11.9
"	7 S-5	10.6	32.6	18.0	31.1	13.1	72.8
"	10 S-5	19.2	55.6	25.2	35.8	10.6	42.1
"	11 S-5	12.6	39.6	26.8	35.0	8.2	30.6
"	12 S-5	13.4	70.6	29.7	36.8	7.1	23.9
18	1 T-5	10.0	40.8	20.6	34.5	13.9	67.5
"	2 T-5	10.3	36.8	21.8	34.1	12.3	56.4
"	3 T-5	10.1	36.9	25.0	34.0	9	36
"	4 T-5	7.4	28.3	26.4	35.5	9.1	34.5
"	5 T-5	5.4	21.9	22.6	33.1	10.5	46.5
"	6 T-5	16.4	26.2	22.3	34.4	12.1	54.3
"	7 T-5	9.5	125.1	25.3	34.3	9	35.6
"	10 T-5	13.7	44.0	26.1	35.1	9	34.5
"	11 T-5	11.3	37.8	28.6	35.5	6.9	24.1
"	12 T-5	9.9	33.1	22.0	34.0	12	54.5
22	1 Y-5A	9.7	37.9	30.1	35.7	5.6	18.6
"	2 Y-5A	8.5	39.8	22.4	34.1	11.7	52.2
"	3 Y-5A	9.6	30.1	28.3	34.6	6.3	22.2
"	4 Y-5A	10.7	41.0	28.1	35.6	7.5	26.7
"	5 Y-5A	9.9	24.7	26.2	31.6	5.4	20.6
"	6 Y-5A	11.7	38.4	23.1	35.5	12.4	53.7
"	7 Y-5A	13.1	48.1	26.8	35.5	8.7	32.5
"	10 Y-5A	9.4	25.5	21.6	33.8	12.2	56.5
"	11 Y-5A	9.9	26.0	30.2	37.5	7.3	24.2
"	12 Y-5A	12.4	31.5	25.4	34.9	9.5	37.4

TABLE 1 (Cont'd.)

Humidity Test Results

Bath No.	Sample No.*	Weight Change mg/sample: Gain From Corrosion	Loss From Corrosion	Average Diffusivity**: Before Corrosion	After Corrosion	Gain	% Gain
23	1 X-5A	12.7	44.6	34.5	36.4	1.9	5.5
"	2 X-5A	9.1	34.6	28.0	35.9	7.9	28.2
"	3 X-5A	12.7	36.4	27.2	35.9	8.7	32
"	4 X-5A	16.1	43.9	32.7	34.9	2.2	6.7
"	5 X-5A	13.1	43.3	30.2	35.6	5.4	17.9
"	6 X-5A	15.1	52.7	36.4	35.4	-1	-2.7
"	7 X-5A	14.3	41.7	29.0	36.8	7.8	26.9
"	10 X-5A	13.0	48.2	29.7	34.8	5.1	17.2
"	11 X-5A	13.3	39.7	30.1	38.3	8.2	27.2
"	12 X-5A	18.5	37.1	30.2	35.7	5.5	18.2
24	1 Z-5A	19.5	24.5	30.1	38.2	8.1	26.9
"	2 Z-5A	10.9	43.0	27.7	36.0	8.3	30
"	3 Z-5A	10.6	32.8	31.0	35.5	4.5	14.5
"	4 Z-5A	11.1	31.1	27.0	34.9	7.9	29.3
"	5 Z-5A	9.8	38.1	26.1	36.1	10	38.3
"	6 Z-5A	6.5	15.4	30.4	38.8	8.4	27.6
"	7 Z-5A	10.8	31.3	27.0	38.8	11.8	43.7
"	10 Z-5A	1.7	44.3	31.5	35.5	4.0	12.7
"	11 Z-5A	12.5	33.3	39.8	39.6	-0.2	-0.5
"	12 Z-5A	16.5	34.5	31.4	36.1	4.7	15
27	1 Y-5	5.3	17.7	30.5	34.4	3.9	12.8
"	2 Y-5	8.7	41.7	28.6	35.4	6.8	23.8
"	3 Y-5	5.9	35.7	27.0	32.4	5.4	20
"	4 Y-5	6.8	39.4	19.6	29.5	9.9	50.5
"	6 Y-5	10.6	30.1	30.3	34.9	4.6	15.2
"	7 Y-5	8.2	36.5	28.3	30.8	2.5	8.8
"	10 Y-5	6.9	62.3	27.6	34.0	6.4	23.2
"	11 Y-5	10.2	30.3	27.2	35.9	8.7	32
"	12 Y-5	12.8	40.4	27.2	33.3	6.1	22.4
28	1 Z-5	14.9	36.1	28.8	35.7	6.9	24
"	2 Z-5	6.1	20.4	20.7	32.2	11.5	55.6
"	3 Z-5	9.3	35.1	28.0	34.4	6.4	22.8
"	6 Z-5	19.0	-	35.7	38.1	2.4	6.7
"	7 Z-5	10.7	54.1	28.2	35.3	7.1	25.2
"	10 Z-5	15.0	50.7	27.8	32.4	4.6	16.6
"	11 Z-5	11.3	34.1	29.6	36.4	6.8	23
"	12 Z-5	11.4	34.6	21.4	31.6	10.2	47.7

*First number in sample designation indicates grade of steel.
**Values are averages of five measurements on each sample.

TABLE 2

Water Film Test Results

Bath No.	Sample No.*	24 hr Corrosion Index White	24 hr Corrosion Index Black	48 hr Corrosion Index White	48 hr Corrosion Index Black
9	8 J-5	2 3	0 0	2 3	0 0
"	9 J-5	3 2	0 0	3 2	0 0
"	13 J-5	2 3	0 0	3 4	0 0
"	14 J-5	2 3	0 0	3 3	0 0
"	14 J-5	4 4	0 0	4 4	0 0
10	8 K-5	3 3	0 0	3 3	0 0
"	9 K-5	2 3	0 0	3 4	0 0
"	13 K-5	3 2	0 0	4 3	0 0
"	14 K-5	3 4	0 0	4 4	0 0
"	15 K-5	3 3	0 0	4 4	0 0
11	8 L-5	4 3	0 0	4 4	0 0
"	9 L-5	3 2	0 0	4 3	0 0
"	13 L-5	4 3	0 0	4 3	0 0
"	14 L-5	3 3	0 0	4 3	0 0
"	15 L-5	3 3	0 0	3 3	0 0
13	8 N-5	3 3	0 0	4 4	0 0
"	9 N-5	4 2	0 0	4 3	0 0
"	13 N-5	3 4	0 0	3 4	0 0
"	14 N-5	3 3	0 0	3 3	0 0
"	15 N-5	3 3	0 0	3 4	0 0
14	8 P-5	1 2	0 0	1 2	0 0
"	9 P-5	2 2	0 0	2 3	0 0
"	13 P-5	1 2	0 0	2 2	0 0
"	14 P-5	1 3	0 0	2 3	0 0
"	15 P-5	3 1	0 0	4 1	0 0
15	8 Q-5	4 4	0 0	4 4	0 0
"	9 Q-5	4 4	0 0	4 4	0 0
"	13 Q-5	4 3	0 0	4 3	0 0
"	14 Q-5	4 4	0 0	4 4	0 0
"	15 Q-5	3 2	0 0	4 3	0 0
16	8 R-5	2 2	0 0	3 3	0 0
"	9 R-5	3 3	0 0	3 3	0 0
"	13 R-5	3 3	0 0	4 4	0 0
"	14 R-5	4 4	0 0	4 4	0 0
"	15 R-5	4 4	0 0	4 4	0 0

TABLE 2 (Cont'd.)

Water Film Test Results

Bath No.	Sample No.*	24 hr Corrosion Index		48 hr Corrosion Index	
		White	Black	White	Black
17	8 S-5	2 3	0 0	2 3	0 0
"	9 S-5	3 3	0 0	3 4	0 0
"	13 S-5	3 2	0 0	4 2	0 0
"	14 S-5	3 2	0 0	4 2	0 0
"	15 S-5	3 1	0 0	4 1	0 0
18	8 T-5	3 3	0 0	4 3	0 0
"	9 T-5	2 3	0 0	3 4	0 0
"	13 T-5	3 4	0 0	4 4	0 0
"	14 T-5	4 3	0 0	4 4	0 0
"	15 T-5	4 4	0 0	4 4	0 0
22	8 Y-5A	2 2	0 0	2 2	0 0
"	9 Y-5A	2 3	0 0	2 3	0 0
"	13 Y-5A	3 3	0 0	4 3	0 0
"	14 Y-5A	3 4	0 0	4 4	0 0
"	15 Y-5A	4 4	0 0	4 4	0 0
23	8 X-5A	3 3	0 0	3 4	0 0
"	9 X-5A	3 3	0 0	3 4	0 0
"	13 X-5A	3 4	0 0	4 4	0 0
"	14 X-5A	3 4	0 0	4 4	0 0
"	15 X-5A	3 3	0 0	3 4	0 0
24	8 Z-5A	2 3	0 0	3 3	0 0
"	9 Z-5A	3 3	0 0	3 4	0 0
"	13 Z-5A	2 3	0 0	3 4	0 0
"	14 Z-5A	3 4	0 0	3 3	0 0
"	15 Z-5A	3 2	0 0	2 4	0 0
27	8 Y-5	2 3	0 0	3 3	0 0
"	9 Y-5	3 3	0 0	4 4	0 0
"	13 Y-5	2 2	0 0	2 3	0 0
"	14 Y-5	4 3	0 0	4 3	0 0
"	15 Y-5	2 3	0 0	3 3	0 0
28	8 Z-5	2 3	0 0	3 4	0 0
"	9 Z-5	2 3	0 0	3 4	0 0
"	13 Z-5	2 3	0 0	3 3	0 0
"	14 Z-5	2 3	0 0	2 4	0 0

*First number in sample designation indicates grade of steel.

APPENDIX III

STATISTICAL ANALYSIS OF COATING TEST DATA

by

H.L. Williams
Consolidated Mining and Smelting Company of Canada Limited,
Trail, B.C.
July 3, 1961

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INTRODUCTION

This appendix covers statistical studies made by the Consolidated Mining and Smelting Company of Canada, Limited, on the test data produced at the Mines Branch, Ottawa, Ontario, and the Steel Company of Canada Limited, Hamilton, Ontario, in the project dealing with the galvanizing behaviour of commercial steel sheet materials. The data consisted of test logs obtained in two statistically-designed experiments.

In experiment "A", the effect of varying the aluminum content of the bath from nil to 0.15% and the immersion time from 10 to 60 seconds was studied for each of 15 grades of steel sheet. The lead content was kept constant at 0.3%.

In experiment "B", the effect of varying the lead content of the bath from 0.3 to 1.0% and the immersion time from 1 to 4 minutes was studied for the same materials. The aluminum content of the bath was nil for all tests in this series.

The galvanizing test conditions comprising 0.0% Al and 60 seconds immersion time were common to both experiments.

INTERPRETATION OF DATA

A description of the data was obtained by developing empirical equations since the true functional form of the various relationships it was desired to study was unknown.

Levels of the independent variables studied were coded; actual variables were related to the coded variables as in Table 1.

TABLE 1

Coded Values of Independent Variables

Experiment	Variables	Coded Values		
		-1	0	+1
"A"	x_1 - Aluminum content - %	0	0.075	0.15
	x_2 - Immersion time - sec	10	35	60
"B"	x_1^1 - Lead content - %	0.3	-	1.0
	x_2^1 - Immersion time - sec	60	120	240

The independent variables were related to the coded variables as follows:

$$x_1 = \frac{\text{Aluminum content, \% - 0.075}}{0.075}$$

$$x_2 = \frac{\text{Immersion time, sec - 35}}{25}$$

$$x_1^1 = \frac{\text{Lead content, \% - 0.65}}{0.35}$$

$$x_2^1 = \frac{\text{Log (Immersion, sec) - 2.0792}}{0.3010}$$

The 15 grades of steel used in the experiments comprised the following:

1. Galvanizing grade, as-received, 24 gauge.
2. Galvanizing grade, cold rolled - 5% reduction.
3. Galvanizing grade, cold rolled - 15% reduction.
4. Armco iron, as-received, 24 gauge.
5. Armco iron, cold rolled - 15% reduction.
6. Aluminum-killed, as-received, 24 gauge.
7. Aluminum-killed, cold rolled - 15% reduction.
8. Hot rolled normalized, as-received, 14 gauge.
9. Hot rolled normalized, cold rolled - 15% reduction.
10. Full hard, as-received, 24 gauge.
11. Bottle top, as-received, 24 gauge.
12. Bottle top, cold rolled - 15% reduction.
13. Alloy Steel A, as-received, 14 gauge.
14. Alloy Steel B, as-received, 14 gauge.
15. Alloy Steel C, as-received, 16 gauge.

For experiment "A" an equation of the form $y = b_o + b_1x_1 + b_2x_2 + b_{11}x_1^2 + b_{22}x_2^2 + b_{12}x_1x_2$ was fitted to the data for each dependent variable. The non significant terms were then discarded and the equations recalculated.

For experiment "B", the same procedure was followed except that the term "$b_{11}x_1^2$" was omitted because only two levels of lead were used.

Graphs have been plotted to illustrate the relationships where appropriate. For plotting and comparative purposes, the 15 grades of steel were separated into six groups as listed below. Evaluation of each of the dependent variables for experiments "A" and "B" is discussed in following sections of this appendix.

(a) 1, 2, 3

(b) 4, 5

(c) 6, 7

(d) 8, 9, 10

(e) 11, 12

(f) 13, 14, 15

EXPERIMENT "A"

Y_1 - Coating Weight (oz/sq ft - sheet)

The regression coefficients of the empirical equations are listed below, together with their standard errors. The standard deviation "S" about the regression is also listed. If a regression coefficient was less than three standard errors in magnitude it was considered to be non significant. Any non significant terms that were left in the equations are marked by an asterisk.

The data used to calculate each equation consisted of 27 coating weights. The equations have been plotted in Figures 1 and 2.

Regression Coefficients for Y_1

Steel	b_o	b_1	b_2	b_{11}	b_{12}
1	1.321	-0.621	0.248	-0.194	-0.122
2	1.327	-0.538	0.216	-0.293	-0.076
3	1.322	-0.529	0.198	-0.311	-0.088
4	1.400	-0.566	0.269	-0.281	-0.072
5	1.339	-0.561	0.196	-0.277	-0.101
6	1.389	-0.684	0.386	-0.123	-0.192
7	1.371	-0.623	0.361	-0.157*	-0.156
8	1.606	-0.691	0.283	-0.312	-0.162
9	1.638	-0.646	0.322	-0.191	-0.133
10	1.483	-0.278	0.396	0.025*	0.041*
11	1.366	-0.553	0.290	-0.192	-0.105
12	1.351	-0.466	0.296	-0.208	0.003*
13	0.920	-0.847	0.232	0.822	-0.296
14	1.598	-0.877	0.355	0.149*	-0.220
15	1.737	-0.477	0.403	0.493*	-0.463*

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.039	0.028	0.028	0.048	0.034	0.118
2	0.024	0.017	0.017	0.029	0.021	0.072
3	0.027	0.019	0.019	0.033	0.024	0.081
4	0.030	0.021	0.021	0.037	0.026	0.091
5	0.026	0.018	0.018	0.032	0.023	0.079
6	0.032	0.023	0.023	0.040	0.028	0.097
7	0.054	0.038	0.038	0.066	0.046	0.161
8	0.043	0.030	0.030	0.053	0.037	0.129
9	0.034	0.024	0.024	0.042	0.030	0.104
10	0.014	0.010	0.010	0.018	0.012	0.043
11	0.020	0.014	0.014	0.024	0.017	0.059
12	0.022	0.016	0.016	0.027	0.019	0.067
13	0.042	0.030	0.030	0.051	0.036	0.125
14	0.082	0.058	0.058	0.101	0.071	0.247
15	0.203	0.143	0.143	0.248	0.176	0.608

The coating weight equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 4, 5 and 11 did not differ to a statistically-significant degree.

(b) Steels 6 and 7 did not differ either except that the equation for steel 6 fitted the data better than the equation for steel 7.

(c) Steels 8 and 9 were also similar except that the equation for steel 9 was a better fit than the equation for steel 8. As shown by the graphs, the equation for steel 10 was quite different from the equations for steels 8 and 9.

(d) The equations for steels 11 and 12 showed marked differences in "b_1" and "b_{12}".

(e) The equations for the alloy steels 13, 14 and 15 showed marked differences. This may have been due in part to the fact that the equations for steels 14 and especially 15 were poor fits. The standard errors were an indirect measure of the goodness of fit.

The nature of the relationships may be seen from the graphs.

Y_2 - Iron Content (g/m^2)

The format used for Y_1 will also be used here and in the following sections.

The data used to calculate each equation consisted of 27 iron content measurements. The equations have been plotted in Figures 3 and 4.

Regression Coefficients for Y_2

Steel	b_0	b_1	b_2	b_{11}	b_{12}
1	19.956	- 9.978	4.167	- 7.311	-2.192
2	20.278	- 9.372	3.856	- 8.472	-2.000
3	19.656	- 9.178	3.828	- 8.289	-2.225
4	19.767	- 9.733	3.989	- 7.256	-1.917
5	19.289	- 9.656	3.638	- 7.233	-2.142
6	20.156	-11.328	4.939	- 6.306	-3.033
7	19.967	-11.294	5.150	- 6.139	-2.400
8	32.156	-13.011	4.650	-15.422	-2.550
9	31.156	-11.483	4.783	-12.450	-1.442
10	22.700	- 1.661	7.156	- 0.517*	1.475*
11	23.311	- 9.439	4.744	- 9.028	-1.292*
12	22.856	- 7.989	4.622	- 9.222	-1.317*
13	13.667	-16.067	5.194	12.289	-5.692
14	21.156	-13.044	4.472	- 1.489*	-1.400*
15	17.233	-10.839	3.833*	10.850	-6.083*

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.592	0.419	0.419	0.725	0.513	1.776
2	0.542	0.383	0.383	0.664	0.469	1.625
3	0.556	0.393	0.393	0.681	0.481	1.668
4	0.404	0.286	0.286	0.495	0.350	1.213
5	0.466	0.330	0.330	0.571	0.404	1.399
6	0.367	0.259	0.259	0.449	0.317	1.100
7	0.734	0.519	0.519	0.899	0.636	2.202
8	0.615	0.435	0.435	0.753	0.532	1.844
9	0.503	0.356	0.356	0.616	0.436	1.509
10	0.576	0.408	0.408	0.706	0.499	1.729
11	0.521	0.368	0.368	0.638	0.451	1.562
12	0.655	0.463	0.463	0.802	0.567	1.965
13	0.584	0.413	0.413	0.715	0.506	1.752
14	1.223	0.865	0.865	1.498	1.059	3.669
15	2.872	2.031	2.031	3.517	2.487	8.615

The iron content equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 4 and 5 did not differ to a statistically-significant degree.

