Atmospheric corrosion behaviour of stainless steels in eight Canadian atmospheres: summary of ten years' results

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NATIONAL RESEARCH COUNCIL
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DIVISION OF BUILDING RESEARCH

ATMOSPHERIC CORROSION BEHAVIOUR OF STAINLESS STEELS IN EIGHT CANADIAN ATMOSPHERES -- SUMMARY OF TEN YEARS' RESULTS

by

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PREFACE

A study was undertaken by the NRC Associate Committee on Corrosion Research and Prevention to obtain information on the atmospheric corrosion behaviour of different architectural metals at various locations across Canada. The first group of metals was selected for exposure in 1953. Although information of this nature is frequently needed for design and maintenance purposes no such similar co-operative study had been previously undertaken in Canada which involved the metal suppliers, users, and research organizations.

The specimens of the different metals were exposed at eight outdoor sites across Canada. The over-all program included several metal and organic coatings applied to steel substrates. This report describes the 10-year performance at the different sites of three stainless steels. One report has already been issued that describes the performance of three aluminum alloys and aluminum bimetallic couples. Other reports covering the 10-year results on other metals will be issued later.

The specimens of stainless steel were furnished by the Atlas Steels Company, Welland, who were also responsible for assessing their performance and compiling this report. This part of the study was under the direction of Dr. R. Osadchuk with the assistance of Mr. R. J. C. MacDonald. The arrangements for exposure and examination of specimens, and some over-all coordination of the program were carried out under the direction of Mr. E. V. Gibbons of the Division of Building Research.

The Division is indebted not only to the Companies who have co-operated in making this study possible, but also to those who have contributed in the provision and servicing of certain exposure sites.

Ottawa
July 1966

N. B. Hutcheon
Assistant Director

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This work was initiated in 1953 by the Associate Committee on Corrosion Research and Prevention (A. C. C. R. P.) of the National Research Council (N. R. C.) with the objective of obtaining relative atmosphere corrosion results for various metals in typical Canadian atmospheres. Details of the program were planned by Sub-committee "C" of the A. C. C. R. P. and carried out at the outdoor exposure sites operated by the Division of Building Research of N. R. C.. Atlas Steels Company, being the major stainless steel producer in Canada, participated in this program by selecting and supplying the stainless steel specimens used.

Triplicate sheet panels of the following metals and alloys were included in the first group selected. They have been exposed at eight sites across Canada for four different time periods:

1. Aluminum Alloys (supplied by Aluminium Laboratories Limited)
   - (a) Alcan 3S-H-14
   - (b) Alcan 57S-H-34
   - (c) Alcan 65S-T-6
   - (d) Alcan 3S-H-14 aluminum alloy riveted to copper, zinc or mild steel with 2S rivets.

2. Steel Alloys (supplied by Steel Company of Canada Limited)
   - (a) Low alloy residual
   - (b) Copper bearing
   - (c) Copper-nickel alloy

3. Stainless Steel Alloys (supplied by Atlas Steels Company)
   - (a) Type 302
   - (b) Type 316
   - (c) Type 430

4. Magnesium Alloys (supplied by Dominion Magnesium Limited)
   (a) AZ80X alloy
   (b) ZK61X alloy

5. Rolled Zinc (supplied by Consolidated Mining and Smelting Company of Canada Limited)

The atmospheric exposure sites were:

Site No.	Location
1	Ottawa, Ontario
2	Saskatoon, Saskatchewan
3	Montreal, Quebec
4	Halifax, Nova Scotia
5	York Redoubt, Nova Scotia
6	Norman Wells, Northwest Territories
7	Esquimalt, British Columbia
8	Trail, British Columbia

The panels were removed after one, two, five and ten year exposure times.

Additional metals that were set out at the sites in subsequent years included specimens of copper, muntz metal, lead alloys and monel. Also exposed were metal coatings on steel of sprayed zinc and sprayed aluminum (sealed and unsealed), aluminized steel, cadmium-plated steel, and four types of galvanizing. Two series of organic paint systems applied to steel to evaluate different steel priming paints have also been exposed. With the paint systems it was the usual practice to re-expose the panels for an additional period after each laboratory examination until failure of the coating had occurred.

The A. C. C. R. P. was disbanded in 1960, but the test program was continued through the Division of Building Research. The performance of the different metals, comprising the first group, after one, two, and five years of exposure have been reported (1, 2). The examination and evaluation of the stainless steel specimens after each exposure period was carried out by Atlas Steels Company. This report summarizes the behaviour of the stainless steel specimens after ten years of exposure.

DESCRIPTION OF MATERIAL

Three types of stainless steels were selected for the program and given the following code designation.

A-8 - Stainless - 302
A-0 - Stainless - 316
A-9 - Stainless - 430

These three types of stainless steels were selected over the other numerous types available because they represented the most commonly used grades for architectural applications at the time the test program was initiated.

In general, stainless steels can be divided into three grades based on their structures; (1) Austenitic (2) Ferritic and (3) Martensitic. The general characteristics of these grades are as follows:

1. Austenitic Grades (302, 316)

These are the 18 per cent chrome - 8 per cent nickel steels. Type 302 is the basic composition grade and is widely known as 18-8.

These grades can be hardened only by cold working; heat treating only tends to soften them. They are non-magnetic in the annealed condition, but some may become slightly magnetic after cold working.

The properties of these steels are controlled by the percentage of chromium, nickel, carbon and manganese in their analysis. Chromium is the most important factor in determining resistance to corrosion and oxidation. Nickel, carbon, and manganese increase the stability of the austenite structure.

In general all of the 18-8 types show equally good resistance to corrosion and in most environments the 200 series (chrome, nickel-manganese) have comparable properties.

Type 316 was developed after it was found that 18-8 types pitted and failed in contact with salt water. An addition of 2 to 3 per cent molybdenum to the basic 18-8 analysis provided an austenitic steel with superior corrosion resistance to sea water and many other types of chemical corrodents.

2. Ferritic Grades (430)

These stainless grades contain chromium but no nickel. They can be hardened to some extent by cold working but not by heat treatment. They are always magnetic.

Of the ferritic steels, type 430 can be used in many applications almost interchangeably with the austenitic 18-8 types. The ferritic steels are restricted, however, to a narrower range of corrosive conditions than the austenitic grades. Among the ferritic steels, type 430 has the best combination of corrosion resistance, useful mechanical properties, good formability, and low cost.

3. Martensitic Grades

These stainless grades contain chromium and with few exceptions no nickel. They can be hardened by heat treatment and are always magnetic. These steels develop maximum corrosion resistance only in the fully heat-treated condition.

Surface Finish

The three types of stainless steels tested in this corrosion program had the following surface finishes.

Type 302 (A-8) - 2B
Type 316 (A-0) - 2B
Type 430 (A-9) - 4B

These finishes, 2B and 4B, represent the finishes most frequently used for architectural applications.

It should be noted that all test specimens were given an air anneal as no bright annealing facilities were available at that time. Annealing in an air atmosphere results in a chromium depletion of the surface layers which adversely affects corrosion resistance. In the case of the type 430 specimens they were given a 4B finish which is a ground finish. As a result the chromium-depleted upper layers would be removed by grinding thus the type 430 was exposed in its most advantageous condition as compared with the other two grades.

Finish 2B is a mill finish which is applied by cold rolling. It has a bright surface appearance and is generally used for curtain walls and industrial, commercial, and transportation equipment.

Finish 4B is a mechanically polished finish. It has a bright, lustrous appearance and is the most commonly used finish for architectural trim, and restaurant, kitchen, and sanitary equipment.

Chemical Analysis

The initial chemical analysis of the three types of stainless steels tested is given in the following table. (These analyses are typical of current practice with the possible exception of Type 316. The carbon content of Type 316 is now held to a 0.08 maximum. This should not influence the present test but would have to be considered if weldments were involved.)

ANALYSIS, PERCENT

Element	Type 302	Type 430	Type 316
Mn	1.24	0.43	1.85
Si	0.41	0.41	0.38
Cr	18.78	16.62	16.92
C	0.12	0.11	0.09
P	0.029	0.030	0.028
Ni	8.60[x]	0.75	12.82
S	0.018	0.025	0.020
Mo	0.23		2.43

[x] previously reported as 6.80%

TEST SITES

A description of the eight test sites operated by the Division of Building Research for the program is given below:

Site 1 - Ottawa

This site is located on the eastern outskirts of the City of Ottawa and can be classified as semi-rural.

Site 2 - Saskatoon

This is a rural site located on the campus of the University of Saskatchewan on the outskirts of Saskatoon.

Site 3 - Montreal

This is an industrial site located on the roof of the C. N. R. building in the Point St. Charles District.

Site 4 - Halifax

This is a marine-industrial site located on the roof of the Federal building in the downtown area - two blocks from the harbour.

Site 5 - York Redoubt

This is a rural-marine site, located on the Atlantic coast approximately seven miles from Halifax. It is at an elevation of 100 feet and 300 feet from the ocean.

Site 6 - Norman Wells

This is a far northern site located in the Mackenzie River Valley approximately 90 miles south of the Arctic Circle.

Site 7 - Esquimalt, B. C. (Rocky Point)

This is a marine site located on the southeast extremity of Vancouver Island, about 15 miles from the City of Victoria. It is at an elevation of 50 feet and approximately 1500 feet from the ocean.

Site 8 - Trail, B. C.

This is a semi-rural site located at Birchbank in the Columbia River Valley six miles north of the City of Trail

The sites are near weather stations of the Meteorological Division of the Department of Transport. Weather records are thus available with respect to precipitation, temperature, hours of sunshine, wind velocity and direction during the periods of exposure. Although considerable time and effort has been devoted to a search for a suitable method to measure atmospheric chlorides in the Halifax area, no entirely satisfactory way has as yet been developed. The lead peroxide method was used to measure the sulphur dioxide content of the atmosphere. This instrument does not measure the volumetric concentration of SO_2 in the atmosphere directly, but presents an integrated measure of the sulphur dioxide "activity" during a period of exposure. This instrument was well suited to measure the relative levels of SO_2 at the exposure sites when metals were under test. It has been found that the sulphur dioxide pollution is greatest at the Halifax marine-industrial site, followed by Montreal, Trail, Ottawa, York Redoubt, Saskatoon, Esquimalt, and Norman Wells in that order. The average sulphur dioxide content, measured by the lead peroxide method, for the different exposure periods at each site is given in Table 9.

EXPERIMENTAL PROCEDURES

(a) General

Four- by six-in. panels of the three alloys, stainless 302, 316, and 430 were cut from regular 16-gauge sheets (0.062 in.).

These panels were identified with punched holes using a template according to the directions provided by Sub-committee "C" of the A. C. C. R. P.. This template is shown in Figure 1.

The panels were then de-burred, degreased, passivated, weighed and sent to the Division of Building Research, Ottawa, for distribution to the various sites.

Eight panels of each alloy were assigned to sites 1 to 7; duplicate panels were removed after each time period. In the case of the Trail site twelve panels of each alloy were assigned; three panels were removed after each exposure period.

The panels were mounted during 1953 and 1954 on the outdoor exposure racks. The specimens were held in place by porcelain insulators at 30 degrees to the horizontal and facing south.

After exposure periods of one, two, five and ten years, specimens were removed from the test sites and sent to the Division of Building Research, Ottawa, where the samples were examined, photographed and condition recorded, then sent to Atlas Steels Company for cleaning and detailed examination and evaluation. The specimens were removed according to the following plan.

One-year exposure	-	Lot #1 panels
Two-year exposure	-	Lot #2 panels
Five-year exposure	-	Lot #3 panels
Ten-year exposure	-	Lot #4 panels

SPECIMEN CLEANING AND EXAMINATION PROCEDURES

The extent of corrosion of the stainless steel specimens was determined by the loss in weight of the panels after being cleaned by a standardized procedure. Observations were made as to the appearance of the panels and extent of pitting. No measurements of pit depth were made.

The cleaning procedure employed consisted of brisk scrubbing with a stiff bristle brush and a mild abrasive for approximately one minute. In the case of the specimens from the the Halifax marine site it was sometimes necessary to use a stainless steel knife on the edges of the specimens to remove the corrosion products.

In order to ensure that no undue loss of metal was occurring during the cleaning procedure, blank panels of the three grades of steel were cleaned side by side with the actual specimens. No corrections were applied to the weight losses.

Following the scrubbing procedure the specimens were rinsed in hot water, distilled water and finally in absolute alcohol and then air dried and weighed.

EXPERIMENTAL RESULTS

Lot #1 specimens which included duplicate panels of each of the three grades of steel from each of the eight sites were removed from test after one year exposure time. The weight loss results are given in Table 1 (A, B, C).

Some of the panels showed a weight gain and this can probably be attributed to an error in weighing or insufficient cleaning.

Figure 2 gives a graphic comparison of the corrosion rates of the three types of stainless steels after one year exposure. Owing to the small loss of metal this graph gives the corrosion rate in mils per year x 1000.

For all three types of steel the Halifax industrial site gives the worst corrosion rate with type 430 having the largest weight loss and type 316 the best at this site. Type 302 exhibits the best over-all corrosion resistance followed by types 430 and 316.

Lot #2 panels were removed from test after two years exposure. The weight loss results are given in Table 2 (A, B, C); Figure 3 shows a plot of the corrosion rates.

Here again types 302 and 430 are quite similar except for the Halifax industrial site where type 430 shows a greater weight loss. Type 316 shows the least corrosion resistance at all the sites except the Halifax industrial site where it is the best.