(b) The equations for steels 6 and 7 did not differ either.

(c) The equations for steels 8 and 9 were similar except for small but significant differences in "b_1" and "b_{11}". The equation for steel 10 was quite different from those for steels 8 and 9.

(d) The equations for steels 11 and 12 were similar except for a small but significant difference in "b_1".

(e) The equations for the alloy steels 13, 14 and 15 showed marked differences. The equations for steels 14 and especially 15 were poor fits.

Y_3 - Steel Weight Loss (g/m^2)

The data used to calculate each equation consisted of 36 steel weight loss measurements. The equations have been plotted in Figures 5 and 6.

Regression Coefficients for Y_3

Steel	b_o	b_1	b_2	b_{11}	b_{12}
1	19.467	-8.833	4.617	-5.917	-3.356
2	19.033	-8.579	4.612	-6.021	-2.619
3	18.967	-8.371	4.312	-6.446	-2.656
4	19.550	-8.412	4.992	-6.238	-2.388
5	19.383	-8.204	4.142	-6.829	-2.456
6	19.617	-9.446	5.333	-4.771	-3.912
7	19.158	-9.550	5.550	-4.050	-3.538
8	19.650	-7.675	6.375	-6.750	-4.019
9	19.933	-6.467	5.888	-6.075	-2.631
10	24.050	-0.675*	6.442	1.792	-0.181*
11	21.467	-8.350	5.171	-5.850	-2.375
12	21.542	-6.925	5.179	-5.100	-2.412
13	20.550	-9.438	6.042	7.371	-5.162
14	19.392	-8.129	6.121	-0.771*	-3.812
15	30.342	-2.079	13.421	2.938	1.075*

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.319	0.226	0.226	0.391	0.276	1.106
2	0.460	0.325	0.325	0.563	0.398	1.593
3	0.431	0.304	0.304	0.527	0.373	1.492
4	0.361	0.255	0.255	0.442	0.312	1.250
5	0.424	0.300	0.300	0.519	0.367	1.468
6	0.319	0.225	0.225	0.390	0.276	1.104
7	0.559	0.395	0.395	0.685	0.484	1.936
8	0.673	0.476	0.476	0.824	0.583	2.331
9	0.599	0.423	0.423	0.733	0.519	2.074
10	0.309	0.218	0.218	0.378	0.267	1.069
11	0.448	0.317	0.317	0.548	0.388	1.551
12	0.442	0.312	0.312	0.541	0.383	1.530
13	0.712	0.551	0.551	0.872	0.617	2.468
14	0.345	0.244	0.244	0.422	0.298	1.194
15	0.713	0.504	0.504	0.874	0.618	2.471

The steel weight loss equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 4 and 5 showed only minor differences of doubtful significance.

(b) The equations for steels 6 and 7 were similar except that equation 6 was a better fit than 7.

(c) The equations for steels 8 and 9 were similar except for small but significant differences in "b_1" and "b_{12}". The equation for steel 10 was quite different from those for steels 8 and 9.

(d) The equations for steels 11 and 12 were similar except for a small but significant difference in "b_1".

(e) The equations for the alloy steels 13, 14 and 15 showed marked differences. The equations for steels 13 and 15 were not as good a fit as equation 14.

(f) The equations for steels 7, 8, 9, 13 and 15 did not fit the data as well as the equations for steels 1, 2, 3, 4, 5, 6, 10, 11, 12 and 14.

Y_4 - Alloy Thickness (mm x 10^{-3})

The data used to calculate each equation consisted of 18 alloy thickness measurements. The equations have been plotted in Figures 7 and 8.

Regression Coefficients for Y_4

Steel	b_0	b_1	b_2	b_{11}	b_{12}
1	17.367	-8.617	3.375	-7.150	
2	17.067	-8.425	3.133	-7.392	
3	17.117	-8.333	2.984	-7.658	
4	17.767	-9.425	3.992	-6.758	-2.000
5	17.133	-9.600	3.325	-6.283	-2.150
6	18.567	-11.108	4.342	-6.125	-2.362
7	18.350	-11.092	4.183	-5.925	-2.075
8	24.633	-10.575	4.525	-12.558	
9	23.983	-9.758	4.925	-10.975	
10	18.367	-3.933	6.492	0.133*	
11	17.583	-9.267	4.125	-6.300	
12	17.083	-7.950	4.325	-6.725	
13	4.700*	-20.092	6.858	16.558	-8.912
14	21.817	-12.525	5.500	-6.608	
15	14.000	-16.133	5.108*	14.767	-11.450

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.791	0.559	0.559	0.968		1.937
2	0.882	0.624	0.624	1.081		2.161
3	0.884	0.625	0.625	1.082		2.164
4	0.675	0.478	0.478	0.827	0.585	1.654
5	0.758	0.536	0.536	0.928	0.656	1.857
6	0.677	0.478	0.478	0.829	0.586	1.657
7	0.758	0.536	0.536	0.929	0.657	1.858
8	1.363	0.964	0.964	1.672		3.338
9	1.221	0.863	0.863	1.496		2.991
10	0.564	0.399	0.399	0.690		1.381
11	0.884	0.625	0.625	1.083		2.166
12	0.805	0.569	0.569	0.986		1.972
13	1.798	1.271	1.271	2.202	1.557	4.404
14	1.784	1.262	1.262	2.185		4.370
15	3.428	2.424	2.424	4.198	2.969	8.397

The alloy thickness equations for the various steels indicated the following:

(a) The equations for steels 1, 2 and 3 were similar and did not differ to a statistically-significant degree.

(b) The equations for steels 4 and 5 were similar.

(c) The equations for steels 6 and 7 were also similar.

(d) The equations for steels 8 and 9 were similar but the equation for steel 10 was quite different.

(e) The equations for steels 11 and 12 were similar and also did not differ statistically from the equations for steels 1, 2 and 3.

(f) The equations for steels 13, 14 and 15 showed marked differences.

(g) The equations for steels 1 to 12 inclusive fitted the data better than the equations for steels 13 and 14, and especially 15.

Y_5 - Proportion of Alloy (%)

The data used to calculate each equation consisted of 18 proportion-of-alloy measurements. The equations have been plotted in Figures 9 and 10.

Regression Coefficients for Y_5

Steel	b_0	b_1	b_2	b_{11}	b_{12}
1	61.167	-18.792	3.258	-29.075	
2	59.700	-21.525	3.217*	-26.692	
3	60.034	-21.742	3.325	-27.592	
4	59.134	-22.175	4.300	-24.192	
5	58.800	-23.875	5.358	-23.392	
6	63.784	-23.600		-30.133	
7	65.684	-25.350		-30.500	
8	71.484	-21.042	3.333	-38.742	3.338
9	67.717	-16.908	5.150	-33.142	5.088
10	56.850	- 2.992	6.458	- 0.708*	4.200
11	59.434	-21.008	5.250	-24.225	4.050
12	58.050	-19.958	7.083	-23.958	2.912*
13	23.600	-33.342	8.083	15.758	-6.325
14	61.284	-18.208		-28.958	
15	38.817	-22.092		15.592*	

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.750	0.530	0.530	0.900		1.788
2	1.589	1.123	1.123	1.946		3.892
3	1.391	0.984	0.984	1.704		3.408
4	1.355	0.958	0.958	1.659		3.318
5	1.390	0.983	0.983	1.703		3.406
6	1.369	0.968	-	1.677		3.354
7	1.863	1.317	-	2.282		4.564
8	0.948	0.670	0.670	1.161	0.821	2.322
9	1.506	1.065	1.065	1.844	1.304	3.688
10	1.324	0.936	0.936	1.621	1.146	3.242
11	1.252	0.885	0.885	1.533	1.084	3.067
12	1.718	1.215	1.215	2.105	1.400	4.209
13	1.265	0.895	0.895	1.550	1.096	3.100
14	3.135	2.217		3.840		7.679
15	4.391	3.105		5.377		10.755

The proportion-of-alloy equations for the various steels indicated the following:

(a) The equations for steels 1, 2 and 3 did not differ to a statistically-significant degree. Since the three equations were similar they were combined for plotting to avoid confusion.

(b) The equations for steels 4 and 5 were similar and were also combined.

(c) The equations for steels 6 and 7 were similar. For these steels, the proportion of alloy was not significantly related to immersion time.

(d) The equations for steels 8, 9, 10 differed to a significant degree. The nature of their differences may be seen in their plots.

(e) The equations for steels 11 and 12 showed a small but statistically-significant difference in b_2.

(f) The equations for alloy steels 13, 14 and 15 were significantly different. The effect of immersion time on proportion alloy was not significant for steels 14 and 15.

(g) The equations for steels 1 to 13 fitted the data better than the equations for steels 14 and 15.

Y_6 - Coating Ductility

Rating: 1 = Excellent, no cracking.

2 = Good, network of fine cracks.

3 = Fair, general cracking, small blocks.

4 = Poor, wide separation of medium-sized blocks.

5 = Very poor, general peeling of coating in large blocks.

The data used here to calculate each equation consisted of 18 ductility ratings. The equations have been plotted in Figure 11.

Regression Coefficients for Y_6

Steel	b_o	b_1	b_2	b_{11}	b_{12}
1	2.500	-0.875	0.292	-0.542	
2	2.250	-0.833	0.458	-0.417*	
3	2.250	-0.750	0.458	-0.500	
4	2.333	-0.833	0.333	-0.500	
5	2.333	-0.750	0.417	-0.583	
6	2.333	-0.833	0.375	-0.500	
7	2.417	-0.833	0.292	-0.583	
10	2.500	0.083*	0.417	-0.417	0.375
11	2.333	-0.833	0.333	-0.500	
12	2.333	-0.833	0.333	-0.500	

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.079	0.056	0.056	0.096		0.193
2	0.161	0.114	0.114	0.198		0.396
3	0.148	0.105	0.105	0.182		0.364
4	0.126	0.089	0.089	0.155		0.309
5	0.122	0.086	0.086	0.149		0.299
6	0.133	0.094	0.094	0.163		0.325
7	0.110	0.078	0.078	0.135		0.270
10	0.041	0.029	0.029	0.050	0.035	0.100
11	0.126	0.089	0.089	0.155		0.309
12	0.126	0.089	0.089	0.155		0.309

The ductility rating equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 4, 5, 6, 7, 11 and 12 did not differ statistically. They were therefore combined for plotting.

(b) The equation for steel 10 differed from the others. The residual variance about the regression line was significantly smaller than for the other equations, i.e., the equation fitted the data a little better.

Y_7 - Coating Adherence

Rating:		
	1 = 0.050 in. bend radius	5 = 0.192 in. bend radius
	2 = 0.070 " " "	6 = 0.252 " " "
	3 = 0.100 " " "	7 = 0.320 " " "
	4 = 0.144 " " "	8 = 0.400 " " "

The data used here to calculate each equation consisted of 18 adherence ratings. The equations have been plotted in Figure 12.

Regression Coefficients for Y_7

Steel	b_0	b_1	b_2	b_{11}	b_{12}
1	4.667	-2.333	0.417	-1.333	
2	4.633	-2.300	0.467	-1.333	
3	4.600	-2.300	0.467	-1.300	
4	4.967	-2.308	0.458	-1.608	
5	4.967	-2.308	0.458	-1.608	
6	4.533	-2.308	0.408	-1.175	
7	4.433	-2.308	0.408	-1.075	
10	5.500	-0.792	0.542	-0.575	0.388
11	4.717	-2.333	0.392	-1.383	
12	4.667	-2.317	0.433	-1.350	

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.175	0.124	0.124	0.215		0.429
2	0.181	0.128	0.128	0.221		0.442
3	0.177	0.125	0.125	0.217		0.433
4	0.166	0.118	0.118	0.204		0.407
5	0.166	0.118	0.118	0.204		0.407
6	0.149	0.105	0.105	0.182		0.364
7	0.141	0.099	0.099	0.172		0.344
10	0.089	0.063	0.063	0.109	0.077	0.218
11	0.162	0.114	0.114	0.198		0.396
12	0.173	0.122	0.122	0.212		0.423

The adherence rating equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 6, 7, 11 and 12 did not differ statistically. They were therefore combined for plotting.

(b) The equations for steels 4, 5 were also similar and were combined for plotting.

(c) The equation for steel 10 differed from the other equations to a marked degree in the high aluminum range.

Y_8 - Coating Spangle Size (Spangles per sq. in.)

The data used here to calculate each equation consisted of 18 spangle size measurements. The equations have been plotted in Figures 13 and 14.

Regression Coefficients for Y_8

Steel	b_0	b_1	b_2	b_{11}	b_{12}
1	102.0	59.0	-18.3	- 24.0	
2	100.3	59.5	-19.7	- 22.8	
3	97.2	62.1	-27.0	- 16.8	
4	119.5	59.7	- 7.1*	- 42.2	
5	106.7	59.2	-16.2	- 28.8	
6	103.3	56.7	-26.0	- 20.7	
7	101.7	56.0	-28.1	- 18.3	
8	143.3	51.2	-32.8	- 76.1	
9	155.8	58.7	-46.2	- 81.5	
10	242.3	90.9	-86.2	-131.1	-56.6
11	292.8	172.7	-	-103.5	
12	308.0	172.7	-	-118.7	
13	239.8	107.5	-29.4	-116.3	
14	256.0	107.5	-	-132.5	
15	260.2	128.7	-	-122.5	

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	7.84	5.54	5.54	9.60		19.20
2	8.16	5.77	5.77	9.99		19.99
3	9.43	6.67	6.67	11.55		23.10
4	4.11	2.91	2.91	5.03		10.07
5	6.34	4.48	4.48	7.76		15.52
6	9.40	6.65	6.65	11.52		23.03
7	9.18	6.49	6.49	11.25		22.49
8	14.06	9.94	9.94	17.22		34.45
9	13.39	9.47	9.47	16.39		32.79
10	12.96	9.16	9.16	15.87	11.22	31.74
11	20.99	14.84	-	25.70		51.40
12	19.92	14.09	-	24.40		48.80
13	10.69	7.56	7.56	13.10		26.19
14	9.13	6.45	-	11.18		22.36
15	27.50	19.45	-	33.68		67.37

The spangle size equations for the various steels indicated the following:

(a) The equations for steels 1 and 2 did not differ significantly and were combined for plotting. The equation for steel 3 showed a small but significant difference in "b_2".

(b) The equations for steels 4 and 5 differed to a significant degree mainly in the coefficients "b_o, b_2" and "b_{11}".

(c) The equations for steels 6 and 7 were similar and were combined for plotting.

(d) The equations for steels 8, 9 and 10 differed to a significant degree. The extent of their differences may be seen from their plots.

(e) The equations for steels 11 and 12 differed to a minor but significant degree, mainly in the coefficients "b_o" and "b_{11}". The effect of immersion time variations on spangle size was not significant for these two steels.

(f) The equations for the alloy steels 13, 14 and 15 were significantly different. The effect of immersion time variations on spangle size was not significant for steels 14 and 15.

(g) The equations for steels 1 to 7, 13 and 14 fitted the data better than the others.

Y_9 - Spangle Contrast of Coating

Rating: 1 = Good, spangles well defined.

2 = Moderate, spangles well defined.

3 = Low or no contrast, spangles outlined only.

4 = No contrast (no spangles).

The data used here to calculate each equation consisted of 18 spangle contrast ratings. The equations have been plotted in Figure 15.

Regression Coefficients for Y_9

Steel	b_0	b_1	b_2	b_{11}	b_{12}
1	1.47	0.56	0.13*	1.48	-0.23
2	1.47	0.53	0.13	1.50	-0.23
3	1.47	0.53	0.13	1.50	-0.23
4	1.55	0.53	0.16	1.42	-0.20
5	1.50	0.53	0.13	1.47	-0.20
6	1.83	0.39	-	1.28	-
7	1.83	0.39	-	1.28	-
8	2.17	0.50	-	0.83	-
9	2.17	0.49	-	0.84	-
10	1.97	-0.28	-	0.48	-
11	1.83	0.43	-	1.32	-
12	1.83	0.43	-	1.32	-
13	2.50	0.17	-	0.83	-
14	3.00	-	-	0.50	-
15	2.97	0.54	-	-0.34	-

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.07	0.05	0.05	0.09	0.06	0.18
2	0.06	0.04	0.04	0.07	0.05	0.14
3	0.06	0.04	0.04	0.07	0.05	0.14
4	0.04	0.03	0.03	0.05	0.03	0.09
5	0.04	0.03	0.03	0.05	0.03	0.10
6	0.08	0.06	-	0.10	-	0.21
7	0.08	0.06	-	0.10	-	0.21
8	0.06	0.04	-	0.07	-	0.15
9	0.07	0.05	-	0.09	-	0.18
10	0.09	0.06	-	0.11	-	0.21
11	0.10	0.07	-	0.12	-	0.24
12	0.10	0.07	-	0.12	-	0.24
13	0.06	0.04	-	0.07	-	0.15
14	0.00	-	-	0.00	-	0.00
15	0.08	0.06	-	0.10	-	0.19

The spangle contrast equations for the various steels indicated the following:

(a) The equations for steels 1 to 5 did not differ significantly and were combined for plotting.

(b) The effect of immersion time variations on spangle contrast was not significant for steels 6 to 15.

(c) The equations for steels 6 and 7 were identical.

(d) The equations for steels 8 and 9 did not differ significantly and were combined for plotting. The equation for steel 10 was significantly different.

(e) The equations for steels 11 and 12 were identical.

(f) The equations for the alloy steels 13, 14 and 15 differed to a significant degree. The equation for steel 14 fitted the data exactly.

Y_{10} - Coating Brightness

Rating: 1 = 0 to 1.25 photometer units

2 = 1.5 to 2.75 " "

3 = 3.0 to 5.5 " "

4 = 6.0 to 11.0 " "

5 = 11.5 + " "

The data used here to calculated each equation consisted of 18 brightness ratings. The equations have been plotted in Figure 16.

Regression Coefficients for Y_{10}

Steel	b_0	b_1	b_{11}
1	2.11	-0.79	-
2	2.17	-0.67	-
3	2.14	-0.75	-
4	2.19	-0.71	-
5	2.11	-0.83	-
6	2.00	-0.50	0.50
7	1.92	-0.50	0.58
8	2.25	-0.83	0.58
9	2.25	-0.50	0.75
10	2.00	-0.50	0.50
11	2.00	-0.50	0.50
12	2.00	-0.50	0.50
13	2.00	-0.75	0.58
14	2.86	-0.79	-
15	2.67	-0.50	0.67

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_{11}	S
1	0.08	0.10	-	0.33
2	0.10	0.13	-	0.45
3	0.08	0.09	-	0.32
4	0.07	0.09	-	0.31
5	0.07	0.09	-	0.30
6	0.00	0.00	0.00	0.00
7	0.05	0.03	0.06	0.12
8	0.12	0.08	0.14	0.28
9	0.19	0.14	0.24	0.47
10	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00
13	0.11	0.08	0.14	0.28
14	0.10	0.12	-	0.42
15	0.17	0.12	0.20	0.41

The brightness reading equations indicated the following:

(a) The equations for steels 1, 2, 3, 4 and 5 did not differ significantly and were combined for plotting.

(b) The equations for steels 6 and 7 were similar and were also combined for plotting.

(c) The equations for steels 8, 9 and 10 differed to a significant degree.

(d) The equations for steels 10, 11 and 12 were identical.

(e) The equations for steels 13, 14 and 15 differed to a significant degree.

Y_{11} - Coating Roughness

Rating: 1 = Very smooth.

2 = Moderately smooth.

3 = Fine to moderately rough sandpaper texture.

4 = Rough texture or uneven surface caused by various defects (ridges, dewetting, black spots, pimples).

The data used here to calculate each equation consisted of 18 roughness ratings. The equations have been plotted in Figure 17.

Regression Coefficients for Y_{11}

Steel	b_o	b_1	b_2	b_{11}	b_{12}
1	1.00	0.07*	-	0.57	0.10
2	1.00	0.12*	-	0.55	0.18
3	1.00	0.10*	-	0.57	0.15
4	1.27	0.23	-	0.47	-
5	1.27	0.22	-	0.45	-
6	1.50	0.23	-	0.28	-
7	1.15	0.21	-	0.64	-
8	2.50	0.71	-	0.14*	-
9	2.50	0.75	-	0.12*	-
10	1.10	-0.08	-0.13	0.32	-0.13
11	1.00	0.13	-	0.63	-
12	1.00	0.05*	-	0.55	-
13	1.97	0.75	-	0.28	-
14	4.00	0.50	-	-0.50	-
15	2.50	0.11	-0.08	-0.89	-0.13

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{11}	SE b_{12}	S
1	0.04	0.03	-	0.05	0.04	0.10
2	0.04	0.03	-	0.05	0.04	0.10
3	0.05	0.03	-	0.06	0.04	0.12
4	0.06	0.04	-	0.07	-	0.14
5	0.06	0.04	-	0.07	-	0.14
6	0.03	0.02	-	0.03	-	0.07
7	0.06	0.04	-	0.08	-	0.15
8	0.05	0.04	-	0.06	-	0.13
9	0.03	0.02	-	0.04	-	0.09
10	0.04	0.03	0.03	0.05	0.03	0.09
11	0.05	0.04	-	0.06	-	0.13
12	0.04	0.03	-	0.04	-	0.09
13	0.02	0.01	-	0.02	-	0.04
14	0.00	0.00	-	0.00	-	0.00
15	0.05	0.03	0.03	0.04	0.03	0.09

The coating roughness equations for the various steels indicated the following:

(a) The equations for steels 1, 2 and 3 did not differ to a significant degree and were combined for plotting.

(b) The equation for steels 4 and 5 were also similar and were combined for plotting.

(c) The equations for steels 6 and 7 were significantly different.

(d) The equations for steels 8 and 9 were similar and were combined for plotting. The equation for steel 10 was significantly different.

(e) The equations for steels 11 and 12 were similar and were combined for plotting.

(f) The equations for steels 13, 14 and 15 differed to a significant degree.

(g) The effect of immersion time variations on roughness was found to be significant for steels 1, 2, 3, 10 and 15, but not for the others.

(h) The equation for steel 14 fitted the data exactly.

Y_{12} - Average Gain in Diffusivity (%)

Variation in aluminum content of the bath and in immersion time failed to show a significant effect upon diffusivity during the humidity tests. Steels 8, 9, 13, 14 and 15 were not included in this test. Nine figures were available for each steel except for steels 2 and 3 where one figure was missing.

The average diffusivities for each steel together with the 95% confidence limits for each average are shown below. There are no significant differences within this group of averages.

Steel	Average Gain in Diffusivity (%)
1	58 ± 34
2	63 ± 38
3	48 ± 31
4	65 ± 44
5	63 ± 40
6	41 ± 16
7	36 ± 20
10	20 ± 24
11	30 ± 24
12	30 ± 24

Y_{13} - Weight Gain After Humidity Test (g)

Variation in aluminum content of the bath and in immersion time failed to show a significant effect upon weight gain from corrosion for most of the steels. Steels 1, 2 and 10 did show some statistically significant effects. However, these may be of no practical value. Steels 8, 9, 13, 14 and 15 were not included in this test. Nine figures were available for each steel studied.

The significant relationships have been plotted in Figure 18.

Regression Coefficients for Y_{13}

Steel	b_o	b_1	b_2	b_{11}	b_{22}	b_{12}
1	0.0171	-	-	-0.0067	0.0102	0.0078
2	0.0269	-	-	-0.0122	-	-
10	0.0150	0.0068	-0.0024	0.0051	0.0051	-0.0035

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{11}	SE b_{22}	SE b_{12}
1	0.0023	-	-	0.0022	0.0022	0.0015
2	0.0028	-	-	0.0034	-	-
10	0.0006	0.0003	0.0003	0.0006	0.0006	0.0004

The average weight gain from corrosion for each steel together with the 95% confidence limits for each average are shown below. There are no significant differences within this group of averages. The readings for steel 12 showed significantly more scatter than for the other steels.

Steel	Average Weight Gain (g)
1	0.0194 ± 0.0066
2	0.0188 ± 0.0058
3	0.0206 ± 0.0077
4	0.0165 ± 0.0047
5	0.0149 ± 0.0058
6	0.0190 ± 0.0063
7	0.0189 ± 0.0072
10	0.0218 ± 0.0059
11	0.0216 ± 0.0069
12	0.0280 ± 0.0221

Y_{14} - Weight Loss After Humidity Test (g)

Variation in aluminum content of the bath and in immersion time failed to show a significant effect upon weight loss from corrosion for most of the steels. Steels 1, 2 and 10 did show some statistically significant effects but these may be of no practical value. Steels 8, 9, 13, 14 and 15 were not included in this test. Nine figures were available for each steel studied.

The significant relationships have been plotted in Figure 19.

Regression Coefficients for Y_{14}

Steel	b_o	b_1	b_{11}
1	0.0899	-	-0.0446
2	0.0731	-	-0.0373
3	0.0490	0.0218	0.0187*

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_{11}
1	0.0086	-	0.0106
2	0.0063	-	0.0077
10	0.0094	0.0066	0.0115

The average weight loss from corrosion for each steel together with the 95% confidence limits for each average are shown below. There are no significant differences within this group of averages.

Steel	Average Weight Loss (g)
1	0.0602 ± 0.0203
2	0.0483 ± 0.0163
3	0.0583 ± 0.0251
4	0.0480 ± 0.0114
5	0.0445 ± 0.0166
6	0.0500 ± 0.0183
7	0.0656 ± 0.0256
10	0.0615 ± 0.0195
11	0.0576 ± 0.0172
12	0.0697 ± 0.0264

Y_{15} + Y_{16} - Corrosion Index (Water Film Test)

Variations in aluminum content of the bath and in immersion time failed to show a significant effect upon either the black or the white corrosion indices for both the 24 and 48 hour tests for all steels. Nine figures were available for each steel for each test.

Some variation in the indices for white corrosion was obtained but no significant relationships were found. The indices for black corrosion were all "o", i.e. no corrosion was observed.

The average white corrosion indices for each steel together with the 95% confidence limits for each average are shown below. There are no significant differences within these two groups of averages. Only steels 8, 9, 13, 14 and 15 were tested in this manner.

Steel	Average White Corrosion Index	
	24 hr	48 hr
8	2.8 ± 0.6	3.1 ± 0.7
9	2.8 ± 0.4	3.3 ± 0.4
13	2.9 ± 0.5	3.4 ± 0.5
14	3.1 ± 0.5	3.4 ± 0.4
15	3.1 ± 0.6	3.4 ± 0.5

Y_{17} - Aluminum Content of Coatings (%)

The data used here to calculate each equation consisted of 18 aluminum analyses. Only coatings deposited from baths containing 0.075% and 0.15% aluminum were analysed for aluminum content. The experiment, as far as this variable is concerned, is therefore a 2 x 3 factorial design, two levels of aluminum in the bath and three immersion times. The equations derived have been plotted in Figure 20.

Regression Coefficients for Y_{17}

Steel	b_o	b_1	b_{12}
1	0.243	0.321	0.045*
2	0.243	0.341	0.093
3	0.252	0.321	0.062
4	0.244	0.321	-
5	0.254	0.326	0.102
6	0.252	0.357	0.087
7	0.256	0.367	0.157
8	0.248	0.360	0.055
9	0.249	0.320	-
10	0.246	0.294	0.058
11	0.257	0.317	-
12	0.254	0.293	-
13	0.220	0.322	-
14	0.227	0.350	0.058*
15	0.224	0.259	-

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_{12}	S
1	0.021	0.030	0.026	0.063
2	0.016	0.023	0.020	0.049
3	0.013	0.018	0.016	0.039
4	0.015	0.021	-	0.044
5	0.021	0.030	0.026	0.064
6	0.016	0.022	0.019	0.047
7	0.007	0.010	0.009	0.022
8	0.012	0.017	0.014	0.035
9	0.016	0.023	-	0.048
10	0.010	0.015	0.013	0.031
11	0.021	0.029	-	0.063
12	0.015	0.021	-	0.044
13	0.018	0.026	-	0.055
14	0.022	0.031	0.027	0.066
15	0.017	0.023	-	0.050

The aluminum content of coating equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 5, 6, 7, 8, 10 and 14 did not differ significantly and were combined for plotting.

(b) The equations for steels 4, 9, 11, 12, 13 and 15 were also similar and were combined for plotting.

(c) The two groups differed mainly in the presence or absence of the interaction term "b_{12}".

EXPERIMENT "B"

Y_1 - Coating Weight (oz/sq ft - sheet)

The data used to calculate each equation consisted of 18 coating weight measurements except for steel 5 where only 12 were available. In the data received, the results for four baths, 25, 26, 27 and 28, were omitted for steel 5. The equations have been plotted in Figure 21.

Regression Coefficients for Y_1

Steel	b_0	b_1	b_2	b_{22}	b_{12}
1	2.401		0.371		
2	2.243		0.452		
3	2.153		0.528	0.155	
4	2.423		0.450	0.073*	-0.102
5	2.160		0.459	0.184	
6	2.830		0.477	0.100	
7	2.562		0.534	0.171	
8	2.744		0.372		
9	2.779		0.360		
10	2.322		0.373	0.150	
11	2.398		0.405	0.077*	
12	2.147		0.371	0.076	
13	4.807		2.317	0.797	
14	3.611		0.546		
15	4.542	-0.164	2.095	1.067	0.258

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_1	SE b_2	SE b_{22}	SE b_{12}	S
1	0.012		0.015			0.052
2	0.019		0.023			0.080
3	0.027		0.019	0.033		0.066
4	0.021		0.015	0.026	0.015	0.053
5	0.026		0.016	0.031		0.045
6	0.011		0.008	0.013		0.026
7	0.020		0.014	0.024		0.048
8	0.017		0.021			0.073
9	0.014		0.017			0.059
10	0.019		0.014	0.023		0.047
11	0.024		0.017	0.029		0.058
12	0.015		0.011	0.018		0.036
13	0.042		0.030	0.051		0.103
14	0.048		0.034			0.117
15	0.059	0.034	0.042	0.073	0.042	0.145

The coating weight equations for the various steels indicated the following:

(a) The equations for steels 1, 2 and 3 differed to a statistically-significant degree. The effect of variations in lead content of the bath upon coating weight was only significant for steels 4 and 15.

(b) The equations for steels 4 and 5 differed to a statistically-significant degree.

(c) The equations for steels 6 and 7 differed to a statistically-significant degree.

(d) The equations for steels 8 and 9 did not differ significantly and were combined for plotting. They did differ from the equation for steel 10.

(e) The equations for steels 11 and 12 differed to a statistically-significant degree.

(f) The equations for steels 13, 14 and 15 also differed.

(g) The equations for steels 1 to 12 fitted the data a little better than the equations for steels 13, 14 and 15.

Y_2 - Iron Content (g/m^2)

The data used to calculate each equation consisted of 18 iron content measurements except for steel 5 where only 12 were available. The equations have been plotted in Figure 22.

Regression Coefficients for Y_2

Steel	b_o	b_1	b_2	b_{22}	b_{12}
1	34.95		9.50	1.93	
2	34.17		9.53	1.35	
3	33.18		10.26	2.42	
4	35.13		8.83	1.27	
5	32.47		8.96	2.68	
6	39.95		10.02	2.32	
7	39.25		11.08	2.41	
8	39.97	-1.80	7.58	1.28	0.98
9	39.58	-0.69*	7.05	1.35	1.03
10	36.07		7.59	1.44	
11	40.58		11.11	- .61	
12	38.97		9.60	-3.20	
13	78.00		32.83	8.97	
14	47.68	1.65	9.63		
15	69.67	-1.07	33.54	13.36	2.02

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{22}	SE b_{12}	S
1	0.28		0.20	0.35		0.70
2	0.37		0.26	0.45		0.90
3	0.49		0.35	0.60		1.21
4	0.36		0.25	0.44		0.88
5	0.13		0.08	0.16		0.23
6	0.71		0.50	0.87		1.74
7	0.45		0.32	0.55		1.10
8	0.33	0.19	0.23	0.40	0.23	0.81
9	0.43	0.25	0.31	0.53	0.31	1.06
10	0.83		0.59	1.02		2.03
11	0.76		0.54	0.93		1.86
12	0.36		0.25	0.44		0.87
13	0.92		0.65	1.13		2.26
14	0.48	0.28	0.34			1.17
15	0.55	0.32	0.39	0.67	0.39	1.34

The iron content equations for the various steels indicated the following:

(a) The equations for steels 1, 2, 3, 4 and 5 did not differ to a significant degree. The equations for steels 1, 2 and 3 were combined for plotting as were also the equations for steels 4 and 5.

(b) The equations for steels 6 and 7 were similar and were combined for plotting.

(c) The equations for steels 8 and 9 were similar and were combined for plotting. The equation for steel 10 differed from those for steels 8 and 9. The effect of variations in lead content of the bath upon iron content of the coating was small and only significant for steels 8, 9, 14 and 15.

(d) The equations for steels 13, 14 and 15 differed to a statistically significant degree.

(e) The equations for steels 1 to 4, 7 to 9, 14 and 15 fitted the data better than the equations for steels 6, 10, 11, 12 and 13. The equation for steel 5 fitted the data better than any of the others.

Y_3 - Steel Weight Loss (g/m^2)

The data used to calculate each equation consisted of 24 steel weight loss measurements except for steel 5 where only 16 were available. The equations have been plotted in Figure 23.

Regression Coefficients for Y_3

Steel	b_0	b_2	b_{22}
1	36.62	9.26	1.71
2	37.21	9.99	
3	36.76	10.12	
4	38.02	10.42	
5	35.37	9.61	
6	40.89	9.29	
7	39.39	10.00	2.62
8	36.50	9.72	
9	37.35	9.97	
10	38.81	8.05	
11	39.58	9.51	
12	37.29	9.90	1.69
13	77.19	37.59	11.51
14	49.05	10.57	
15	75.52	37.31	8.22

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_2	SE b_{22}	S
1	0.28	0.20	0.34	0.79
2	0.22	0.27		1.09
3	0.07	0.08		0.32
4	0.16	0.20		0.80
5	0.41	0.48		1.58
6	0.30	0.33		1.31
7	0.35	0.24	0.42	0.98
8	0.52	0.63		2.53
9	0.18	0.22		0.88
10	0.19	0.24		0.94
11	0.27	0.33		1.33
12	0.46	0.32	0.50	1.29
13	1.28	0.91	1.57	3.63
14	0.54	0.66		2.63
15	1.73	1.23	2.12	4.90

The steel weight loss equations for the various steels indicated the following:

(a) The equations for steels 2 and 3 did not differ to a statistically-significant degree and were combined for plotting. The equation for steel 1 differed only slightly but significantly from those for steels 2 and 3.

(b) The equations for steels 4 and 5 differed to a significant degree.

(c) The equations for steels 6 and 7 showed minor but significant differences.

(d) The equations for steels 8 and 9 were similar and have been combined for plotting. The equation for steel 10 differed significantly from those for steels 8 and 9.

(e) The equations for steels 11 and 12 showed minor but significant differences.

(f) The equations for steels 13 and 15 were similar and were combined for plotting. The equation for steel 14 differed significantly from those for steels 13 and 15.

(g) The effect of variation in lead content of the bath upon steel weight loss was not significant for any of the steels tested.

(h) The equation for steel 3 fitted the data slightly better than the equations for steels 1, 2, 4, 6, 7 and 9 to 12. The equations for this group fitted the data better than the equation for steel 5 which in turn fitted the data better than the equations for steels 8 and 14. The equations for steels 13 and 15 were the poorest fit of all.

Y_4 - Alloy Thickness (mm x 10^{-3})

The data used to calculate each equation consisted of 12 alloy thickness measurements except for steel 5 where only 8 were available. The equations have been plotted in Figure 24.