One other point about the two-year results is the poor showing of type 316 at the Montreal site. Although these specimens had been rechecked at the time, it is believed that there is a definite error in weighing in this case.

Lot #3 panels were removed from test after five years exposure. The weight loss results are given in Table 3 (A, B, C); a graphic comparison of the corrosion rate is shown in Figure 4.

The results show the three types of stainless steels as being quite similar in corrosion behaviour. Type 430 again shows the greatest weight loss at the Halifax industrial site and type 316 the least.

Lot #4 panels were removed from test after ten years exposure. The results for these specimens are given in Table 4 and Figure 5.

Here also the three types of steels are quite similar in their corrosion behaviour, and once again type 430 shows the largest weight loss at the Halifax industrial site and type 316 the smallest.

Comments on the appearance of the corrosion specimens before cleaning are available for most of the specimens and are included in Tables 1 to 4.

Figures 6, 7 and 8 show the four lots of stainless steel from each exposure site after cleaning. In these photographs only specimen 1 of each lot is shown; in the case of A-O material the specimen from site 7 is missing. Comments on the appearance of each of the specimens in the photographs are given in Tables 5, 6, and 7.

Samples exposed at sites 4 and 6 were selected from each type of steel after the ten-year exposure period for confirmatory chemical analysis. These results are given in Table 8. There are no significant differences from the original analysis except in the case of stainless 302 from the Halifax industrial site. Here there is a significant drop in the chromium content from 18.78 to 18.21 per cent.

A metallographic examination of these same samples, from sites 4 and 6 after the ten-year period was also made along with a blank which had not been exposed at any of the sites. Microphotographs of these samples are given in Figures 9, 10 and 11.

From these results it is seen that the corrosion of the three types of steel is a general corrosion restricted mainly to the surface of the panels. No evidence of intergranular attack was found.

Figures 12 to 19 show graphically the corrosion behaviour of the three types of stainless steels versus test site.

DISCUSSION OF RESULTS AND RECOMMENDATIONS

The high levels of SO_2 in the atmosphere at the Halifax industrial site (situated on the roof of the Federal Building), provides a very severe exposure condition. The level is influenced by the smoke from the chimney nearby that serves this building.

Under this unusual environment all three types performed exceptionally well with stainless 316 being least affected. The average sulphur dioxide content of the atmosphere at each site for each exposure period is given in Table 9. From this table the behaviour of the three different types of stainless steels at the Halifax industrial site can be partly attributed to the high sulphur dioxide content of the atmosphere. A listing of the eight sites in order of decreasing corrosion resistance is as follows:

1. Norman Wells - Site 6
2. Saskatoon - Site 2
3. Ottawa - Site 1
4. Trail - Site 8
5. Montreal - Site 3
6. Esquimalt - Site 7
7. York Redoubt - Site 5
8. Halifax - Site 4

It is obvious when this listing is compared with Table 9 that sulphur dioxide alone does not account for the corrosion of the stainless steel.

One further observation about the corrosion rates is that all three types of stainless steel showed a decrease in corrosion rate after the one-year exposure period. This decrease in the corrosion rate with time is standard for most materials, at least up to the point where spalling or flaking of the material occurs. The decrease in the case of the stainless steels is due to the protective oxide coating which forms on stainless steel whenever it is exposed to an oxidizing atmosphere. Once formed, the oxide slows down further corrosion. In the results reported here there are three exceptions to this rule of decreasing corrosion rate: the 430 type stainless after the 10-year period at the two Halifax area sites and at the Esquimalt site. These differences are quite small, however, and can be attributed to spalling of the oxide film or errors in weighing.

Type 430 stainless steel performed very favourably at several test sites. As mentioned previously these specimens had a ground 4B finish which would remove any chrome-depleted surface layers resulting from air annealing. The test results for the 430 stainless steel in what was referred to as industrial or semi-rural sites should not be taken as the basis for recommending the use of Type 430 in downtown or highly industrialized areas.

Stainless steel producers currently recommend type 430 for indoor architectural purposes only.

This work has pointed out the importance of and necessity for careful documentation and standardized weighing and cleaning procedures of all long-range corrosion testing programs.

It is unfortunate that quantitative evaluation of the extent of pitting was not followed in the case of the stainless steel specimens as this would give a complete picture of the performance of the stainless steel specimens.

In view of the results obtained for the stainless steels, it is recommended that consideration be given to other corrosion testing programs on Atlas alloys where the principal application involves use in an atmosphere where corrosion would be expected.

CONCLUSIONS

1. The results for the stainless steel used in this program show that the three types are quite similar in their corrosion behaviour. All three types showed good corrosion resistance in a rural cold and dry climate.

2. Type 302 stainless steel shows the best over-all corrosion resistance to typical Canadian atmospheres.

3. Type 316 stainless steel is definitely superior under adverse conditions such as the Halifax industrial marine test site.

4. Type 430 stainless steel, although showing the least over-all corrosion resistance, did perform favourably at several test sites.

5. All three types of stainless steel show a decrease in their corrosion rates after the one-year exposure period. This decrease is standard for most materials, at least up to the point where spalling or flaking of the material occurs.

6. It should be noted that in all cases the weight losses are quite small and it is difficult to make any real distinction between the three as to performance.

7. The high level of atmospheric sulphur dioxide at the Halifax industrial site makes it the most aggressive environment with regard to the over-all performance of the three stainless steels.

8. The stainless appearance of types 302 and 316 with 2B finish is retained although dulled somewhat after the ten-year period of exposure.

9. Stainless 430 specimens with #4 finish from the Halifax industrial site even after cleaning are very black. From the other sites the 430 specimens are quite bright and lustrous, retaining much of their original finish after cleaning. Even before cleaning their appearance is quite good except for staining.

REFERENCES

(1) The Corrosion Behaviour of Major Architectural and Structural Metals in Canadian Atmospheres - Summary of Two Year Results. NRC, Associate Committee on Corrosion Research and Prevention, Ottawa, 24 February 1959.

(2) Gibbons, E. V. Atmospheric Corrosion Testing of Metals in Canada. National Research Council, Division of Building Research, Research Paper No. 124, Ottawa, June 1961, NRC 6260.

TABLE 1 (A)

ONE YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 302 (A-8)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	195.398	195.397	-.001	.00015	
1	Ottawa	2	199.447	199.446	-.001		
2	Saskatoon	1	196.877	196.874	-.003	.00039	
2	Saskatoon	2	199.316	199.314	-.002		
3	Montreal	1	196.870	196.870	.000	.00031	
3	Montreal	2	199.111	199.107	-.004		
4	Halifax (Industrial)	1	198.327	198.182	-.145	.02100	
4	Halifax (Industrial)	2	198.096	197.975	-.121		
5	Halifax (Rural)	1	197.215	197.209	-.006	.00071	
5	Halifax (Rural)	2	199.426	199.423	-.003		
6	Norman Wells	1	194.443	194.442	-.001		
6	Norman Wells	2	194.791	194.793	+.002		
7	Esquimalt	1	197.443	197.440	-.003	.00055	
7	Esquimalt	2	195.955	195.951	-.004		
8	Trail	1	196.754	196.782	+.028		
8	Trail	2	200.377	200.387	+.010		
8	Trail	3	196.393	196.392	-.001		

TABLE 1 (B)

ONE YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 316 (A-O)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	211.905	911.905	.000	.00031	
1	Ottawa	2	211.805	211.801	-.004		
2	Saskatoon	1	206.305	206.302	-.003	.00054	
2	Saskatoon	2	206.795	206.791	-.004		
3	Montreal	1	202.652	202.647	-.005	.00062	
3	Montreal	2	204.154	204.151	-.003		
4	Halifax (Industrial)	1	205.485	205.421	-.064	.01156	
4	Halifax (Industrial)	2	206.210	206.125	-.085		
5	Halifax (Rural)	1	207.377	207.377	.000	.00070	
5	Halifax (Rural)	2	207.455	207.446	-.009		
6	Norman Wells	1	210.707	210.705	-.002	.00078	
6	Norman Wells	2	210.004	209.996	-.008		
7	Esquimalt	1	200.640	200.636	-.004	.00078	
7	Esquimalt	2	205.052	205.046	-.006		
8	Trail	1	205.806	205.798	-.008		
8	Trail	2	205.947	205.938	-.009	.00118	
8	Trail	3	208.234	208.228	-.006		

TABLE 1 (C)

ONE YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 430 (A-9)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	187.565	187.560	-.005	.00072	
1	Ottawa	2	187.538	187.534	-.004		
2	Saskatoon	1	185.164	185.160	-.004	.00057	
2	Saskatoon	2	189.341	189.338	-.003		
3	Montreal	1	189.930	189.927	-.003	.00040	
3	Montreal	2	187.566	187.564	-.002		
4	Halifax (Industrial)	1	190.367	189.917	-.450	.06900	
4	Halifax (Industrial)	2	186.118	185.716	-.402		
5	Halifax (Rural)	1	192.189	192.184	-.005	.00056	
5	Halifax (Rural)	2	191.888	191.886	-.002		
6	Norman Wells	1	187.832	187.831	-.001	.00015	
6	Norman Wells	2	191.342	191.341	-.001		
7	Esquimalt	1	194.603	194.602	-.001	.00008	
7	Esquimalt	2	189.259	189.259	.000		
8	Trail	1	188.458	188.458	.000		
8	Trail	2	189.876	189.876	.000		
8	Trail	3	188.381	188.382	+.001		

TABLE 2 (A)

TWO YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 302 (A-8)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	195.847	195.845	-.002	.00012	
1	Ottawa	2	199.142	199.141	-.001		
2	Saskatoon	1	201.775	201.775	.000	.00004	
2	Saskatoon	2	193.673	193.672	-.001		
3	Montreal	1	199.010	199.010	.000	.00020	
3	Montreal	2	196.402	196.397	-.005		
4	Halifax (Industrial)	1	197.272	196.998	-.274	.01800	
4	Halifax (Industrial)	2	194.642	194.457	-.185		
5	Halifax (Rural)	1	199.424	199.419	-.005	.00035	
5	Halifax (Rural)	2	195.506	195.502	-.004		
6	Norman Wells	1	196.696	196.695	-.001	.00008	
6	Norman Wells	2	194.628	194.627	-.001		
7	Esquimalt	1	196.390	196.386	-.004	.00032	Few scattered pits
7	Esquimalt	2	196.130	196.126	-.004		
8	Trail	1	193.192	193.190	-.002		
8	Trail	2	195.421	195.425	+.004		Few scattered pits
8	Trail	3	196.680	196.679	-.001		

TABLE 2 (B)

TWO YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 316 (A-O)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	205.135	205.130	-.005	.00019	
1	Ottawa	2	208.275	208.275	.000		
2	Saskatoon	1	204.797	204.795	-.002	.00016	
2	Saskatoon	2	205.565	205.563	-.002		
3	Montreal	1	207.570	207.508	-.062x	.02300	
3	Montreal	2	210.590	210.058	-.532x		
4	Halifax (Industrial)	1	210.640	210.465	-.175	.01287	
4	Halifax (Industrial)	2	199.943	199.787	-.156		
5	Halifax (Rural)	1	209.970	209.898	-.072	.00295	
5	Halifax (Rural)	2	211.612	211.608	-.004		
6	Norman Wells	1	205.580	205.569	-.011	.00051	
6	Norman Wells	2	208.257	208.255	-.002		
7	Esquimalt	1	201.972	201.960	-.012	.00090	Scattered pits
7	Esquimalt	2	206.657	206.646	-.011		
8	Trail	1	208.966	208.955	-.011	.00088	Scattered pits
8	Trail	2	206.324	206.317	-.007		Patchy area of pits
8	Trail	3	208.014	207.998	-.016		Scattered pits

x These results could be due to an error in weighing

TABLE 2 (C)

TWO YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 430 (A-9)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	186.918	186.916	-.002	.00012	
1	Ottawa	2	189.335	189.334	-.001		
2	Saskatoon	1	189.534	189.534	.000		
2	Saskatoon	2	189.741	189.741	.000		
3	Montreal	1	192.045	192.045	.000	.00004	
3	Montreal	2	189.815	189.814	-.001		
4	Halifax (Industrial)	1	191.193	190.611	-.582	.04831	
4	Halifax (Industrial)	2	187.804	187.186	-.618		
5	Halifax (Rural)	1	187.466	187.461	-.005	.00036	
5	Halifax (Rural)	2	191.467	191.463	-.004		
6	Norman Wells	1	187.472	187.472	.000		
6	Norman Wells	2	191.985	191.985	.000		
7	Esquimalt	1	192.359	192.357	-.002	.00016	Slight brown spots
7	Esquimalt	2	187.282	187.280	-.002		Few scattered pits
8	Trail	1	192.046	192.043	-.003		Few pits, grey smudge on edge
8	Trail	2	190.046	190.044	-.002	.00022	Grey smudge on edge
8	Trail	3	189.856	189.853	-.003		Grey smudge on edge

TABLE 3 (A)