Regression Coefficients for Y_4

Steel	b_o	b_1	b_2	b_{22}
1	31.85		9.55	
2	31.42		9.99	
3	31.39		10.21	
4	33.26		8.21	
5	32.73		7.93	
6	36.30		8.74	1.86
7	35.90		9.86	2.51
8	34.24		8.54	
9	34.23		8.71	
10	31.60		7.26	2.06
11	30.70		8.64	1.49
12	30.78		9.26	
13	99.52		52.16	11.71
14	43.31		9.19	
15	88.15	-4.51	48.74	20.61

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{22}	S
1	0.39		0.48		1.35
2	0.35		0.43		1.21
3	0.41		0.50		1.43
4	0.26		0.32		0.92
5	0.41		0.47		1.11
6	0.19		0.14	0.24	0.39
7	0.16		0.11	0.19	0.32
8	0.40		0.49		1.40
9	0.41		0.50		1.41
10	0.41		0.29	0.51	0.83
11	0.21		0.15	0.26	0.42
12	0.19		0.24		0.67
13	1.21		0.86	1.48	2.42
14	0.67		0.82		2.33
15	1.54	0.89	1.09	1.89	3.09

The alloy thickness equations for the various steels indicated the following:

(a) The equations for steels 1, 2 and 3 did not differ to a significant degree and were combined for plotting.

(b) The equations for steels 4 and 5 were also similar and were combined for plotting.

(c) The equations for steels 6 and 7 showed a minor but significant difference in "b_2".

(d) The equations for steels 8 and 9 were similar and were combined for plotting. The equation for steel 10 differed from those for steels 8 and 9.

(e) The equations for steels 11 and 12 differed to a minor but significant degree. The equation for steel 11 had a significant term for "b_{22}", that for steel 12 did not.

(f) The equations for steels 13, 14 and 15 differed to a significant degree. Alloy steels 13 and 15 differed to a very marked degree in alloy thickness from all the other steels tested.

(g) The effect of variation in lead content of the bath upon alloy thickness was only significant for steel 15.

(h) The equations for steels 6, 7 and 11 fitted the data a little better than the equations for steels 1 to 5, 8 to 10 and 12, which group in turn fitted the data better than the equations for steels 13, 14 and 15.

Y_5 - Proportion of Alloy (%)

The data used to calculate each equation consisted of 12 proportion-of-alloy measurements except for steel 5 where only 8 were available. The equations have been plotted in Figure 25.

Regression Coefficients for Y_5

Steel	b_o	b_2
1	61.49	8.88
2	65.11	7.81
3	65.09	6.54
4	63.21	4.19
5	67.01	3.33
6	60.83	4.18
7	65.76	4.34
8	58.28	6.78
9	57.34	7.32
10	63.92	4.35
11	60.43	6.52
12	65.52	8.59
13	93.34	6.18
14	56.31	5.52
15	88.68	8.39

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_2	S
1	0.56	0.69	1.94
2	0.88	1.08	3.05
3	1.15	0.81	2.29
4	0.92	1.12	3.18
5	0.83	0.96	2.26
6	0.15	0.18	0.52
7	0.35	0.43	1.20
8	0.56	0.69	1.95
9	0.62	0.76	2.14
10	0.45	0.56	1.57
11	0.24	0.29	0.82
12	0.62	0.76	2.14
13	1.42	1.74	4.91
14	1.23	1.50	4.25
15	0.81	0.99	2.81

The proportion of alloy equations for the various steels indicated the following:

(a) The equations for steels 2 and 3 did not differ to a statistically-significant degree and were combined for plotting. The equation for steel 1 differed from those for steels 2 and 3.

(b) The equations for steels 4 and 5 differed to a significant degree.

(c) The equations for steels 6 and 7 differed to a significant degree.

(d) The equations for steels 8 and 9 were similar and were combined for plotting. The equation for steel 10 differed significantly from those for steels 8 and 9.

(e) The equations for steels 11 and 12 differed to a significant degree.

(f) The equations for steels 13, 14 and 15 differed to a significant degree.

(g) The effect of variation in lead content of the bath upon proportion of alloy was not significant for any of the steels tested.

(h) The equations for steels 6 and 11 fitted the data a little better than the equations for steels 1, 3, 5 and 7 to 10, which group in turn fitted the data better than the equations for steels 2, 4 and 15. The equations for steels 13 and 14 were the poorest fit of all.

Y_6 - Coating Ductility

Rating: See experiment "A".

The data used here to calculate each equation consisted of 12 ductility ratings except for steel 5 where only 8 were available. The equations have been plotted in Figure 26. Panels from steels 8, 9, 13, 14 and 15 were not tested for ductility. Ratings for steels 7, 11 and 12 were estimated.

Regression Coefficients for Y_6

Steel	b_o	b_2	b_{22}
1	3.25	0.31	
2	3.21	0.25	
3	3.00	0.25	0.25
4	3.21	0.31	
5	3.00	0.25	0.25
6	3.17		
7	3.08		
10	2.79	0.44	
11	3.08		
12	3.08		

Standard Errors of Regression Coefficients

Steel	SE b_0	SE b_2	SE b_{22}	S
1	0.06	0.08		0.22
2	0.04	0.06		0.16
3	0.00	0.00	0.00	0.00
4	0.06	0.08		0.21
5	0.00	0.00	0.00	0.00
6	0.06	0.07		0.19
7	0.06			0.20
10	0.08	0.09		0.26
11	0.06			0.20
12	0.06			0.20

The ductility equations for the various steels indicated the following:

(a) The equations for steels 1, 2 and 4 did not differ to a significant degree.

(b) The equations for steels 3 and 5 were identical and fitted the data exactly.

(c) The equation for steel 10 differed from the others.

(d) Steels 7, 11 and 12 failed to show a ductility, immersion time relationship. The ratings used for these steels were estimated.

(e) The effect of variation in lead content of the bath upon ductility rating was not significant for any of the steels tested.

Y_7 - Coating Adherence

Rating: See Experiment "A".

The data used here to calculate each equation consisted of 12 adherence ratings except for steel 5 where only 8 were available. Since the ratings given for the various steels for each experimental condition were very uniform, only one equation was developed. This applied to all the steels tested.

This equation is given below together with the standard errors of the "b_s". It is plotted in Figure 27.

$$Y_7 = 6.54 + 0.99\, x_2^1 + 0.46\, x_2^{12}$$

SE b's	0.01	0.01	0.01

$$S = 0.073$$

Y_8 - Coating Spangle Size (Spangles per sq in.)

The data used here to calculate each equation consisted of 12 spangle size measurements except for steel 5 where only 8 were available. The equations have been plotted in Figure 28.

Regression Coefficients for Y_8

Steel	b_0	b_1	b_2	b_{22}	b_{12}
1	15.00	- 9.33			
2	14.83	- 9.50			
3	12.00	- 6.50			
4	9.33	- 4.83			
5	10.67	- 6.33			
6	19.75	-15.08			
7	21.75	-16.92			
8	6.17	- 3.50			
9	5.83	- 3.17			
10	9.67	- 5.33			
11	13.00	- 6.92	6.62	9.62	-7.88
12	13.00	- 5.58	4.38	7.38	-5.88
13	13.42	- 2.92	4.12		4.62
14	5.00	- 3.83	-2.25	2.75	1.75
15	6.67	- 2.83			

Standard Errors of Regression Coefficients

Steel	SE b_o	SE b_1	SE b_2	SE b_{22}	SE b_{12}	S
1	2.39	2.39				8.26
2	2.88	2.88				9.97
3	0.79	0.79				2.74
4	0.57	0.57				1.96
5	0.99	0.99				2.43
6	1.07	1.07				3.69
7	1.27	1.27				4.41
8	0.20	0.20			0.24	0.68
9	0.25	0.25			0.31	0.87
10	0.82	0.82				2.85
11	1.23	0.71	0.87	1.51	0.87	2.46
12	1.20	0.69	0.85	1.47	0.85	2.41
13	0.98	0.98	1.20		1.20	3.38
14	0.39	0.22	0.27	0.47	0.27	0.24
15	0.59	0.59				1.74

The spangle size equations for the various steels indicated the following:

(a) The equations for steels 1 and 2 did not differ to a statistically-significant degree and were combined for plotting. The equation for steel 3 differed from those for steels 1 and 2.

(b) The equations for steels 4 and 5 did not differ to a statistically-significant degree and were combined for plotting.

(c) The equations for steels 6 and 7 were also similar and were combined for plotting.

(d) The equations for steels 8 and 9 were similar and were combined for plotting. The equation for steel 10 differed significantly from those for steels 8 and 9.

(e) The equations for steels 11 and 12 were similar and were combined for plotting.

(f) The equations for steels 13, 14 and 15 differed to a significant degree.

(g) The effect of variation in immersion time upon spangle size was significant for steels 11, 12, 13 and 14, but not for the others.

(h) The equations for steels 8, 9 and 14 fitted the data better than the equations for steels 3 to 7, 10 to 13 and 15, which group in turn fitted the data better than the equations for steels 1 and 2.

Y_9 - Spangle Contrast of Coating

Rating: See experiment "A".

The data used in these calculations consisted of 12 spangle contrast ratings except for steel 5 where only 8 were available.

The spangle contrast ratings recorded varied from 2.0 to 3.5 in steps of 0.5. About 77% were rated as 3.0, 13% as 2.5 and 9% as 3.5.

Steels 6, 7, 10, 11 and 13 showed no variation at all. Data for the other steels indicate that there was a small increase in contrast rating with an increase in lead content of the bath from 0.3 to 1.0%. There was also a tendency for the rating to increase with an increase in immersion time. These changes were small and no graphs have been plotted.

The average spangle contrast ratings for the various steels were as follows:

Steel	Contrast Rating
1, 2, 3, 4, 5	2.9
6, 7, 10, 11, 12, 13	3.0
8, 9	3.1
14	3.3
15	2.5

Y_{10} - Coating Brightness

Rating: See experiment "A".

The data used in these calculations consisted of 12 brightness measurements except for steel 5 where only 8 were available.

Steels 1 to 7 and 10 to 12 inclusive taken as a group indicated that an increase in immersion time from 1 to 4 minutes decreased the brightness rating from about 3.0 to about 2.5. An increase in lead content of the galvanizing bath from 0.3 to 1.0% tended to decrease the brightness rating by about 0.5 units for the 2 and 4 minute immersion times.

Steel 8 followed the same general pattern but the measurements were about 0.5 units higher.

With steel 9 an increase in lead content of the galvanizing bath from 0.3 to 1% increased the brightness measurement from 3.0 to 3.5. No other effect was apparent.

With steel 13 an increase in lead content of the bath from 0.3 to 1% increased the brightness measurement from about 3.8 to 5.0.

Steel 14 showed a small drop (0.5 units) in brightness rating with an increase in immersion time.

Steel 15 showed a tendency toward an increase in brightness measurement with an increase in immersion time.

The average brightness ratings for the various steels are as follows:

Steel	Brightness Rating
1, 11	2.8
2, 3	2.5
4, 5, 7, 12	2.6
6, 10	2.7
8	3.0
9	3.2
13	4.4
14	3.1
15	3.8

No graphs have been plotted for this section.

Y_{11} - Coating Roughness

Rating: See experiment "A".

The data used in these calculations consisted of 12 roughness ratings except for steel 5 where only 8 were available.

Steels 8 and 9 showed a tendency for the roughness rating to increase about 0.3 with an increase in lead content of the galvanizing bath from 0.3 to 1% Pb.

Steel 13 showed a tendency for the roughness rating to increase about 0.5 with an increase in immersion time from 1 to 4 minutes.

The other steels failed to show significant relationships for the roughness rating.

The average roughness ratings for the various steels are as follows:

Steel	Roughness Rating
1, 3, 4, 5, 7, 9, 10, 11 12, 15	1.5
2	1.4
6	1.9
8, 13	1.8
9	1.7
14	3.4

No graphs have been plotted for this section.

Y_{12} - Average Gain in Diffusivity (%)
Y_{13} - Weight Gain After Humidity Test (g)
Y_{14} - Weight Loss After Humidity Test (g)
Y_{15} - Corrosion Index (White), 24 hr Water Film Test
Y_{16} - Corrosion Index (White), 48 hr Water Film Test

Variation in lead content of the bath and in immersion time failed to show a significant effect upon any of the above dependent variables. Six figures were available for each steel for most of the tests. In all there were nine missing figures in these tests.

The indices for black corrosion were all "o", indicating no observable black corrosion.

The averages for each steel for each of these variables together with the 95% confidence limits for each average are as follows:

Steel	Y_{12} (%)	Y_{13} (g)	Y_{14} (g)	Y_{15} (Index)	Y_{16} (Index)
1	23 ± 16	12 ± 5	36 ± 14	-	-
2	40 ± 15	9 ± 2	34 ± 9	-	-
3	28 ± 15	15 ± 13	49 ± 38	-	-
4	33 ± 24	11 ± 4	47 ± 23	-	-
5	31 ± 23	11 ± 3	34 ± 13	-	-
6	19 ± 21	15 ± 7	40 ± 19	-	-
7	35 ± 23	11 ± 2	41 ± 9	-	-
8	-	-	-	2.5 ± 0.3	3.0 ± 0.7
9	-	-	-	2.8 ± 0.3	3.4 ± 0.5
10	28 ± 18	11 ± 7	48 ± 13	-	-
11	23 ± 12	12 ± 1	34 ± 6	-	-
12	27 ± 13	14 ± 3	41 ± 15	-	-
13	-	-	-	2.7 ± 0.5	3.2 ± 0.5
14	-	-	-	3.2 ± 0.5	3.5 ± 0.5
15	-	-	-	2.7 ± 0.8	3.2 ± 0.7

There are no significant differences within each set of averages.

SUMMARY

The nature of the relationships studied may be seen by reference to the equations listed and their plots on the attached graphs.

The effect of immersion time upon the various dependent variables in experiment "A" appears in general to be linear. If the 0.3% Pb tests in experiment "B" were combined with the experiment "A" series, it would be found that many of these variables would show a curvilinear relationship with immersion time.

The full hard steel, 10, and the alloy steels 13, 14 and 15 do not appear to follow quite the same pattern as the others. The steel 14 relationships resemble the others more than do those for steels 13 and 15. The steel 14 coating buildup tended to taper off after the first minute of immersion time as did most of the others, but the coating buildup for steels 13 and 15 continued at a high rate.

Variation in the lead content from 0.3 to 1.0% had very little effect (experiment "B") upon most of the dependent variables measured. Its main effect appeared to be on spangle size. An increase in lead content tended to increase the spangle size.

For each variable throughout the foregoing text, the number of figures used in the regression calculations has been provided. For variables Y_7, Y_8, Y_9, Y_{10}, Y_{11}, Y_{15} and Y_{16} each individual figure used in the calculations was an average of two individual figures obtained from the experiment under identical conditions.

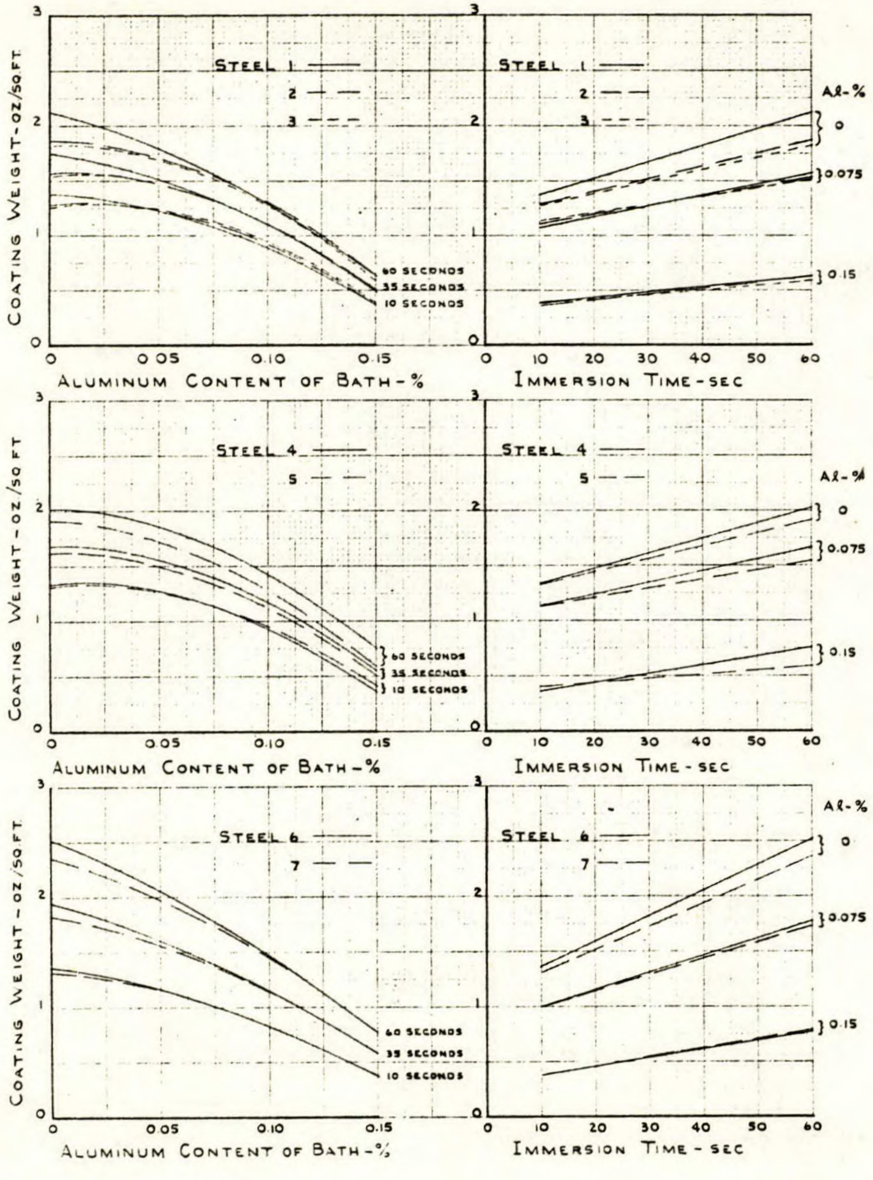
The data obtained from the accelerated corrosion tests in both experiments failed to yield concrete information. Such information as was provided was inconclusive and reappraisal of the tests used appears advisable.

It is to be noted that atmospheric corrosion tests at a fully instrumented semi-industrial site are in progress and the results obtained will be made available at a later date.

FIG. 1

Y1- COATING WEIGHT VS ALUMINUM CONTENT AND IMMERSION TIME

FIG. 2



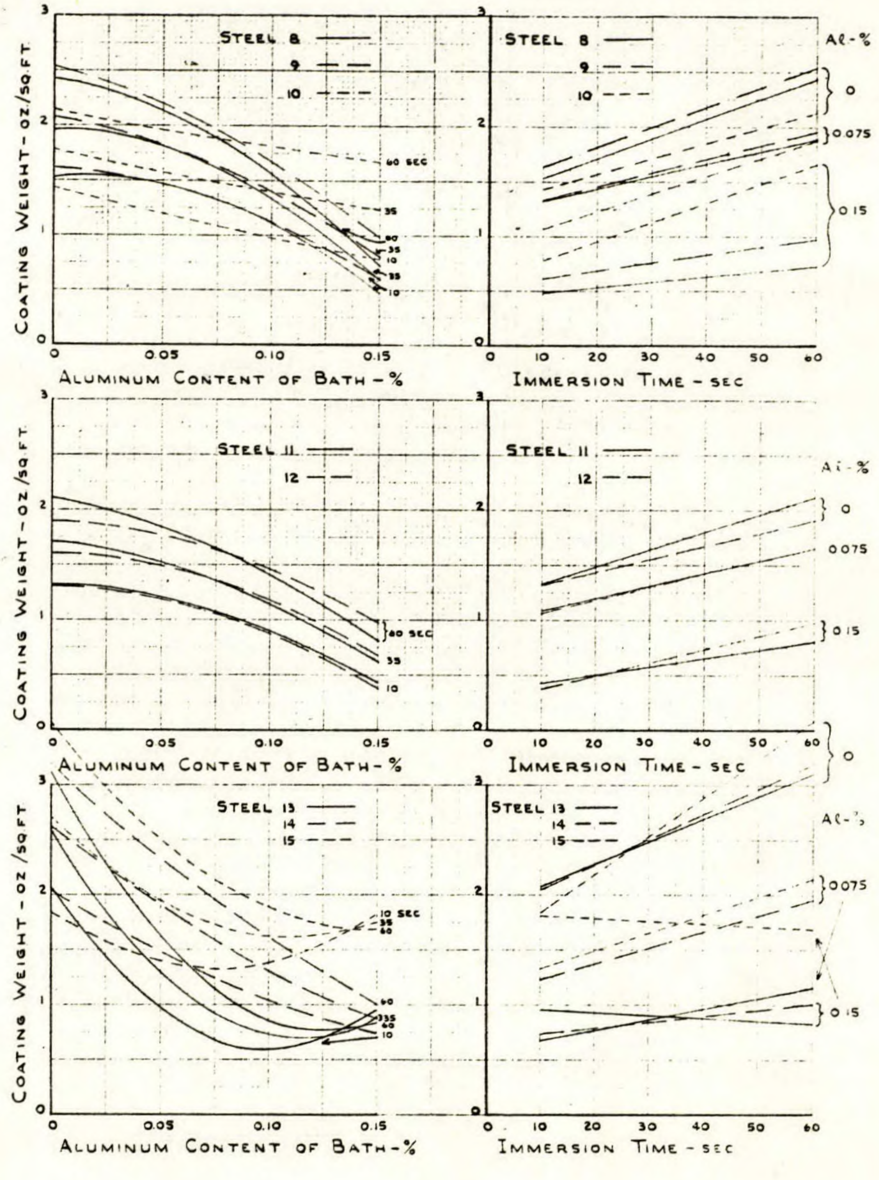


FIG. 3

Y2-Iron Content vs Aluminum Content and Immersion Time

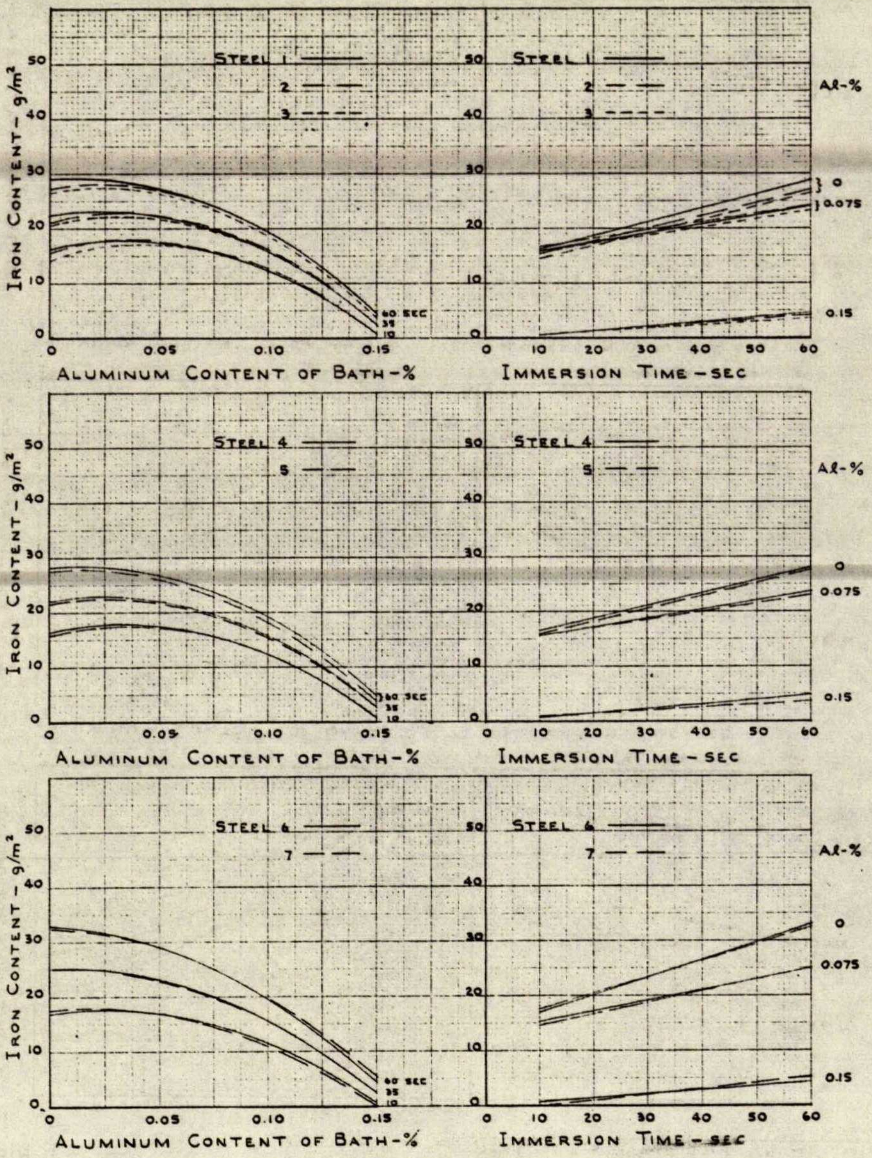
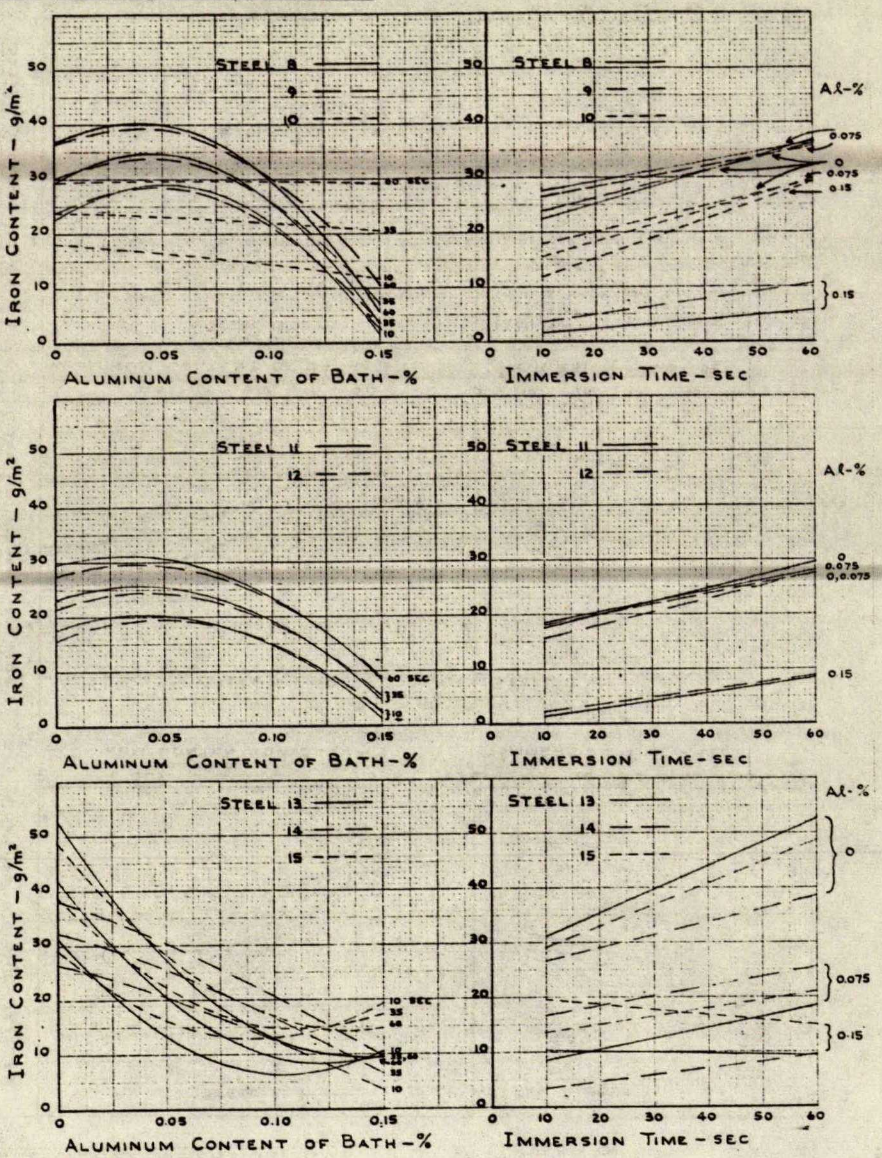


FIG. 4



Y3-Steel Weight Loss vs Aluminum Content and Immersion Time

FIG. 5

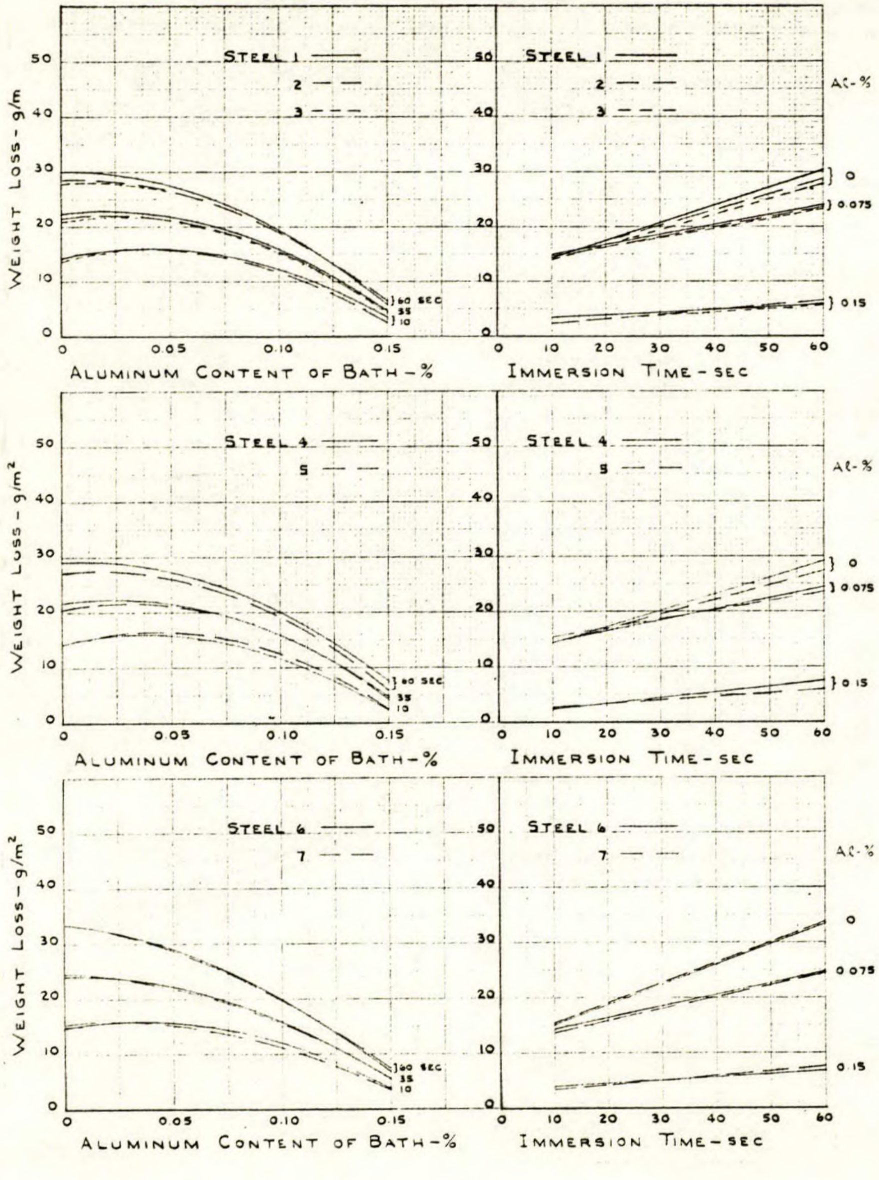


FIG. 6

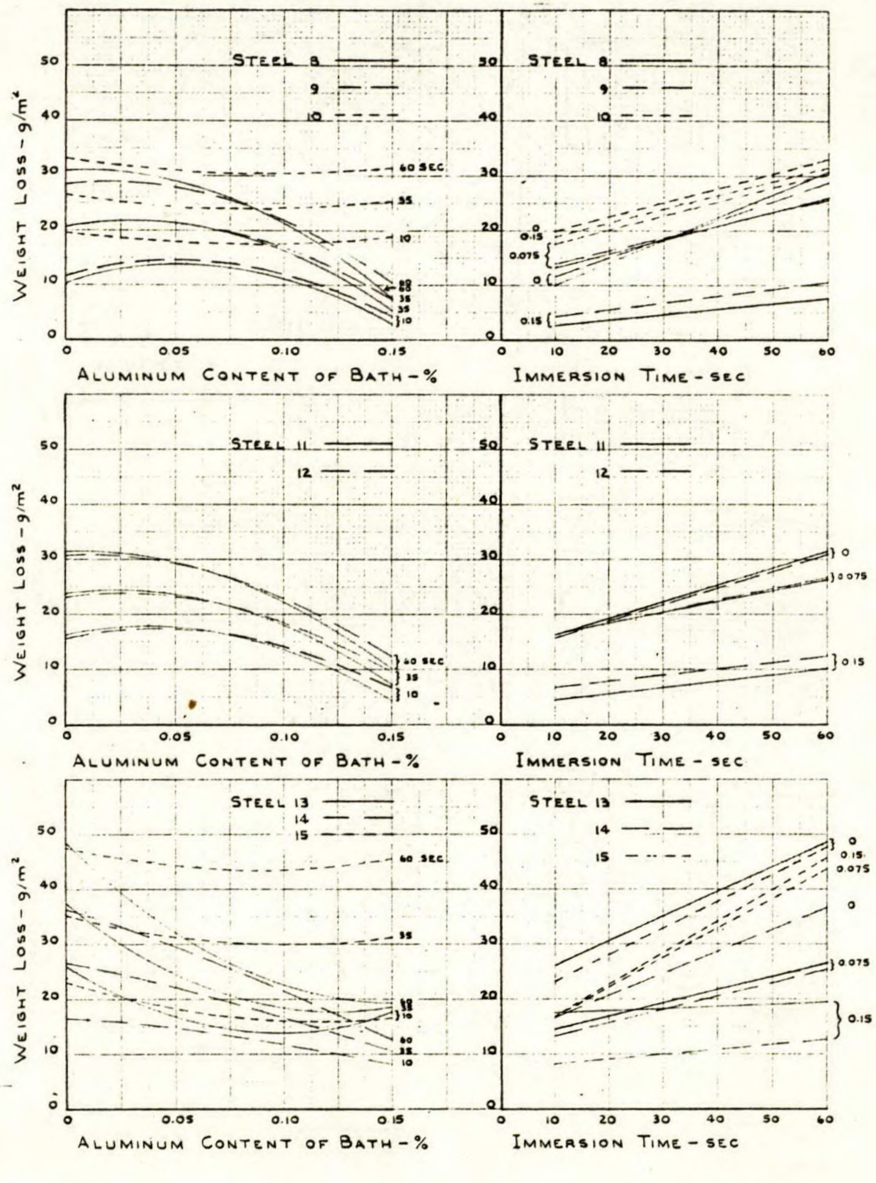
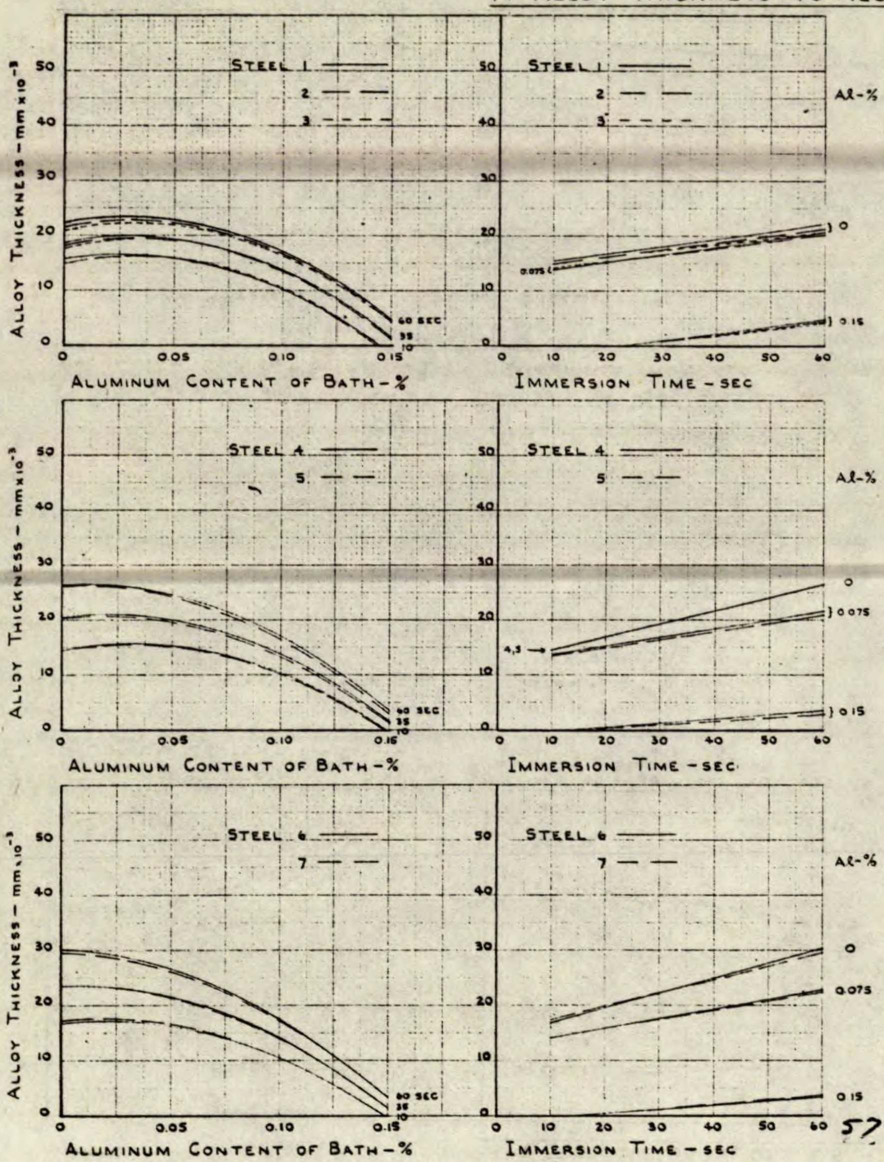