FIVE YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 302 (A-8)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	197.919	197.918	-.001	.00003	Dull stainless colour, no pitting
1	Ottawa	2	197.556	197.555	-.001		" " "
2	Saskatoon	1	196.497	196.498	+.001		Dull stainless, slight stains and pitting
2	Saskatoon	2	199.093	199.094	+.001		" " "
3	Montreal	1	196.638	196.638	+.001	.00003	Brownish stains, slight pitting
3	Montreal	2	197.288	197.285	-.003		" " "
4	Halifax (Industrial)	1	199.865	199.275	-.590	.03544	Black & brown stains, much pitting
4	Halifax (Industrial)	2	194.642	192.975	-1.667		" " "
5	Halifax (Rural)	1	200.872	200.874	+.002	.00017	Dull stainless, brown stains and pitting
5	Halifax (Rural)	2	194.469	194.456	-.013		" " "
6	Norman Wells	1	196.257	196.256	-.001	.00002	Bright stainless finish, slight stain
6	Norman Wells	2	192.945	192.945	.000		" " "
7	Esquimalt	1	199.575	199.570	-.005	.00020	Silvery-white, slight pitting, scratches
7	Esquimalt	2	198.578	198.570	-.008		" " "
8	Trail	1	200.032	200.030	-.002		Slight stain on edges
8	Trail	2	196.119	196.115	-.004	.00006	Slight pitting, stain on edges
8	Trail	3	193.474	193.474	.000		Slight stain on edges

TABLE 3 (B)

FIVE YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 316 (A-0)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	205.595	205,587	-.008	.00005	Dull stainless colour, no
1	Ottawa	2	210.272	210.277	+.005		" pitting "
2	Saskatoon	1	213.695	213.707	+.012		Dull stainless, slight stains and pitting
2	Saskatoon	2	213.895	213.901	+.006		" "
3	Montreal	1	207.240	207.237	-.003	.00012	Brownish stains, pitting
3	Montreal	2	205.650	205.645	-.005		" "
4	Halifax (Industrial)	1	207.575	207.164	-.411	.01300	Brownish black stains, much pitting
4	Halifax (Industrial)	2	200.225	199.801	-.424		" "
5	Halifax(Rural)	1	203.360	203.247	-.113	.00193	Dull stainless, slight stains and pitting
5	Halifax(Rural)	2	211.057	211.047	-.010		" "
6	Norman Wells	1	207.760	207.758	-.002		Bright stainless, no pitting
6	Norman Wells	2	212.207	212.220	+.013		" "
7	Esquimalt	1	208.622	208.620	-.002	.00016	Silvery-white, slight pitting
7	Esquimalt	2	212.008	212.000	-.008		Silvery-white, slight pitting scratches
8	Trail	1	205.199	205.200	+.001		Slight stain on edges, no pitting
8	Trail	2	207.392	207.390	-.002	.00008	" "
8	Trail	3	206.077	206.070	-.007		Slight stain on edges, slight pitting

TABLE 3 (C)

FIVE YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 430 (A-9)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	188.374	188.374	-.001	.00002	Dull stainless colour, no pitting
1	Ottawa	2	187.251	187.251	.000		" " "
2	Saskatoon	1	189.320	189.320	.000	.00000	Brownish stains, slight pitting
2	Saskatoon	2	192.466	192.466	.000		" " "
3	Montreal	1	186.025	186.025	.000	.00003	Brownish stains, slight pitting
3	Montreal	2	188.918	188.916	-.002		" " "
4	Halifax (Industrial)	1	191.112	189.836	-1.276	.04233	Brownish black stains, much pitting
4	Halifax (Industrial)	2	188.765	187.409	-1.356		" " "
5	Halifax(Rural)	1	187.101	187.089	-.012	.00036	Brownish stains, some pitting
5	Halifax(Rural)	2	191.318	191.308	-.010		" " "
6	Norman Wells	1	189.675	189.676	+.001		Bright stainless, no pitting
6	Norman Wells	2	188.863	188.863	.000		" " "
7	Esquimalt	1	189.236	189.230	-.006	.00013	Silvery-white, slight pitting, scratches
7	Esquimalt	2	186.812	186.810	-.002		" " "
8	Trail	1	192.520	192.520	.000		Slight stain on edges, no pitting
8	Trail	2	190.111	190.110	-.001		" " "
8	Trail	3	189.827	189.828	+.001		" " "

TABLE 4 (A)

TEN YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 302 (A-8)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	199.417	199.415	-.002	.00002	Dull, slight brown stain, interference colour
1	Ottawa	2	199.953	199.952	-.001		Dull stainless colour, stains on edges, I.C.
2	Saskatoon	1	195.185	195.186	+.001		Dull, slight brown stains
2	Saskatoon	2	199.913	199.915	+.002		Dull stainless steel colour
3	Montreal	1	193.116	193.114	-.002	.00005	Dull, stained, pitted, black edges, I.C.
3	Montreal	2	198.378	198.374	-.004		Brownish, stained, I.C.
4	Halifax (Industrial)	1	197.412	196.765	-.647	.00999	Greyish, stained, pitted, black edges, I.C.
4	Halifax (Industrial)	2	194.195	193.575	-.620		Black & dark grey staining, pitted, I.C.
5	Halifax(Rural)	1	194.770	194.762	-.008	.00017	Dull, brown stain on edges
5	Halifax(Rural)	2	194.611	194.597	-.014		Dull stainless colour, stained brown edges, I.C.
6	Norman Wells	1	194.972	194.971	-.001		Bright stainless finish, slight stain
6	Norman Wells	2	195.330	195.332	+.002		Bright, slightly pitted, I.C.
7	Esquimalt	1	197.129	197.123	-.006	.00013	Silvery-white, brown stains on edges
7	Esquimalt	2	198.293	198.283	-.010		" " "
8	Trail	1	197.565	197.581	+.016		Silvery-white, grey stains on edges
8	Trail	2	197.952	197.941	-.011	.00003	" " "
8	Trail	3	196.199	196.188	-.011		Grey-brown stains around edges.

Note:- I.C. = Interference colour

TABLE 4 (B)

TEN YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 316 (A-0)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (MILS PER YEAR)	COMMENTS
1	Ottawa	1	210.232	210.232	.000	.00004	Dull, brown stain, pitted, I.C.
1	Ottawa	2	205.325	205.320	-.005		Dull, stained, pitted
2	Saskatoon	1	209.852	209.855	+.003		Dull, slight brown stain
2	Saskatoon	2	214.580	214.581	+.001		Daull, stained, pitted
3	Montreal	1	208.312	208.307	-.005	.00009	Dull, stained, pitted
3	Montreal	2	205.695	205.689	-.006		Greyish, dark grey stains, pitted
4	Halifax (Industrial)	1	208.387	207.975	-.412	.00640	Stained, black edges, pitted, I.C.
4	Halifax (Industrial)	2	202.872	202.459	-.413		Black edges, greyish brown stains, pitted, I.C.
5	Halifax (Rural)	1	205.970	205.900	-.070	.00060	Dull, slight brown stains, slight pitting
5	Halifax (Rural)	2	205.927	205.920	-.007		Dull, brown stains, slightly pitted
6	Norman Wells	1	203.150	203.155	+.005		Dull, slightly pitted
6	Norman Wells	2	211.312	211.311	-.001		Bright stainless colour, slight staining
7	Esquimalt	1	213.004	212.994	-.010	.00015	White silvery lustre, small black dots
7	Esquimalt	2	214.178	214.169	-.009		Brown spots & grey specks, pitted
8	Trail	1	209.943	209.942	-.001		Dull, grey streaks, pitted
8	Trail	2	207.820	207.807	-.013	.00009	Grey streaks, pitted
8	Trail	3	206.975	206.972	-.003		Dull, grey streaks, brown stains, pitted

Note: I.C. = Interference colour

TABLE 4 (C)

TEN YEAR RESULTS OF STAINLESS STEEL ALLOY TYPE 430 (A-9)

SITE NO.	SITE LOCATION	SPEC. NO.	ORIGINAL WEIGHT (GMS)	WEIGHT AFTER CLEANING (GMS)	WEIGHT DIFFERENCE (GMS)	AVERAGE CORROSION RATE (Mils per year)	COMMENTS
1	Ottawa	1	188.257	188.259	+.002		Dull, slight brown stain, I.C.
1	Ottawa	2	186.139	186.140	+.001		Dull, stain on edges, I.C.
2	Saskatoon	1	189.196	189.195	-.001		Dull, slight brown stain
2	Saskatoon	2	191.421	191.423	+.002		Dull stainless colour, slight stain
3	Montreal	1	191.811	191.810	-.001	.00002	Dull, slight stain, slight pitting
3	Montreal	2	192.113	192.111	-.002		Greyish, brownish-grey stain, pitted
4	Halifax (Industrial)	1	191.529	188.564	-2.965	.04727	Black spalling oxide, pitted.
4	Halifax (Industrial)	2	189.136	186.247	-2.889		Black and dark grey staining, pitted.
5	Halifax (Rural)	1	186.851	186.822	-.029	.00044	Slight brown staining, slight pitting
5	Halifax (Rural)	2	191.258	191.233	-.025		Dull, slight staining
6	Norman Wells	1	192.624	192.624	.000		Bright, slightly stained
6	Norman Wells	2	191.566	191.567	+.001		Bright, slightly stained
7	Esquimalt	1	190.808	190.792	-.016	.00026	Silvery, rust streaks, I.C.
7	Esquimalt	2	191.328	191.312	-.016		Silvery, brown streaks, I.C.
8	Trail	1	188.422	188.413	-.009	.00018	Silvery lustre, slight brown stains
8	Trail	2	190.899	190.885	-.014		Brown stains on edges, I.C.
8	Trail	3	184.776	184.765	-.011		Silvery lustre, milky blotches, stains

I.C. = Interference colour

TABLE 5 - continued

VISUAL APPEARANCE OF STAINLESS STEEL (302) SAMPLES A-8
MATERIAL AFTER CLEANING

Site No.	Lot No.	Spec. No.	Appearance
1	3	1	Dull stainless steel colour, silvery-white and slight brown stains, interference colour, (silvery-white blotches on reverse side).
2	3	1	Dull grey colour, light silver-grey blotches, slight brown stains, (milky-white blotches and dark brown stains on back)
3	3	1	Dull grey colour, dark grey and slight brown stains especially along edges, slightly pitted, (silver-grey stains on back).
4	3	1	Dull grey colour, pitted, greyish-white blotches, black and dark grey stains along edges.
5	3	1	Dull stainless steel colour, dark grey and light brown stains along edges, interference colour, (more stains and greyish brown spots on back).
6	3	1	Bright stainless steel finish, slight brown stains, (silver-white blotches and grey stains on back).
7	3	1	Silvery-white appearance, dark grey and brown stains and spots especially along edges, (more rust stains, silver-grey stains on back).
8	3	1	Silvery-white appearance, grey-brown stains along edges, (milky-white stains on back).
1	4	1	Dull stainless steel colour, very slight brown and grey stains along edges, interference colour.
2	4	1	Dull stainless steel colour, slight brown stains, a few silvery-white blotches.
3	4	1	Dull grey colour, slight brown and grey staining, interference colour.
4	4	1	Dark grey colour, pitted, brown and greyish-black stains especially near edges, bluish interference colour, (more staining and milky white spots on back).
5	4	1	Dull stainless steel colour, brown stains along edges, (brownish-grey spots and bluish I.C. on back).
6	4	1	Bright stainless steel finish, slight brown stains
7	4	1	Silvery-white appearance, slight brown stains near edges, (milky-white streaks on back).
8	4	1	Silvery-white appearance, slight brown stains.

TABLE 6

VISUAL APPEARANCE OF STAINLESS STEEL (316) SAMPLES A-O
MATERIAL AFTER CLEANING

Site No.	Lot No.	Spec. No.	Appearance
		Blank	Bright, slightly stained, top left corner - pits
1	1	1	Bright, slightly stained
2	1	1	Bright, slightly stained, scattered pits
3	1	1	Greyish stains, scattered pits
4	1	1	Dull grey, dark grey stains, pitted
5	1	1	Bright, slightly stained, pitted
6	1	1	Dull, stained, slightly pitted
7	1	1	Missing
8	1	1	Dull, brown and dark grey stains, pitted
1	2	1	Bright, stained, pitted
2	2	1	Brownish stains, pitted
3	2	1	Dull, dark grey stains, pitted
4	2	1	Dull, black edges, grey and brown stains, pitted
5	2	1	Bright, slightly stained, pitted
6	2	1	Bright, grey stains, slightly pitted
7	2	1	Bright, slightly pitted and stained
8	2	1	Bright, top left corner pitted and stained
1	3	1	Dull, slightly stained and pitted
2	3	1	Dull, greyish stains, slightly pitted
3	3	1	Dull, greyish, stained and pitted
4	3	1	Dull grey, black edges, dark and light grey stains and pitted
5	3	1	Dull, greyish stains, pitted
6	3	1	Bright, slightly stained
7	3	1	Dull, pitted
8	3	1	Dull grey, dark grey stains, pitted, brown edges
1	4	1	Dull, greyish, stained and pitted
2	4	1	Dull, slight brown stains, slightly pitted
3	4	1	Dull, greyish, stained
4	4	1	Dull grey, dark grey stains, black edges, pitted
5	4	1	Dull, brownish stains, slightly pitted
6	4	1	Dull, slightly stained, pitted
7	4	1	Dull, slightly pitted
8	4	1	Greyish dull, slightly stained and pitted

TABLE 7

VISUAL APPEARANCE OF STAINLESS STEEL (430) SAMPLES A-9
MATERIAL AFTER CLEANING

Site No.	Lot No.	Spec. No.	Appearance
1	1	1	Bright stainless steel metallic lustre, shiny
2	1	1	Bright shiny stainless steel metallic lustre, very slight filmy-white stains
3	1	1	Bright shiny stainless steel metallic lustre, very slight filmy-white stains
4	1	1	Bright stainless steel colour, pitted, black spalling oxide specks, black edges (heavy coating of dark brown and black oxide on back)
5	1	1	Bright stainless steel finish, slight brownish-grey staining
6	1	1	Bright stainless steel finish, still quite shiny, slight filmy-white stains
7	1	1	Silvery bright stainless steel finish, somewhat shiny, brown rust spots especially along edges, interference colours on edges
8	1	1	Silvery bright stainless steel finish, slight brown stains near edges, slight interference colour.
1	2	1	Bright stainless steel metallic lustre, slight brown and filmy-white stains, shiny
2	2	I	Bright stainless steel finish, somewhat shiny, slight brown and filmy white stains
3	2	1	Bright stainless steel finish, somewhat shiny, slight pitting, slight brown and filmy-white stains
4	2	1	Bright stainless steel colour, pitted, black spalling oxide in patches and specks, black edges (heavy coating of dark brown and black oxide on back).
5	2	1	Bright stainless steel finish, slight brownish-grey staining in spots and along edges, interference colours, (extensive brownish-grey staining and interference colours on back).
6	2	1	Bright stainless steel metallic lustre, shiny, very slight filmy-white staining.
7	2	1	Bright stainless steel metallic lustre, shiny, brown rust spots and interference colours, slight filmy-white stains
8	2	1	Bright stainless metallic lustre, shiny, slight brownish-grey stains along edges, interference colours.