FIG. 7

FIG. 8

Y4-ALLOY THICKNESS VS ALUMINUM CONTENT AND IMMERSION TIME



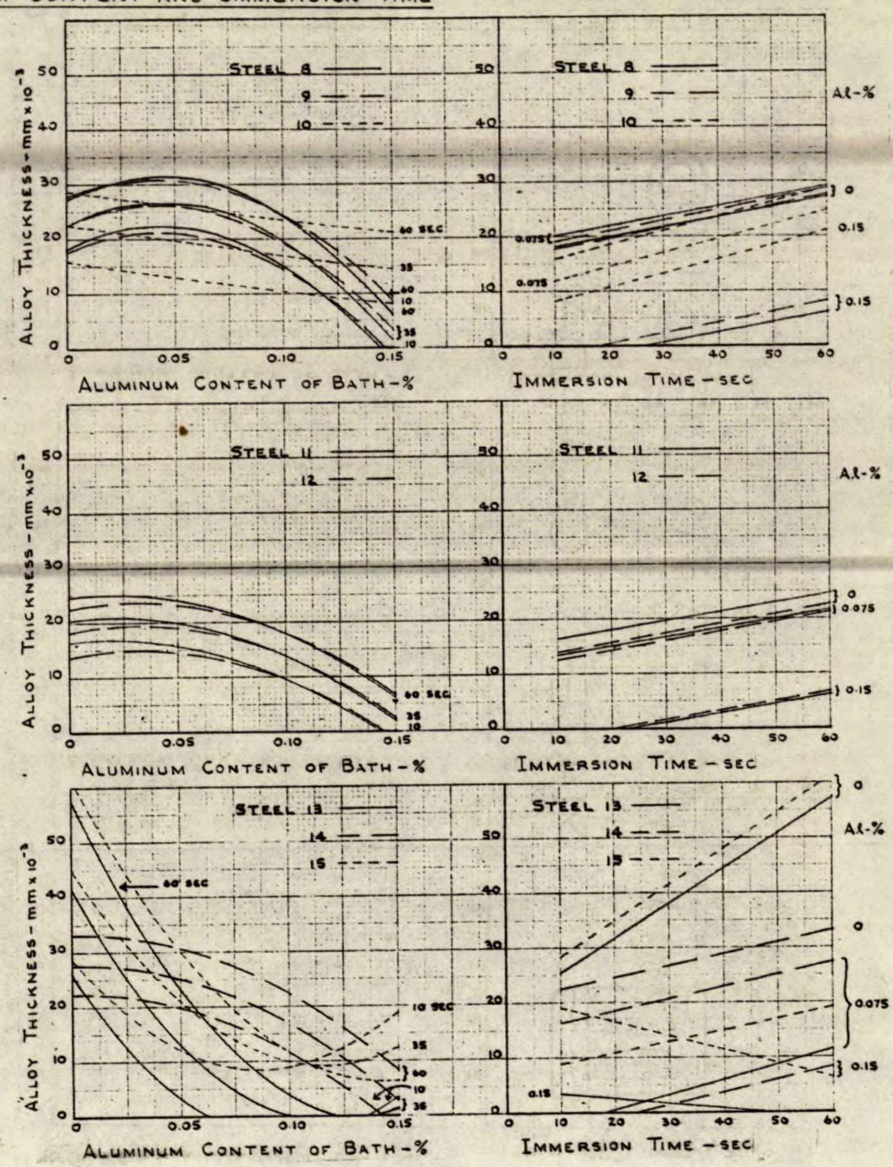


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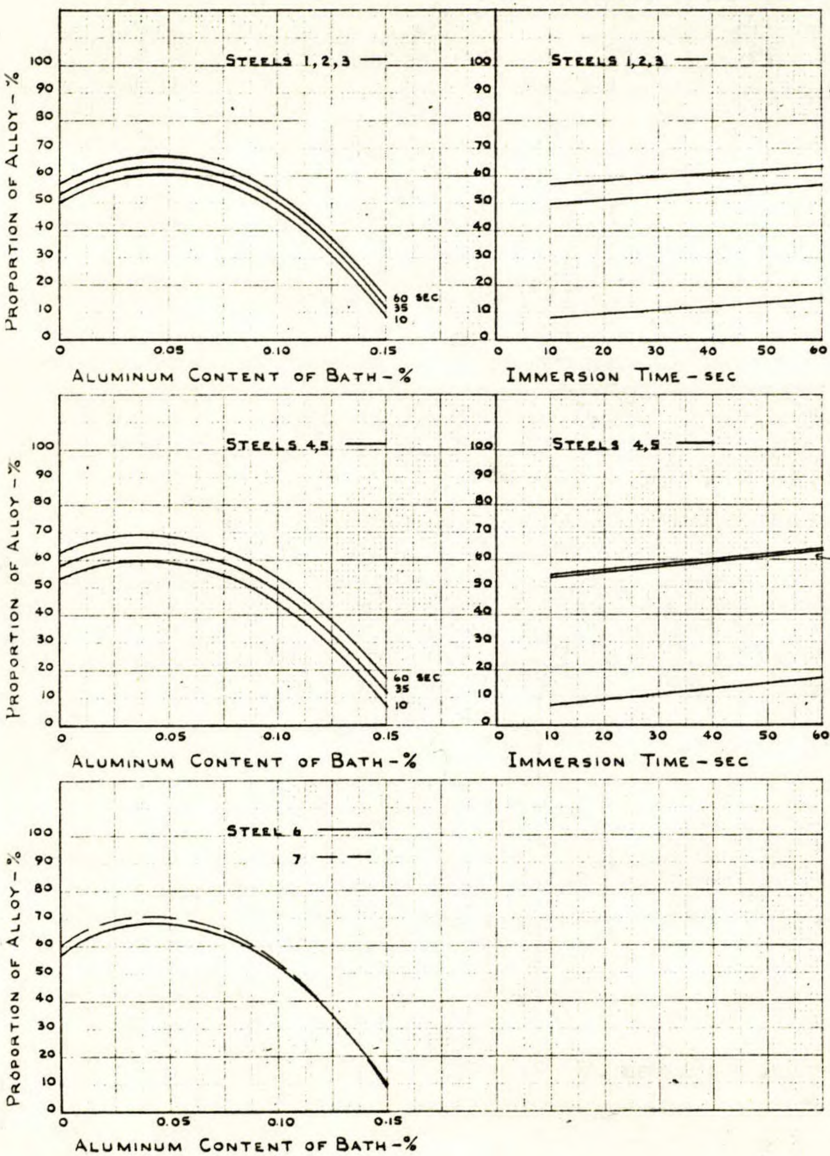
FIG. 9

FIG. 10

Y5 - Proportion of Alloy vs Aluminum Content and Immersion Time



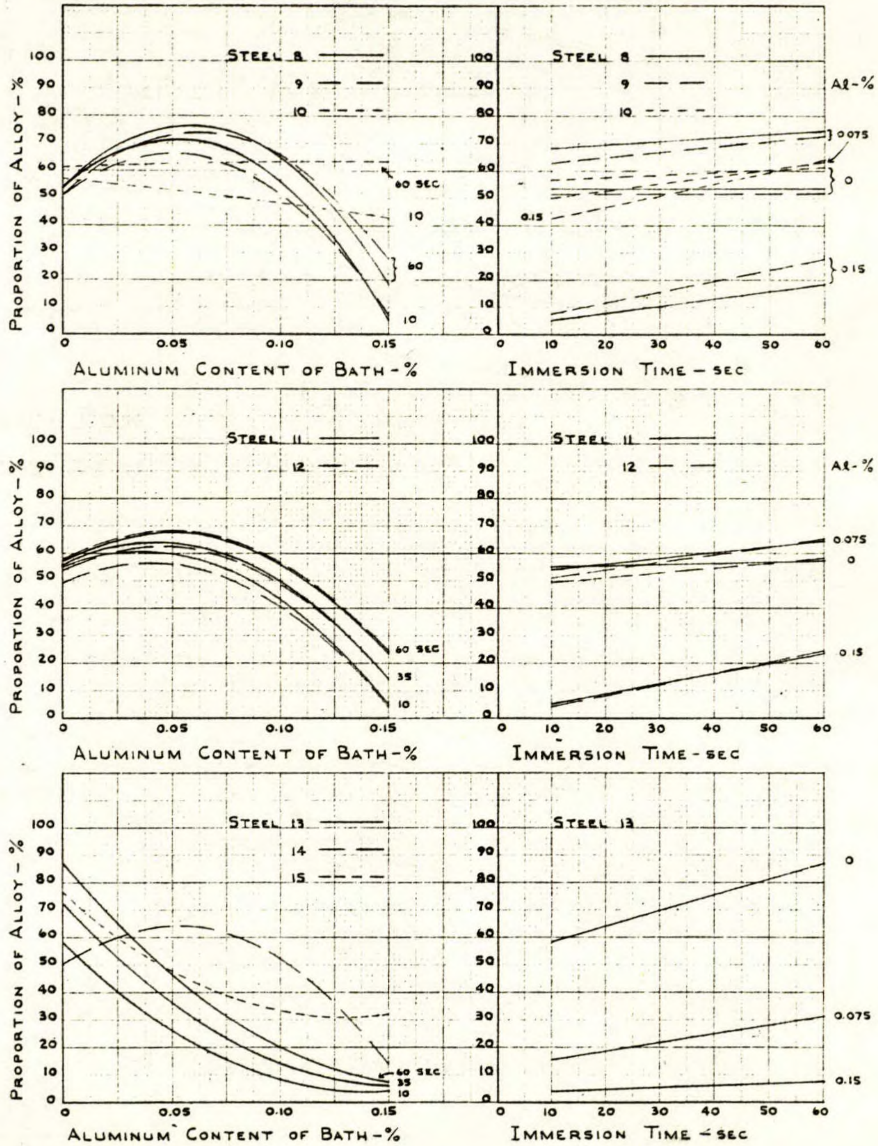


FIG. 11 Y6-DUCTILITY RATING VS ALUMINUM CONTENT AND IMMERSION TIME

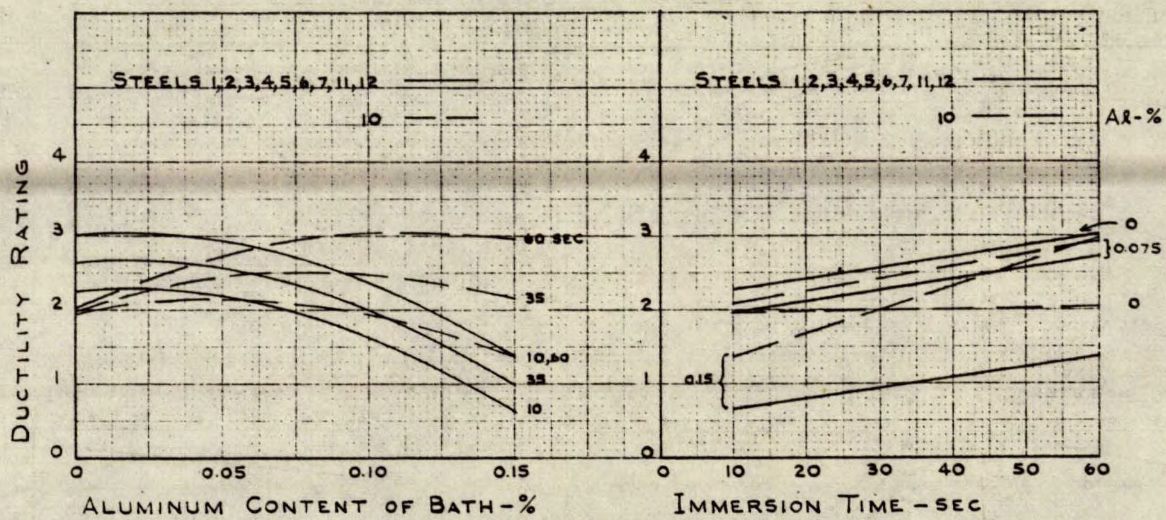


FIG. 12 Y7-ADHERENCE RATING VS ALUMINUM CONTENT AND IMMERSION TIME

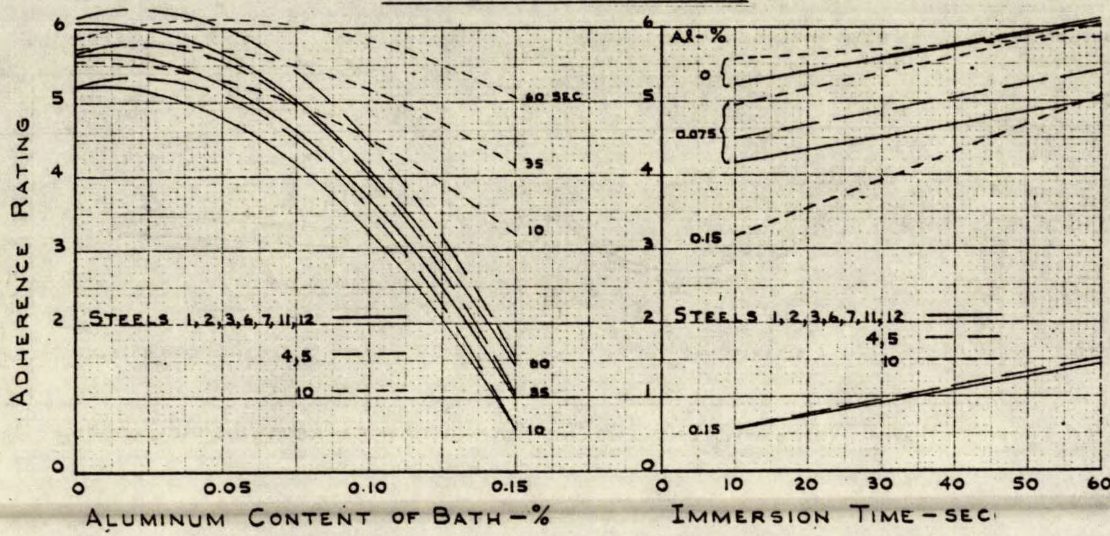
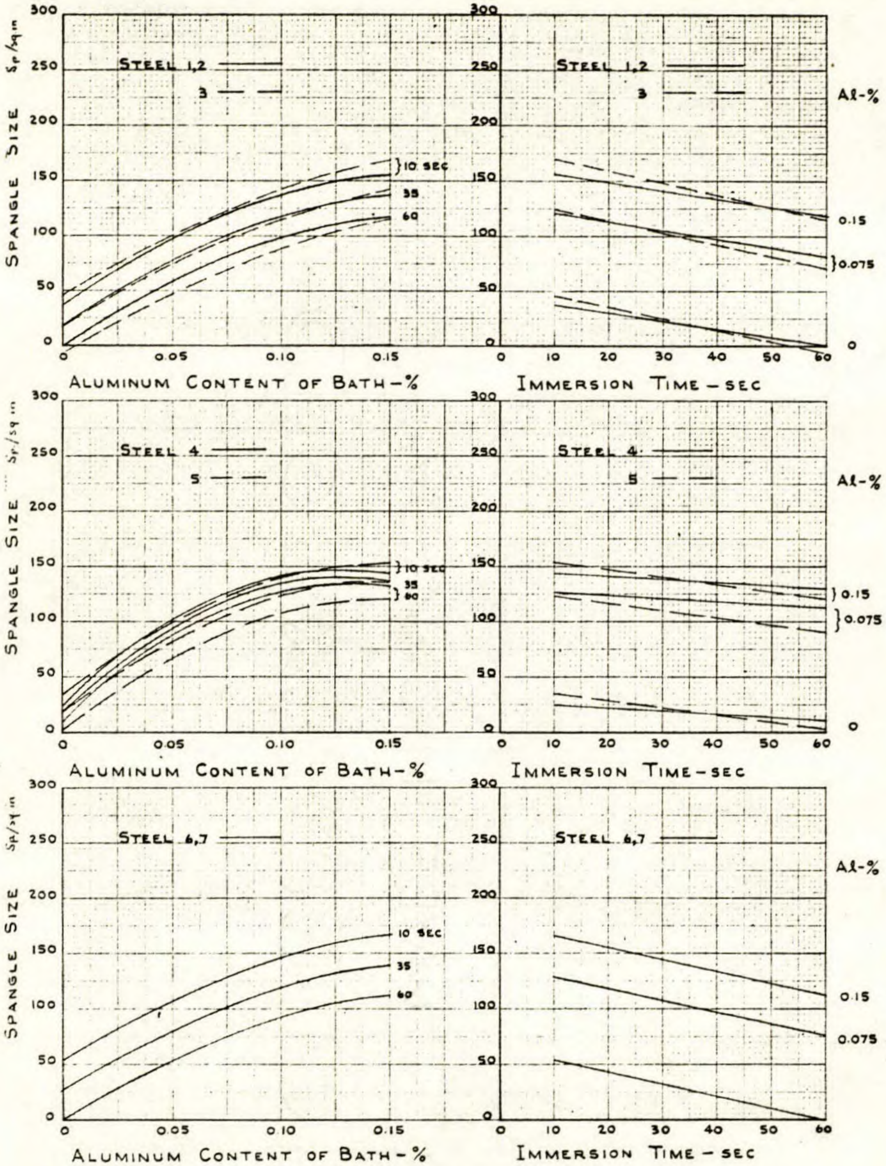