TABLE 7 - continued

VISUAL APPEARANCE OF STAINLESS STEEL (430) SAMPLES A-9
MATERIAL AFTER CLEANING

Site No.	Lot No.	Spec. No.	Appearance
1	3	1	Bright stainless steel metallic lustre, shiny, slight brownish-grey stains along edges, interference colour, slight filmy-white stains.
2	3	1	Bright stainless steel metallic lustre, shiny, slight brown and filmy-white stains.
3	3	1	Bright greyish stainless steel colour, slight pitting, slight brown and milky-white blotches especially near bottom edge.
4	3	1	Bright greyish stainless steel colour, pitted, black spalling oxide in patches and specks, black edges, (heavy coating of dark brown and black oxide on back).
5	3	1	Bright stainless steel finish, brownish-grey spots and stains along edges, slight pitting.
6	3	1	Bright metallic stainless steel lustre, shiny.
7	3	1	Silvery bright stainless steel finish, extensive rust streaks on edges and interior, interference colours.
8	3	1	Silvery stainless steel finish, brownish-grey stains along edges, interference colours.
1	4	1	Greyish stainless steel colour, somewhat shiny, slight brownish grey stains along edges, interference colours
2	4	1	Greyish stainless steel colour, somewhat shiny, very slight brown staining
3	4	1	Dull greyish stainless steel colour, greyish-brown, and filmy stains near edges, interference colours
4	4	1	Dull greyish colour, pitted, black and dark brown oxide specks especially along edges
5	4	1	Bright stainless steel finish, somewhat shiny, slight pitting, slight brown stains and interference colour near edges, slight filmy stains
6	4	1	Bright stainless steel finish, shiny, very slight brown staining
7	4	1	Bright silver - grey stainless finish, shiny very slight brown stain on edges
8	4	1	Bright silver-grey stainless finish, shiny, very bright stain along edges

TABLE 8

CHEMICAL ANALYSIS OF STAINLESS STEELS AFTER TEN YEARS EXPOSURE

CHEMICAL ANALYSIS - PER CENT

Material and Site No.	C	Mn	P	S	Si	Cr	Mo	Ni
A-8 SS 302								
Site #6	0.11	1.30	0.024	0.019	0.48	18.93	-	8.56
Site #4	0.11	1.28	0.026	0.018	0.47	18.21	-	8.51
A-9 SS 430								
Site #6	0.07	0.45	0.030	0.017	0.39	16.70	-	0.71
Site #4	0.08	0.47	0.030	0.018	0.39	16.71	-	0.71
A-O SS 316								
Site #6	0.07	1.94	0.026	0.020	0.38	17.06	2.35	12.84
Site #4	0.065	1.92	0.026	0.019	0.39	17.04	2.35	12.84

TABLE 9

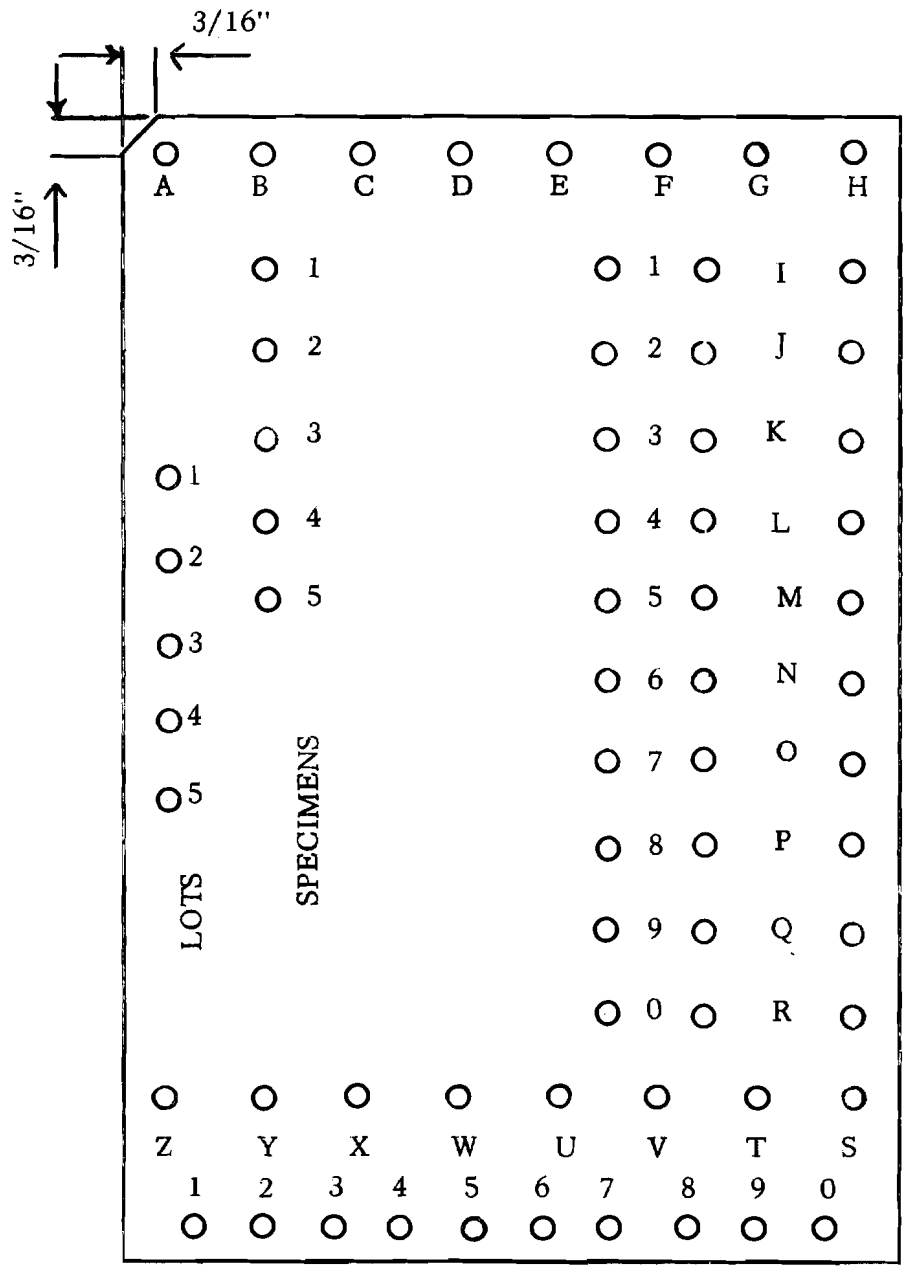
AVERAGE SULPHUR DIOXIDE CONTENT OF ATMOSPHERE AT EACH EXPOSURE SITE

(Reported as Mg SO_3/day/100 sq cm lead peroxide)

EXPOSURE SITE	ONE YEAR	TWO YEARS	FIVE YEARS	TEN YEARS
Ottawa - 1	0.52	0.49	0.50	0.52
Saskatoon-2	0.33	0.27	0.20	0.15
Montreal-3	2.19	2.22	1.99	1.69
Halifax - Industrial - 4	14.67	12.83	9.55	6.48
Halifax - Rural -5	0.51	0.50	0.33	0.28
Norman Wells	0.02	0.008	0.022	0.009
Esquimalt-7	0.06	0.05	0.06	0.05
Trail-8	0.81	0.83	0.74	0.68

FIGURE 1 - TEMPLATE FOR SPECIMEN IDENTIFICATION

The template used to identify the panels exposed at the various sites is shown below. The template is notched at the upper left hand corner. The metal designation is obtained from the letters around the outside edge and the vertical numbers 1 to 0 on the right hand side of the panel. The row of numbers on the bottom designate the site number (1 to 0). Lot and specimen numbers are also shown.