FIG. 13

Y8-SPANGLE SIZE VS ALUMINUM CONTENT AND IMMERSION TIME

FIG. 14



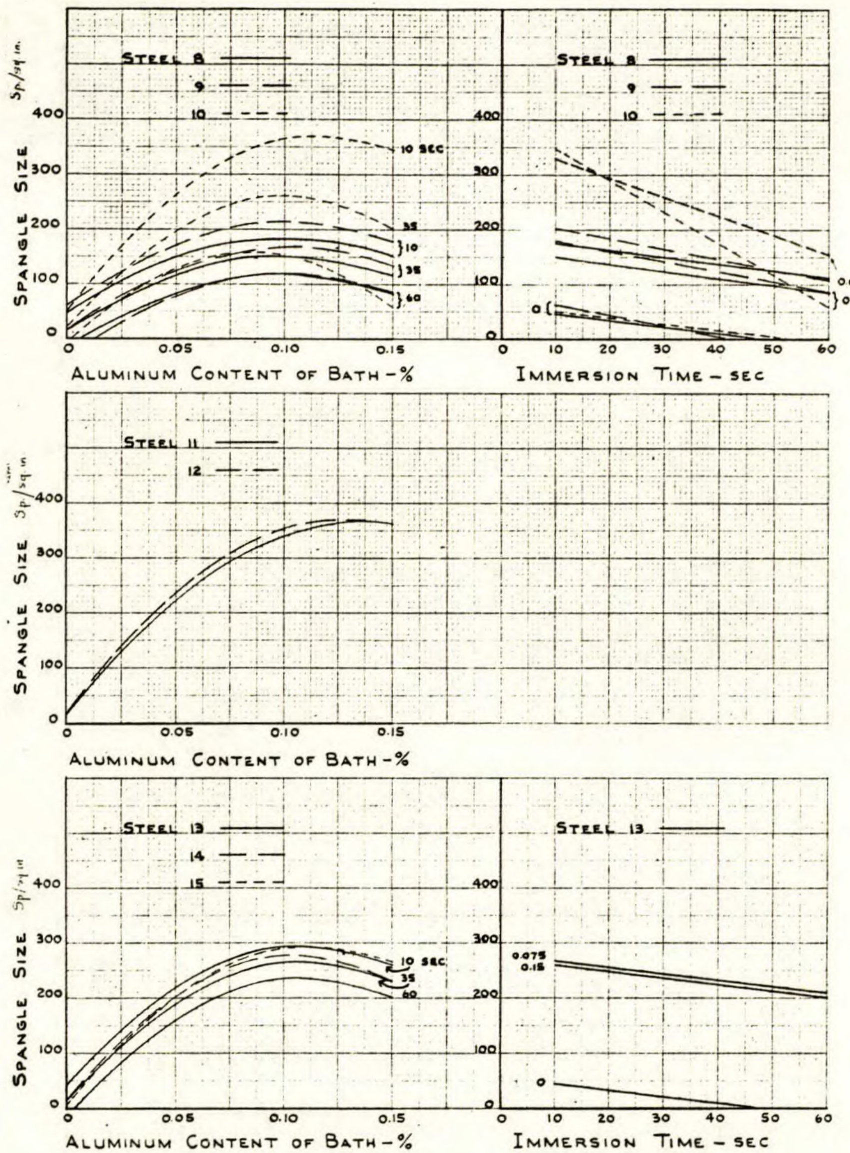
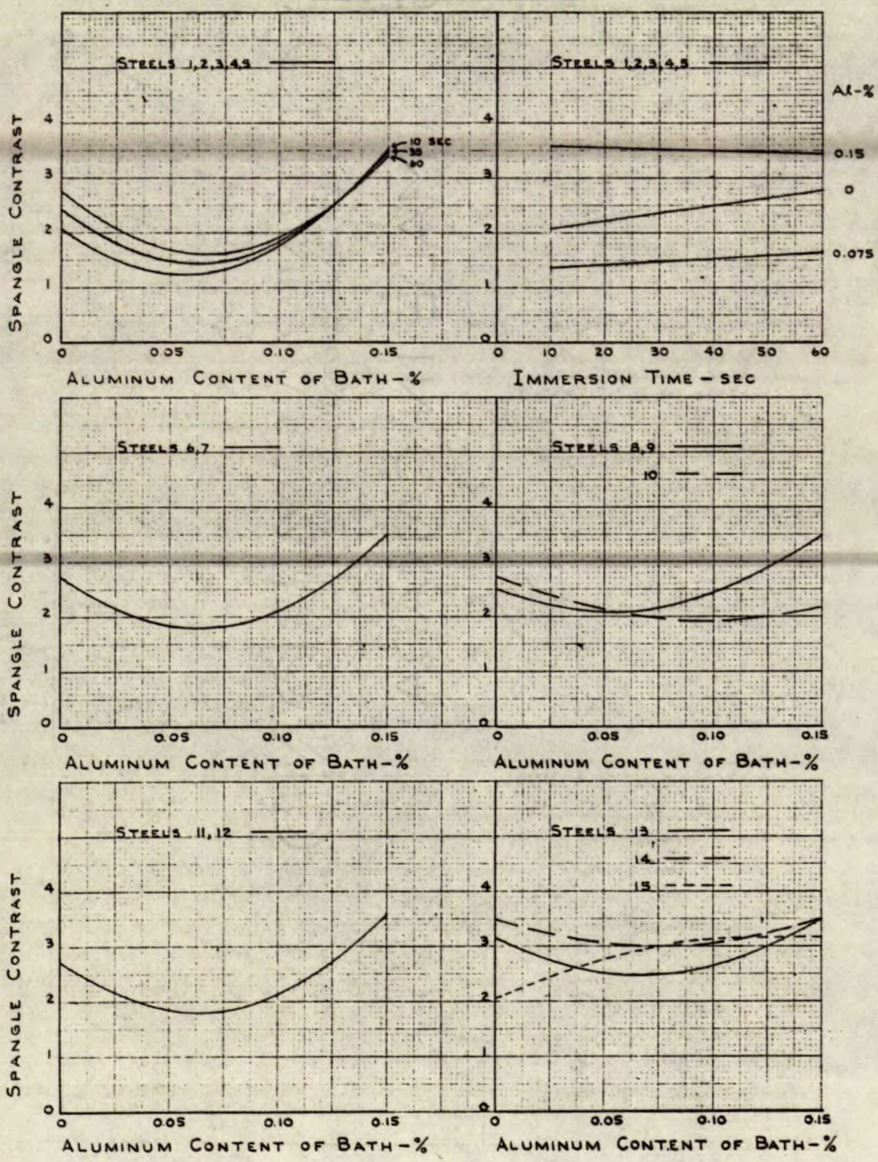


FIG. 15 Y9-SPANGLE CONTRAST VS ALUMINUM CONTENT AND IMMERSION TIME



Y10-BRIGHTNESS VS ALUMINUM CONTENT FIG. 16

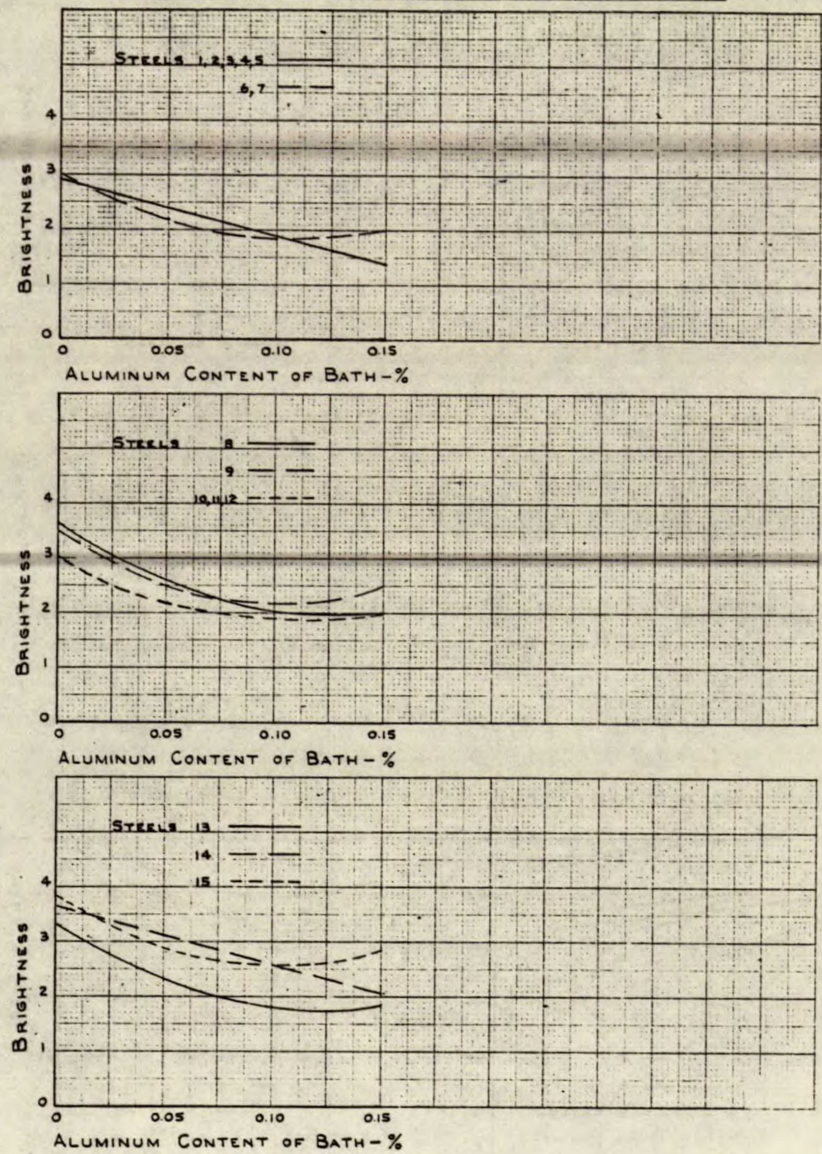
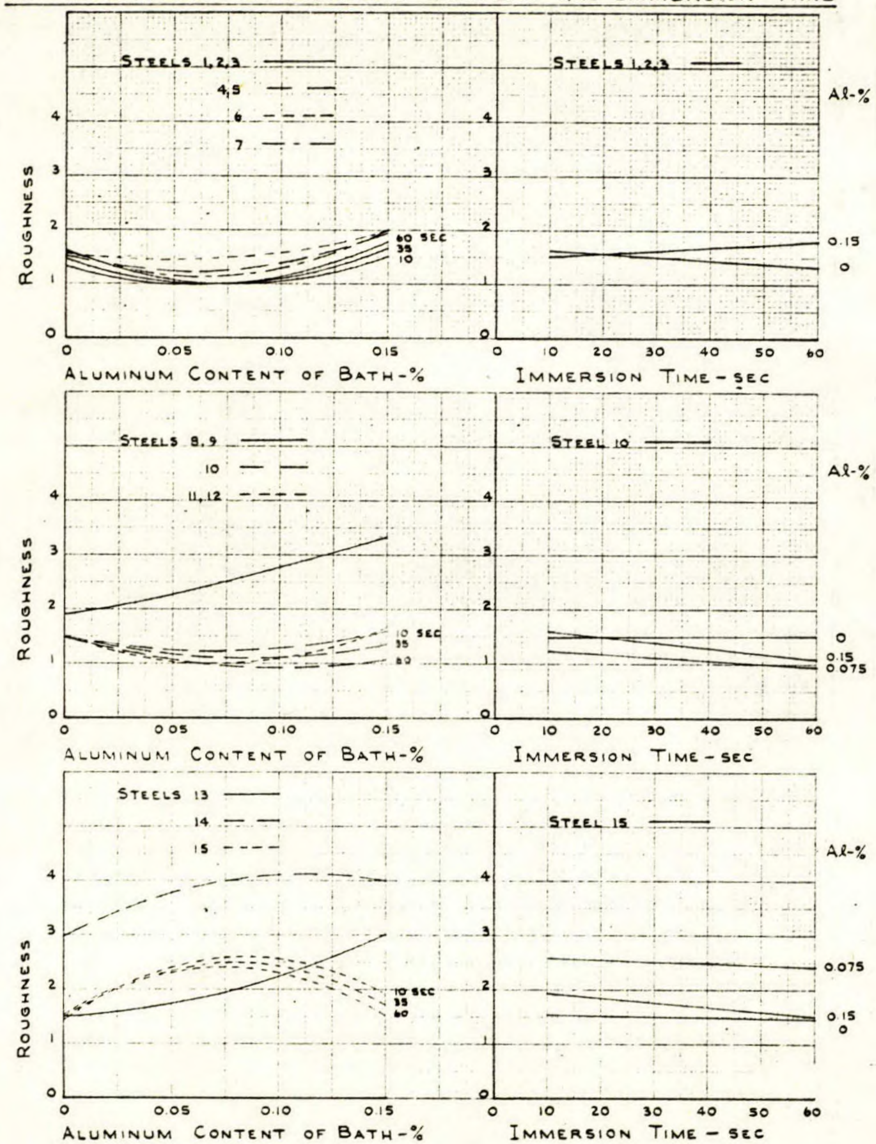