All holes 1/8" diameter

FIGURE 2 - STAINLESS STEELS -
ONE YEAR EXPOSURE

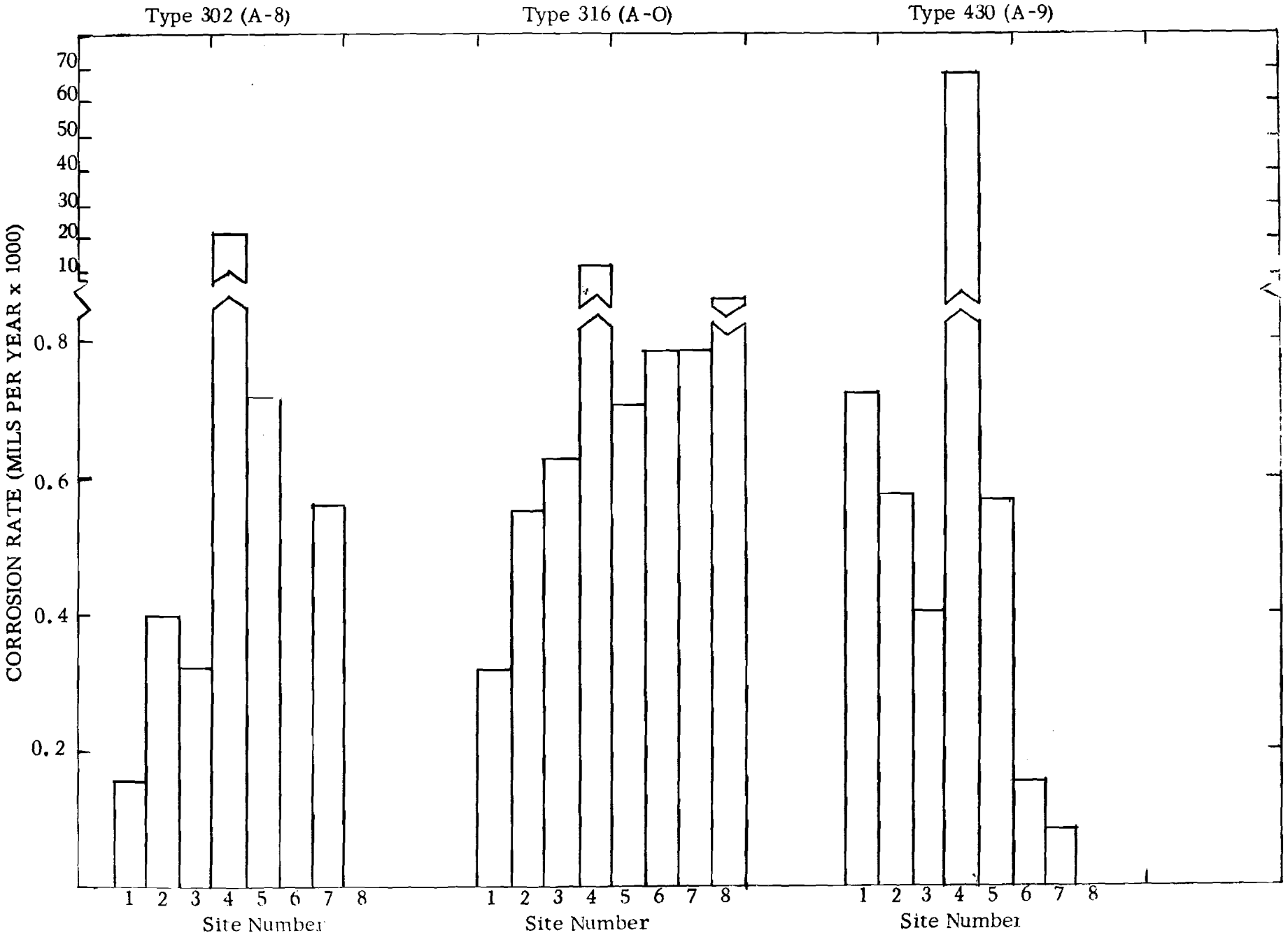


FIGURE 3

STAINLESS STEELS - TWO YEARS EXPOSURE

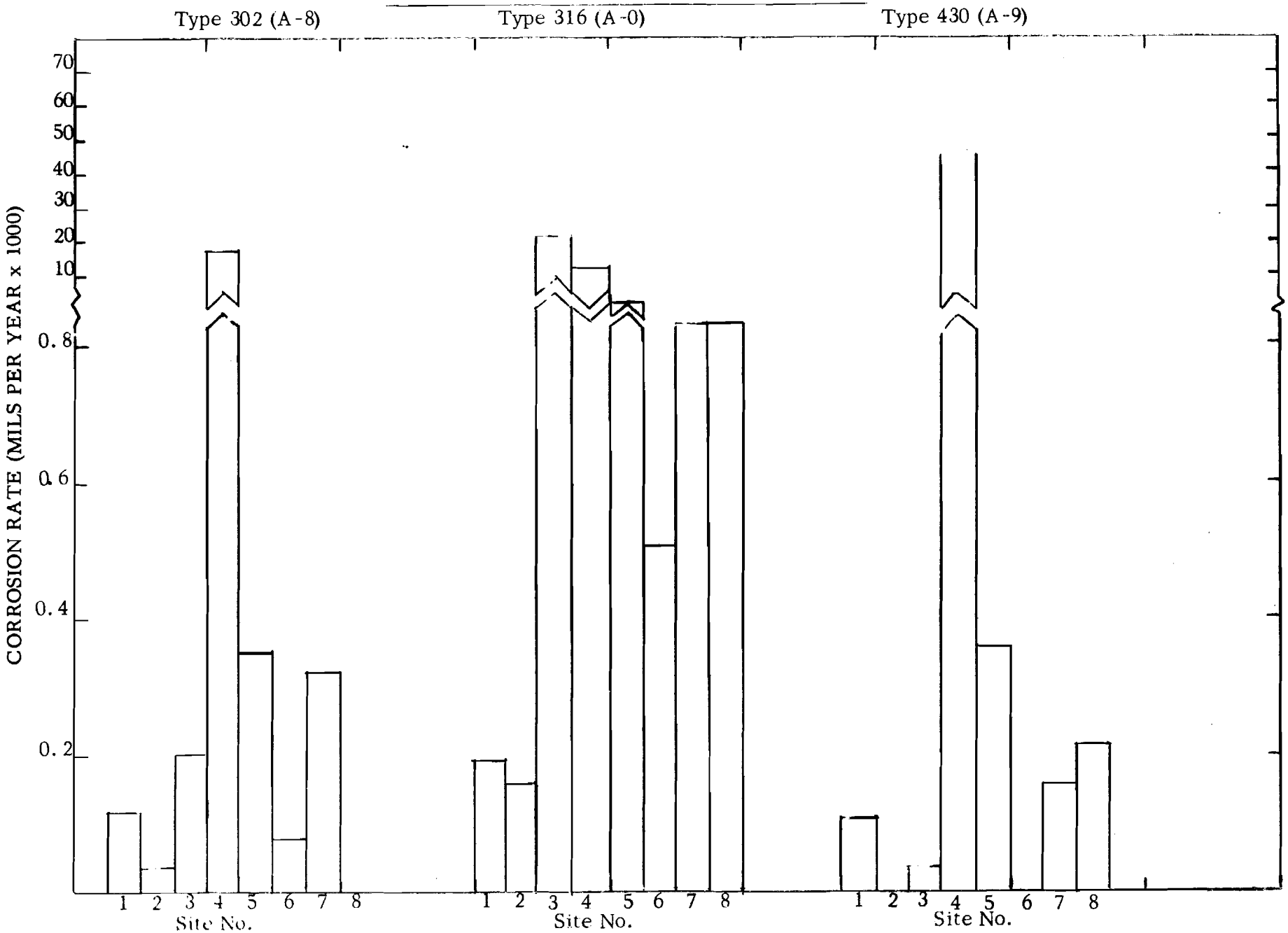


FIGURE 4

STAINLESS STEEL - FIVE YEARS EXPOSURE

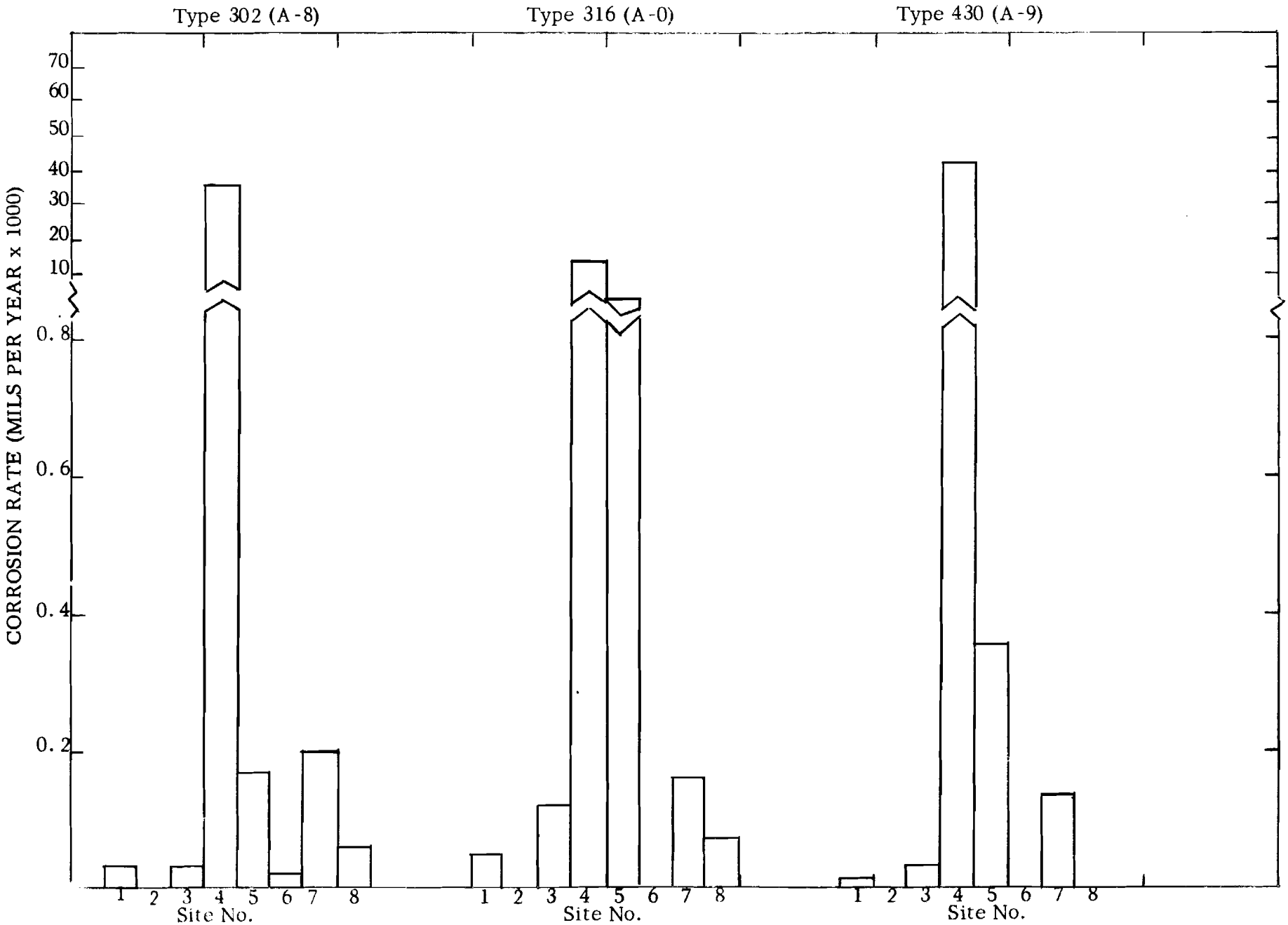
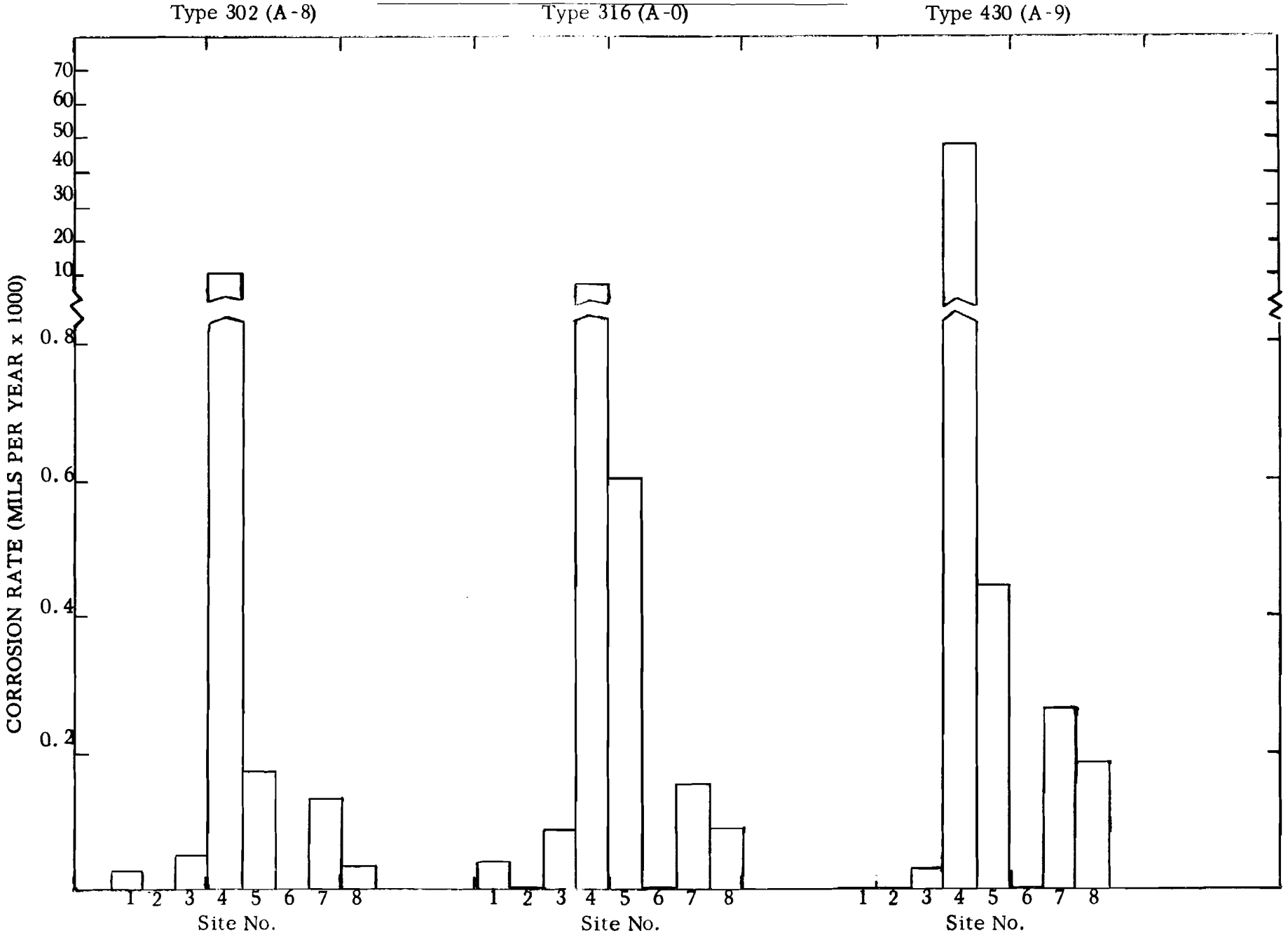


FIGURE 5

STAINLESS STEEL - TEN YEARS EXPOSURE



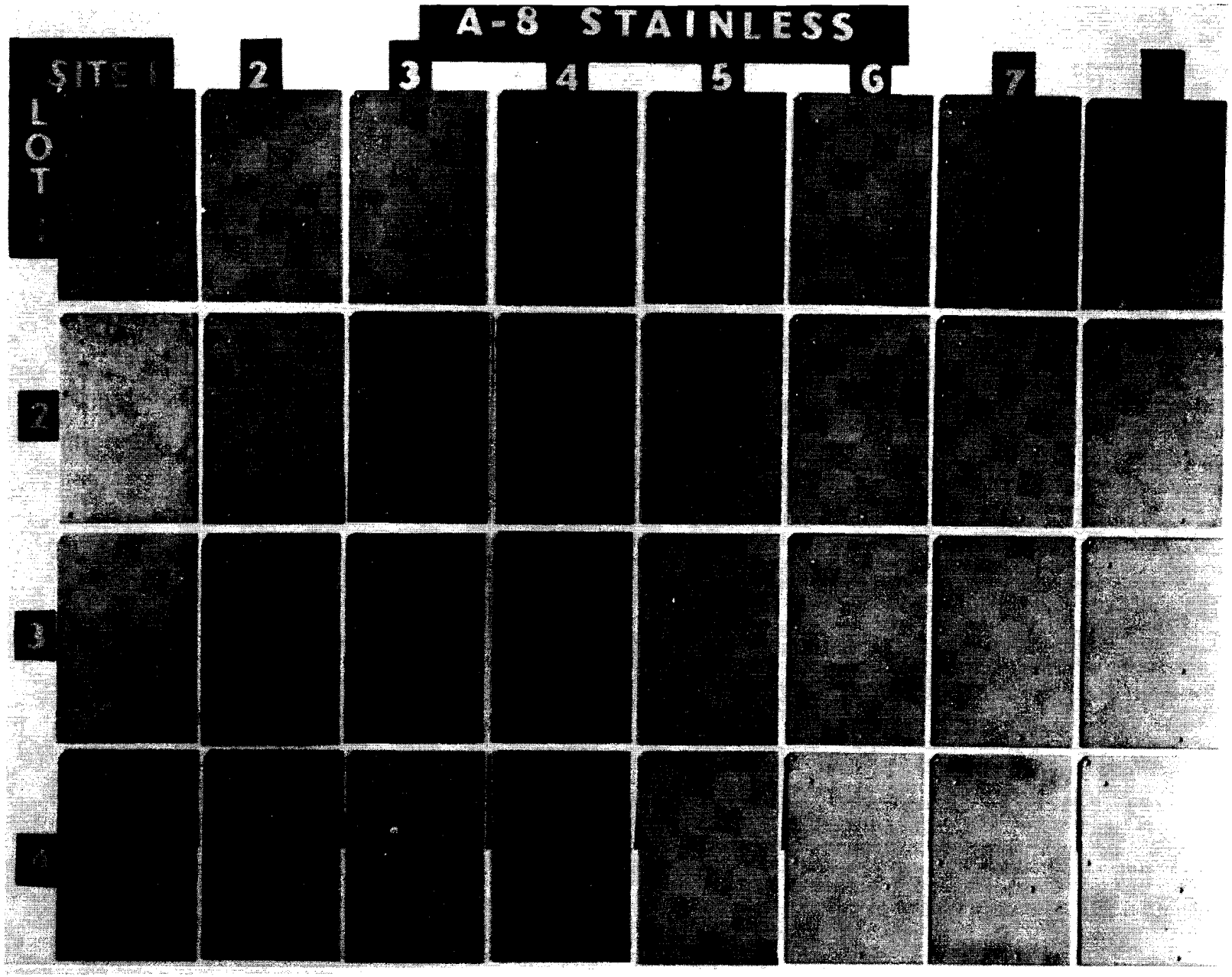


Figure 6

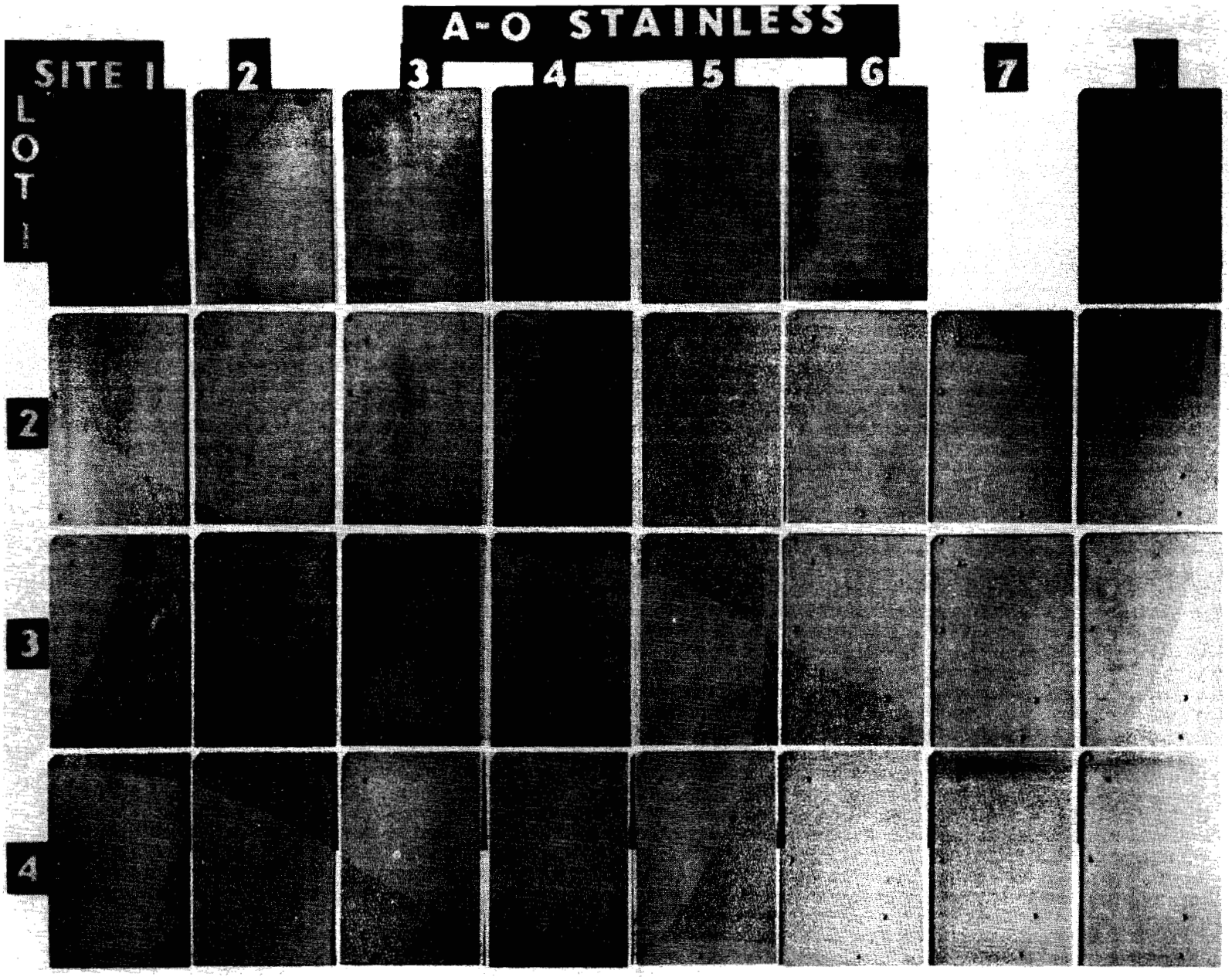


Figure 7

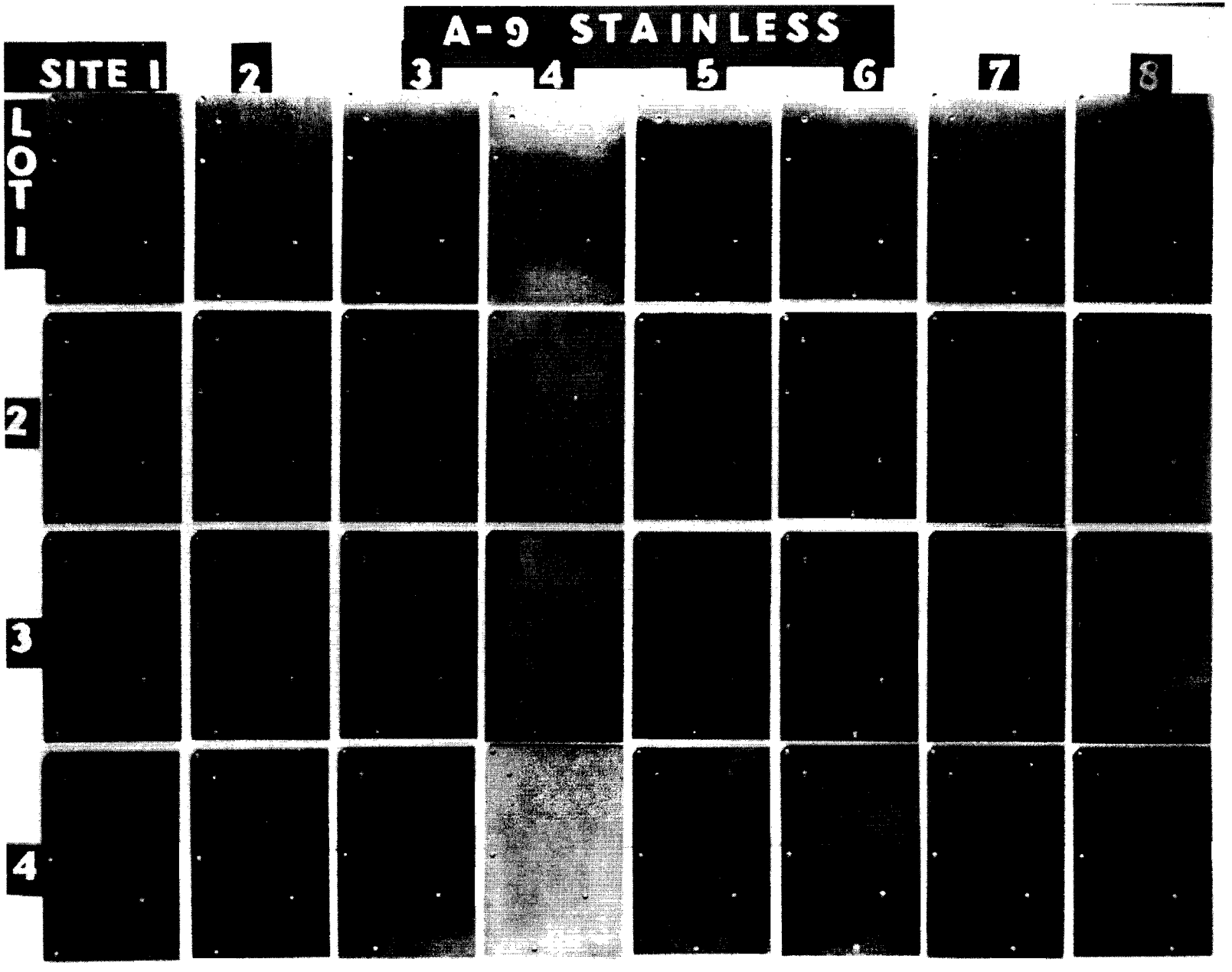
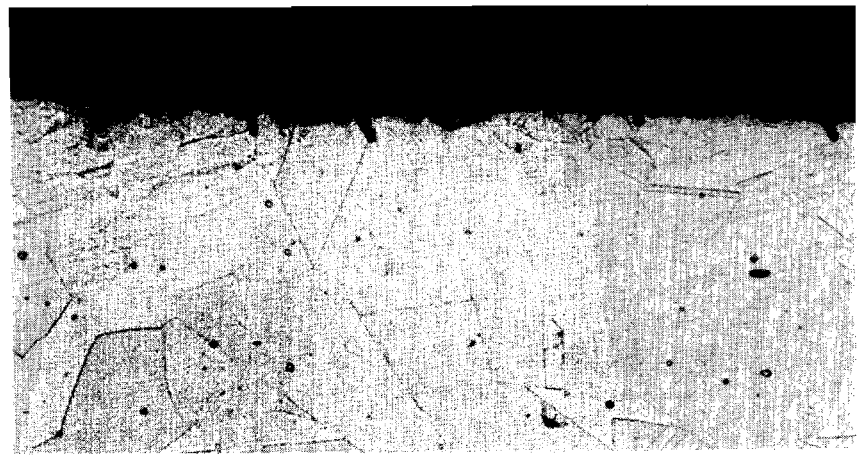


Figure 8

STAINLESS - 302



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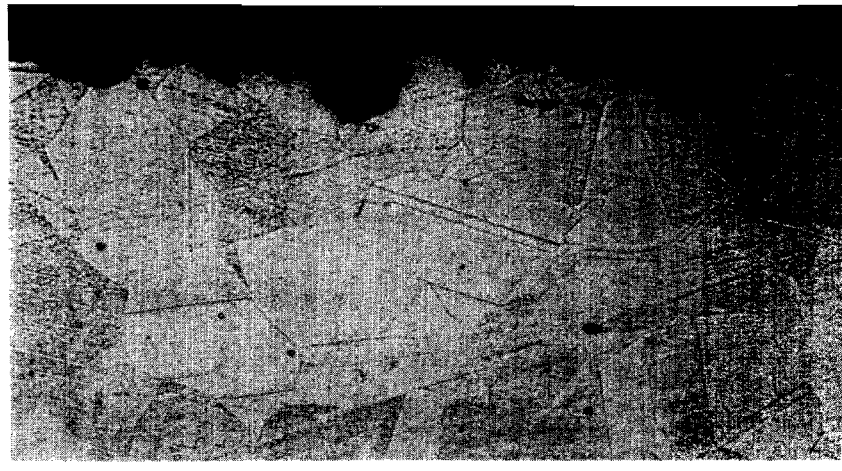