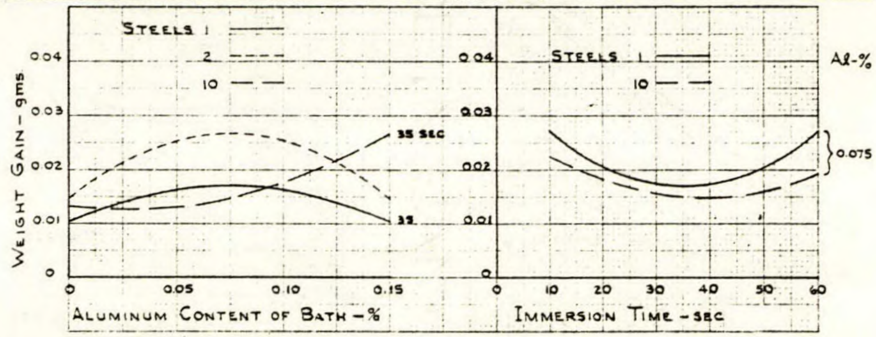
FIG. 17

Y11 - ROUGHNESS VS ALUMINUM CONTENT AND IMMERSION TIME



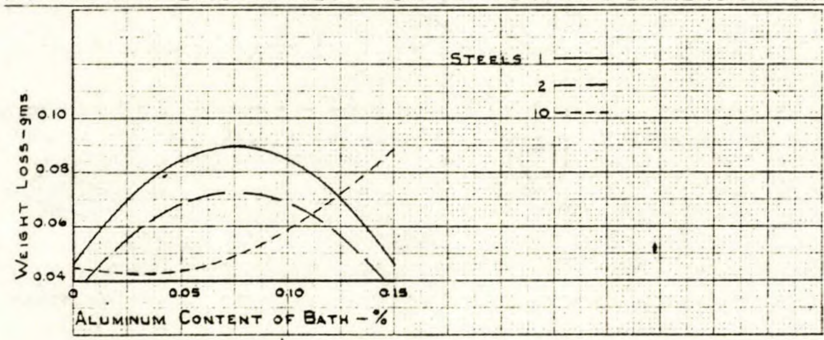
Y13 - WEIGHT GAIN VS ALUMINUM CONTENT AND IMMERSION TIME

FIG. 18



Y14 - WEIGHT LOSS VS ALUMINUM CONTENT AND IMMERSION TIME

FIG. 19



Y17 - ALUMINUM IN COATING VS ALUMINUM CONTENT

FIG. 20

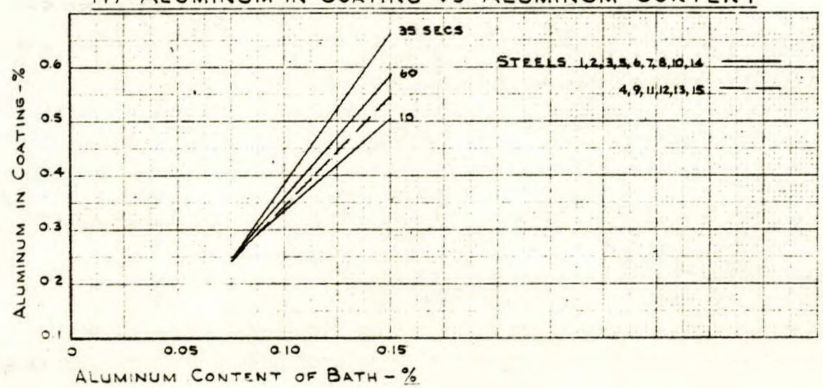


FIG. 21 Y1-COATING WEIGHT VS IMMERSION TIME

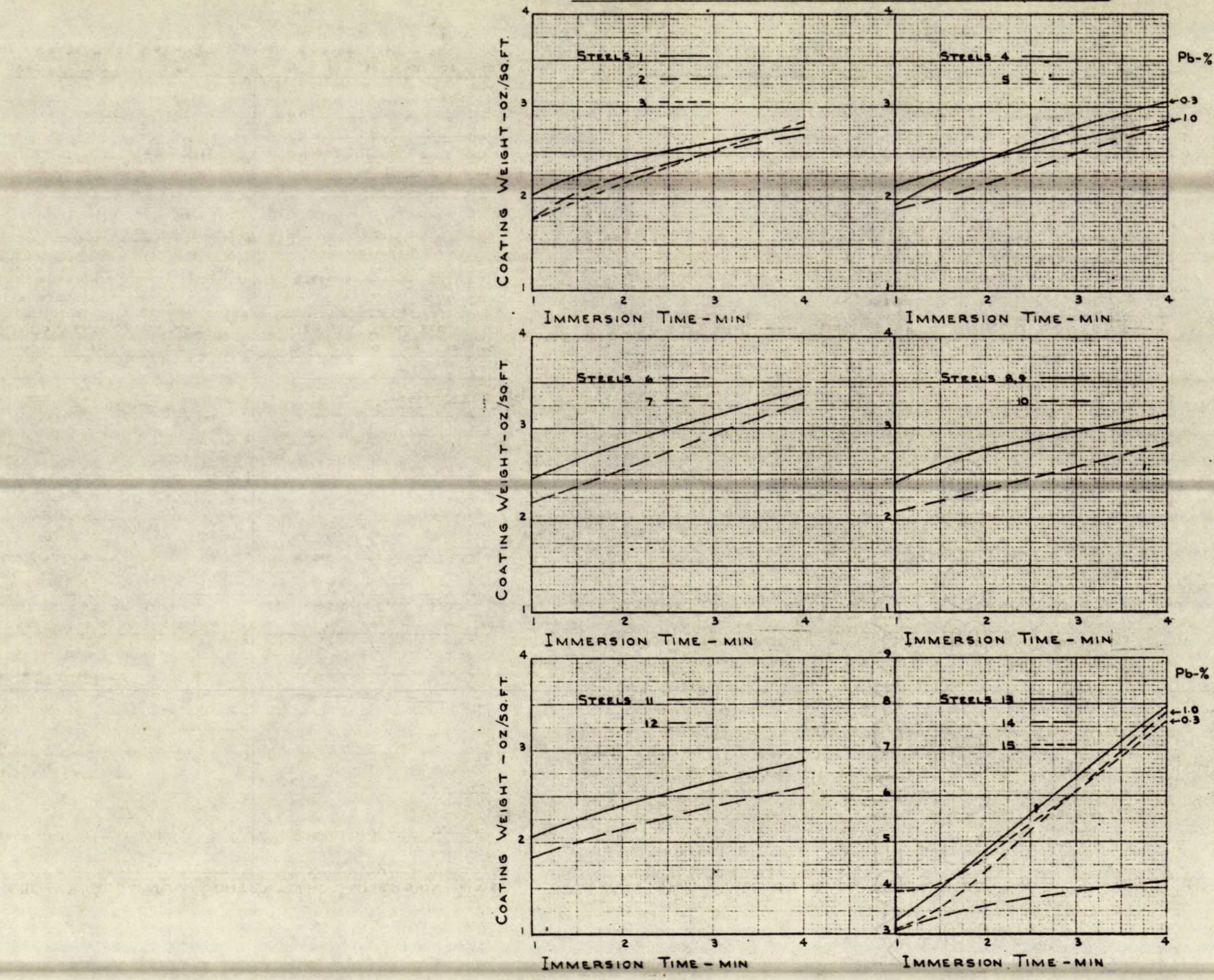
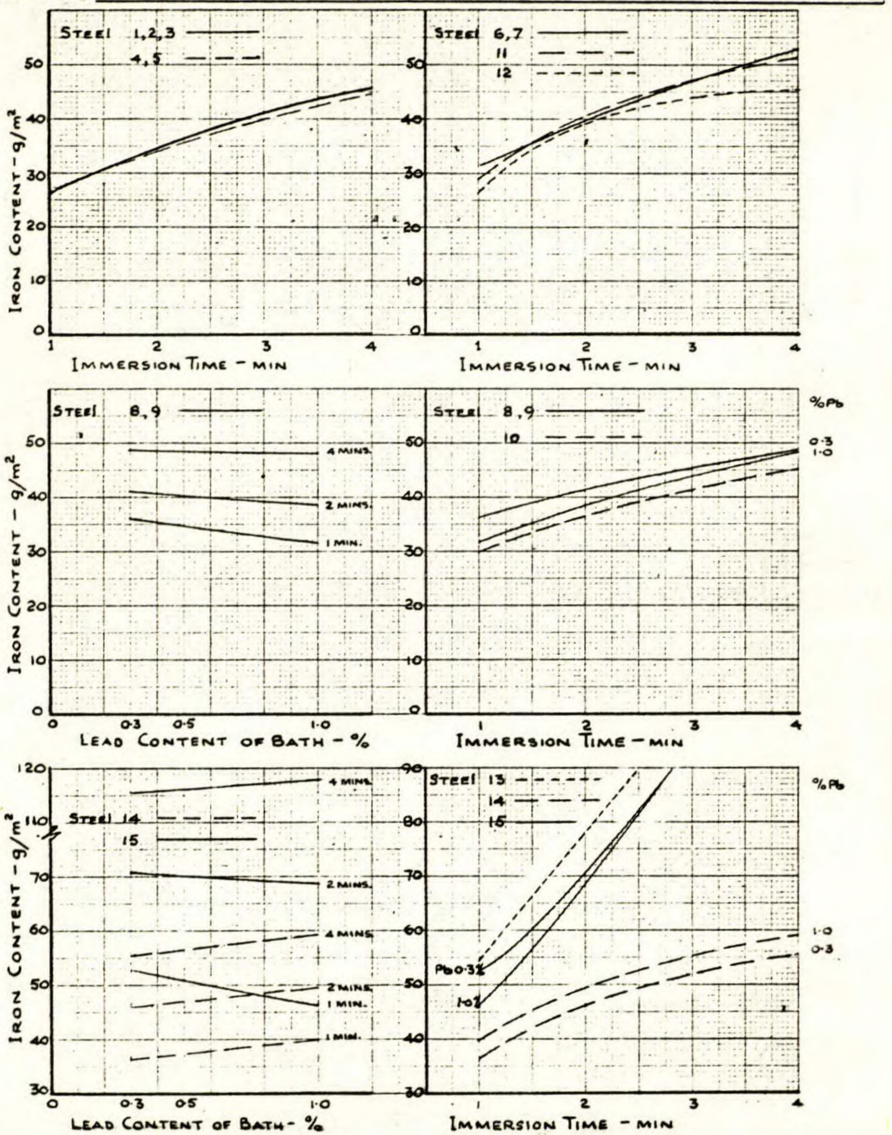


FIG. 22–Y2 IRON CONTENT VS LEAD CONTENT AND IMMERSION TIME.



Y3 – STEEL WEIGHT LOSS VS IMMERSION TIME FIG. 23

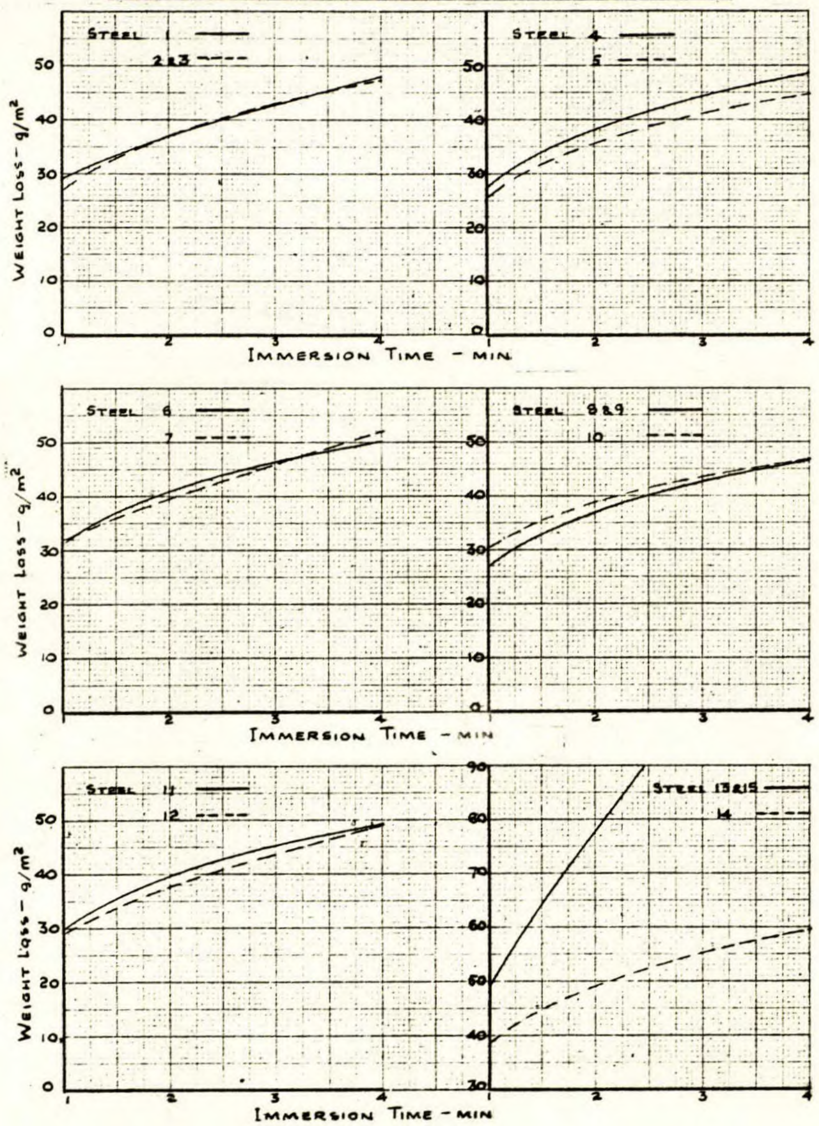
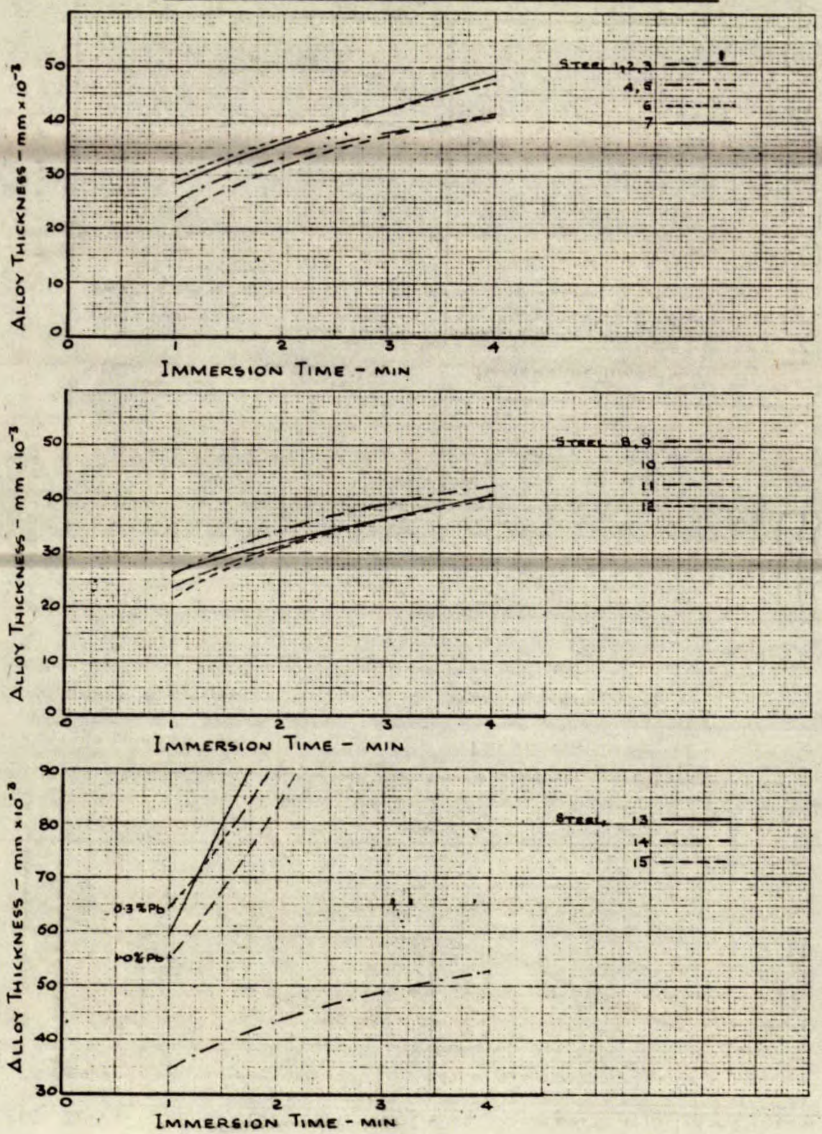


FIG. 24 Y4 - ALLOY THICKNESS VS IMMERSION TIME



Y5 - PROPORTION OF ALLOY VS IMMERSION TIME FIG. 25

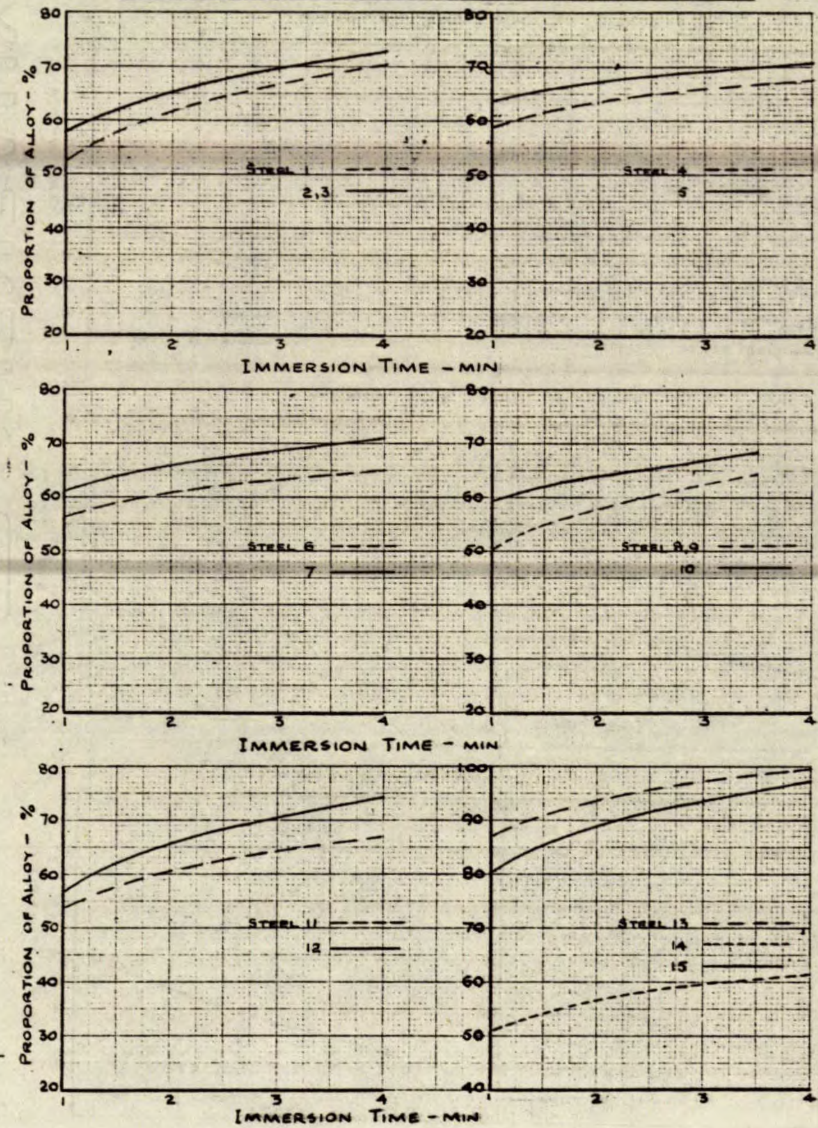


FIG. 26

Y6 - DUCTILITY RATING VS IMMERSION, TIME

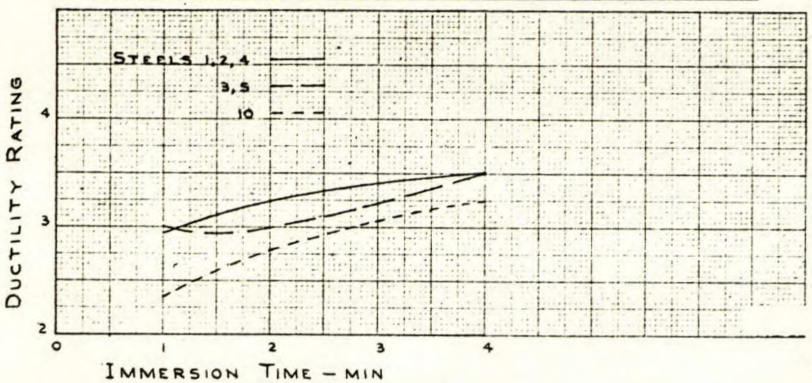
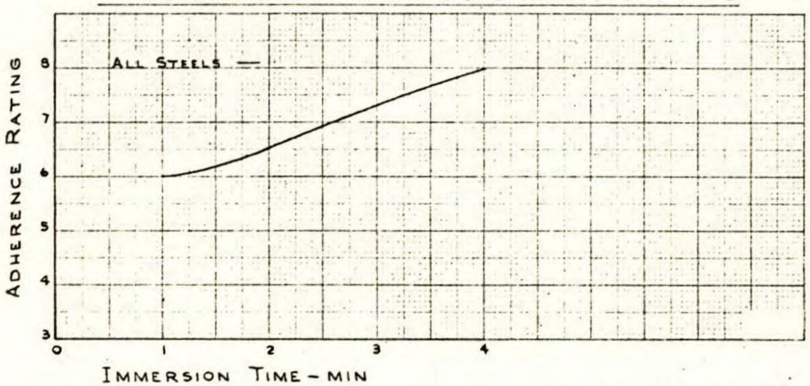


FIG. 27

Y7 - ADHERENCE RATING VS IMMERSION TIME



Y8 - SPANGLE SIZE VS IMMERSION TIME

FIG. 28