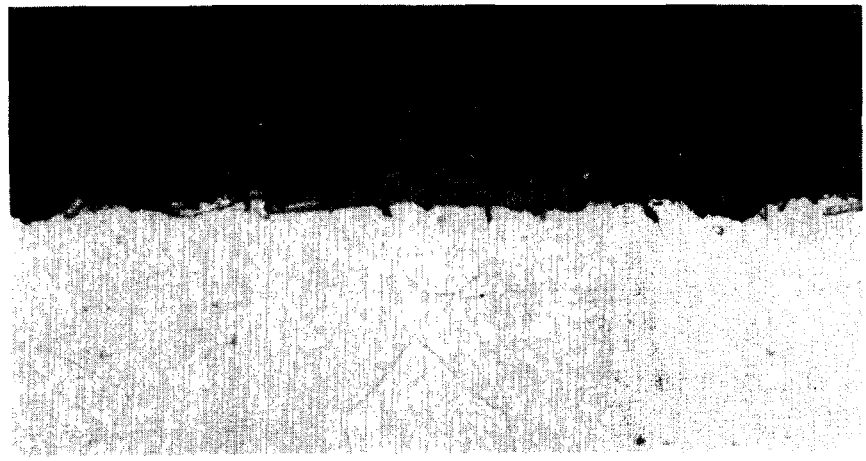
SITE #4 - HALIFAX, INDUSTRIAL

SITE #6 - NORMAN WELLS

FIGURE 9 - ELECTROLYTIC ETCH, 10% OXALIC ACID, 30 SECONDS, 6 VOLTS

500X

STAINLESS - 316



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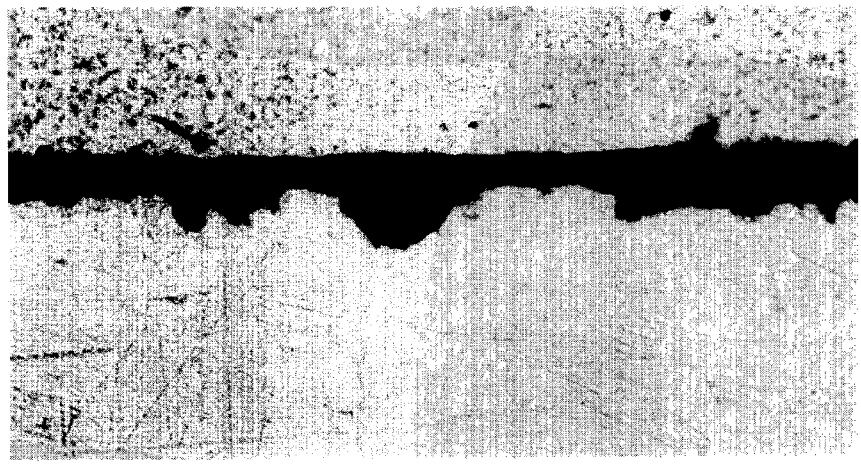
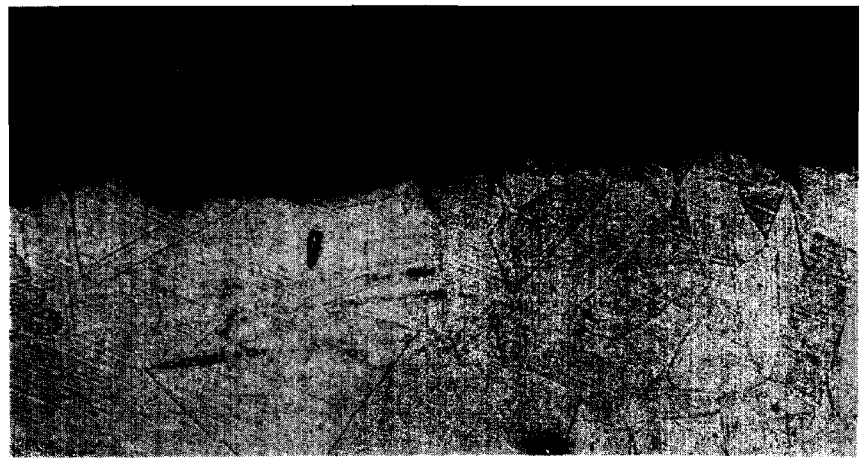


SITE #4 - HALIFAX, INDUSTRIAL



SITE #6 - NORMAN WELLS

FIGURE 10 - ELECTROLYTIC ETCH, 10% OXALIC ACID, 30 SECONDS, 6 VOLTS
500X

STAINLESS - 430

BLANK

SITE #4 - HALIFAX, INDUSTRIAL

SITE #6 - NORMAN WELLS

FIGURE 11 - ELECTROLYTIC ETCH, 10% OXALIC ACID, 30 SECONDS, 6 VOLTS

500X

FIGURE 12

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 1 (OTTAWA)

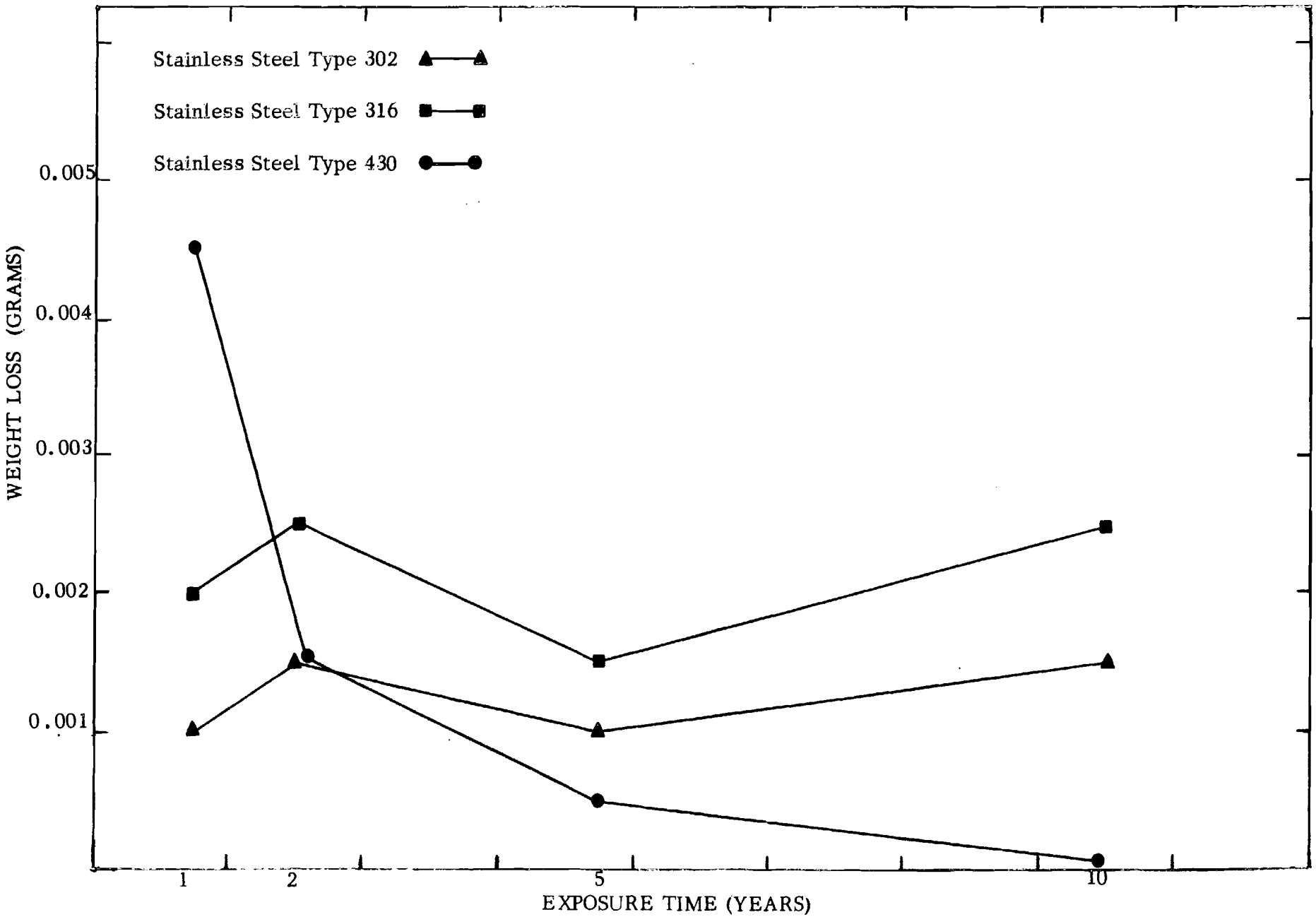


FIGURE 13

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 2 (SASKATOON)

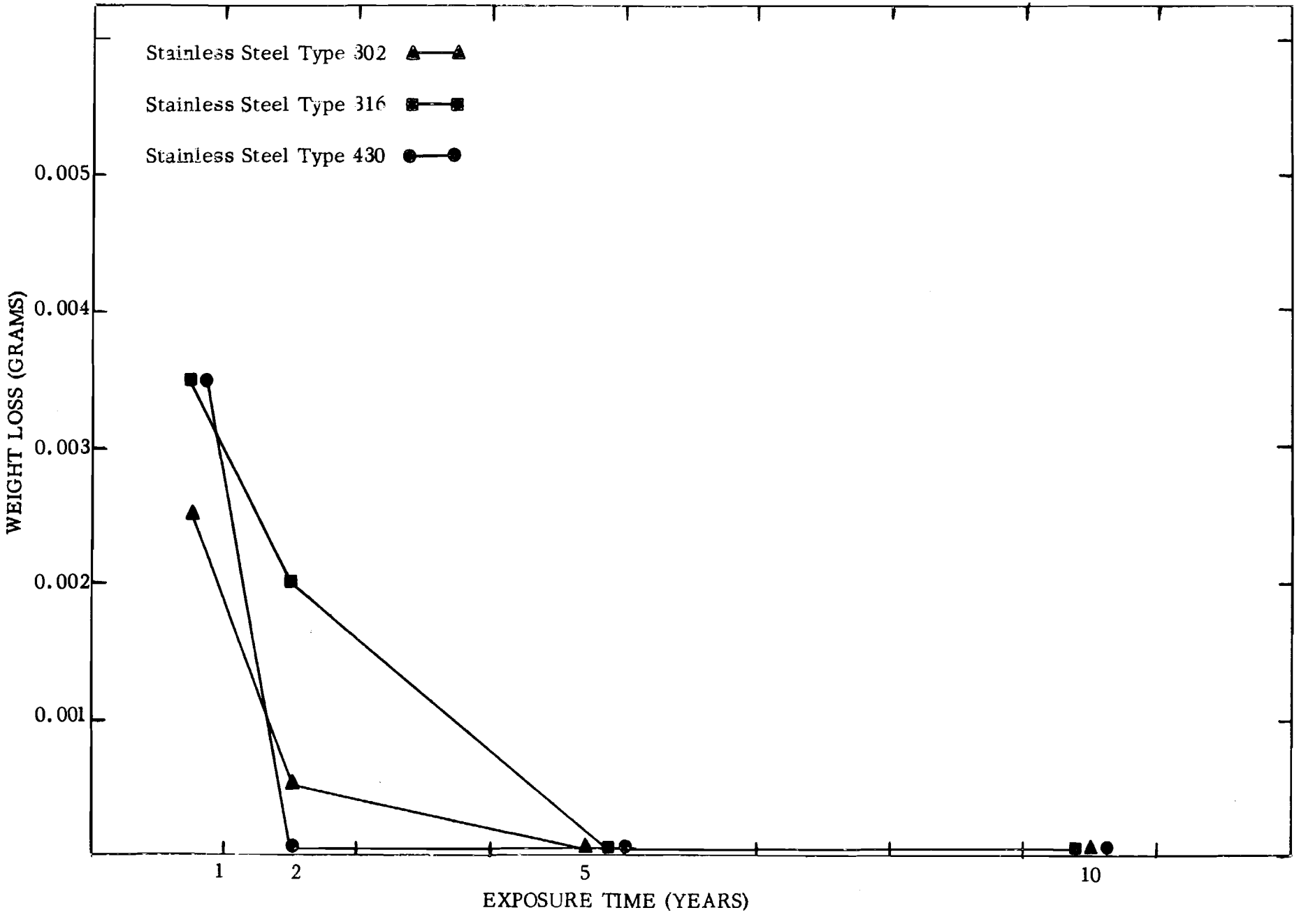


FIGURE 14

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 3 (MONTREAL)

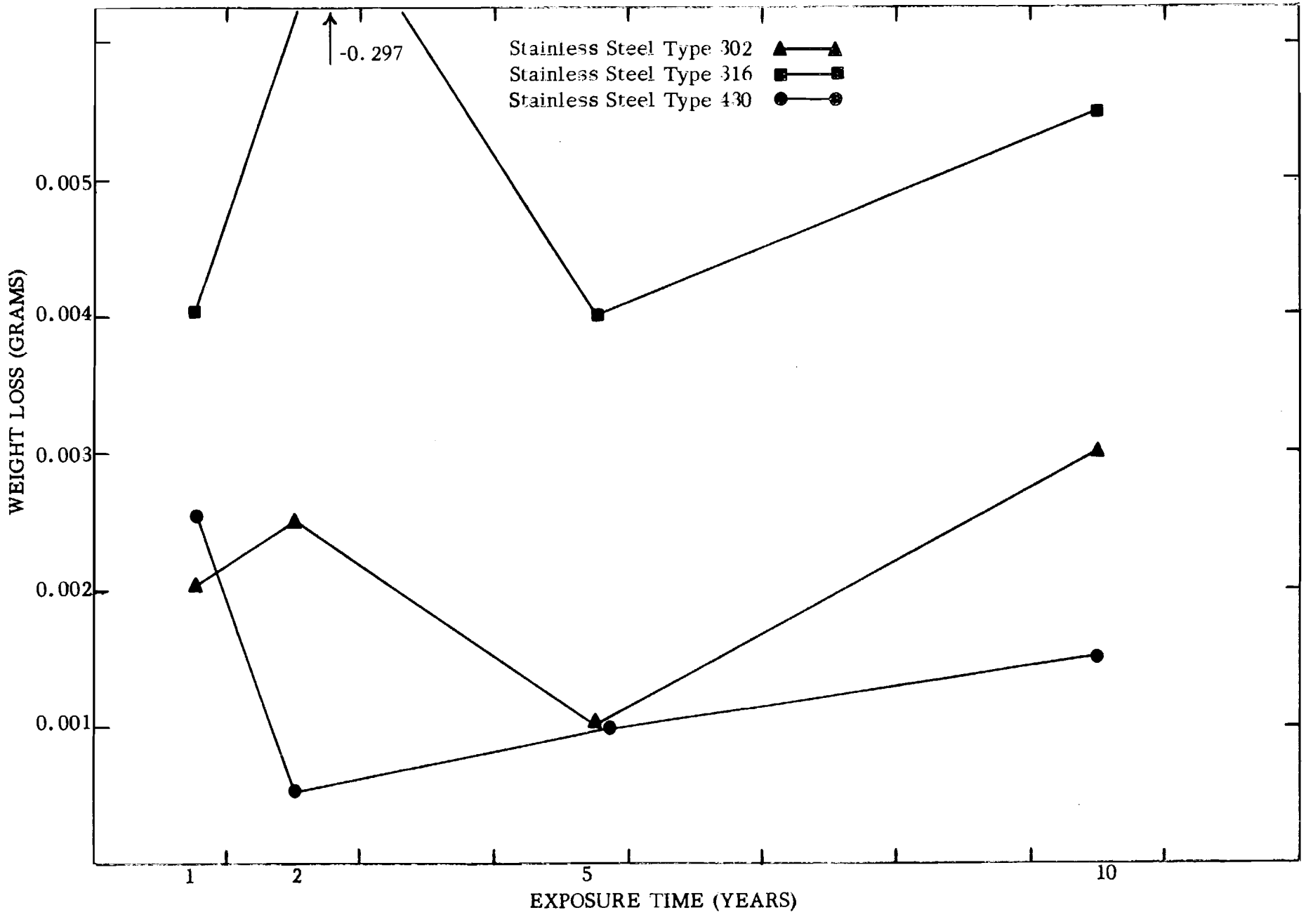


FIGURE 15

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 4 (HALIFAX INDUSTRIAL)

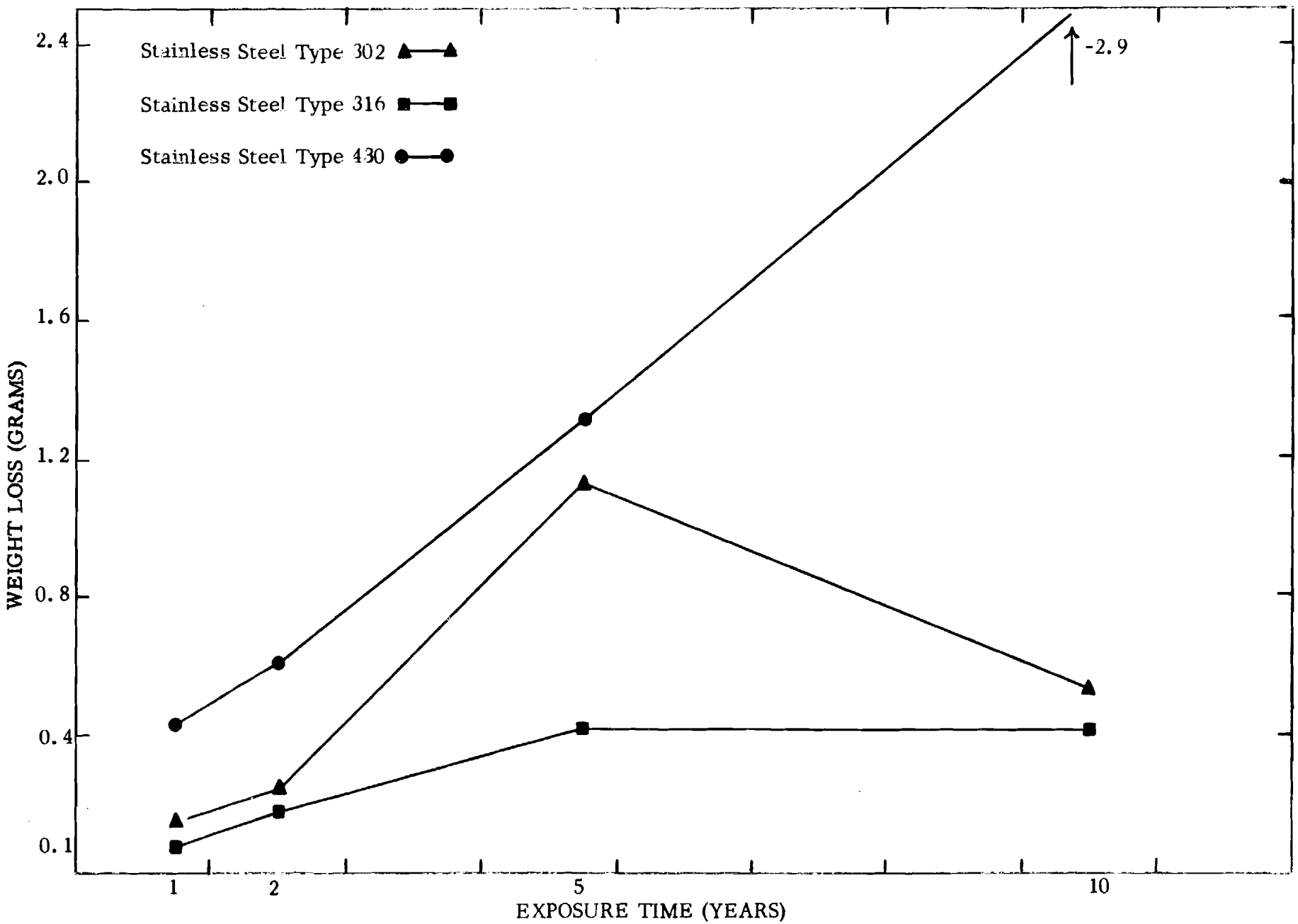


FIGURE 16

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 5 (HALIFAX - RURAL)

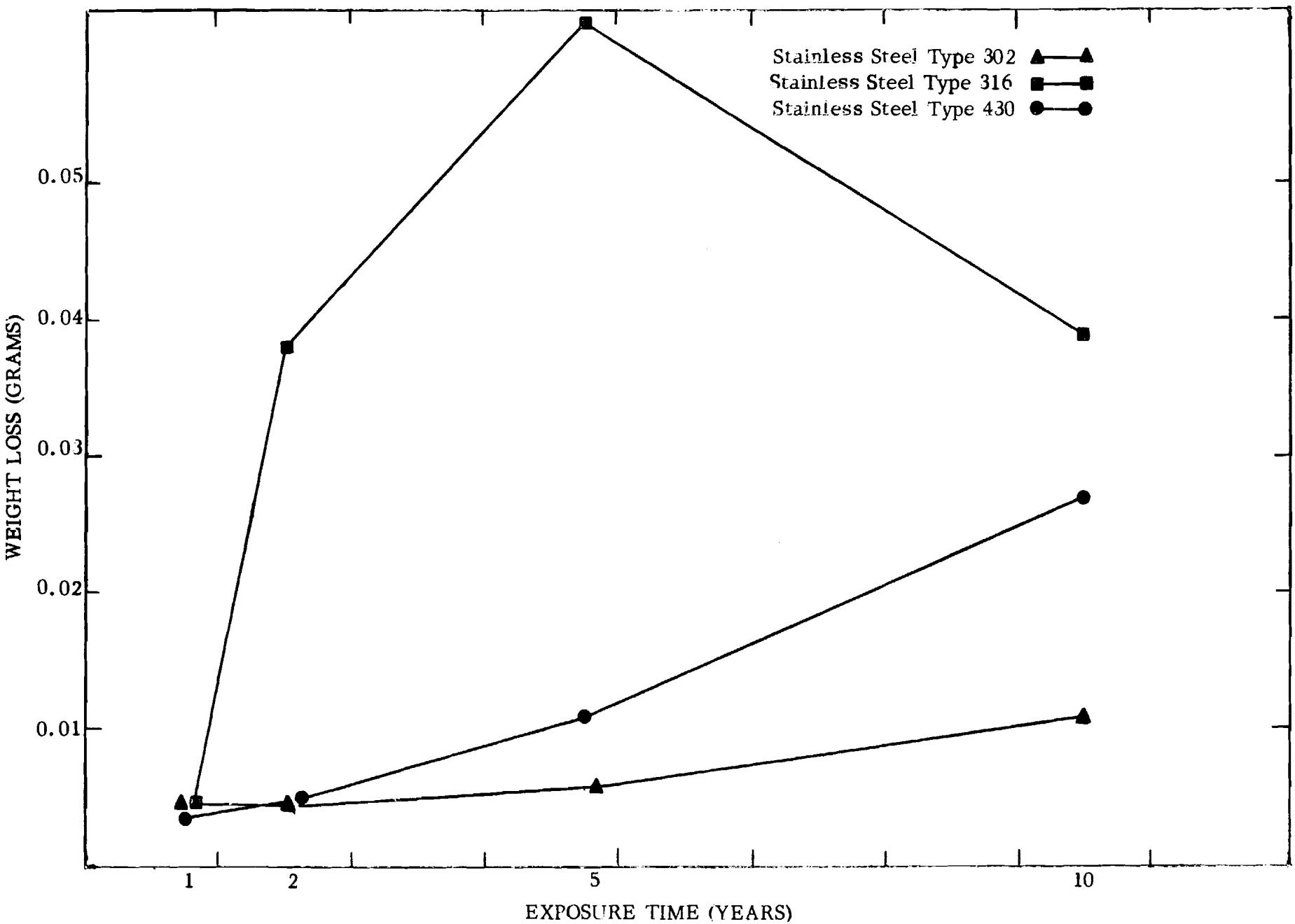


FIGURE 17

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 6 (NORMAN WELLS)

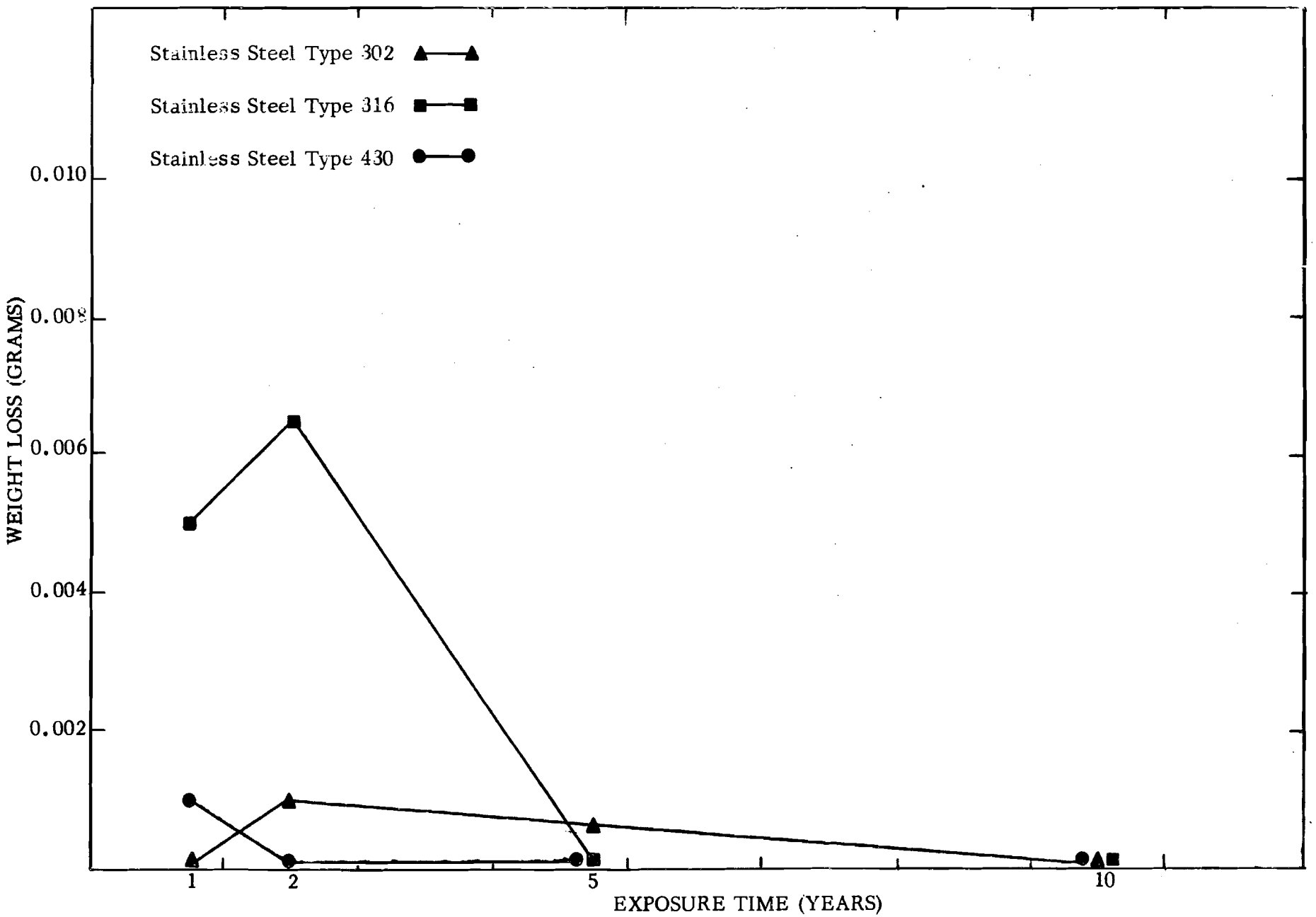


FIGURE 18

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 7 (ESQUIMALT)

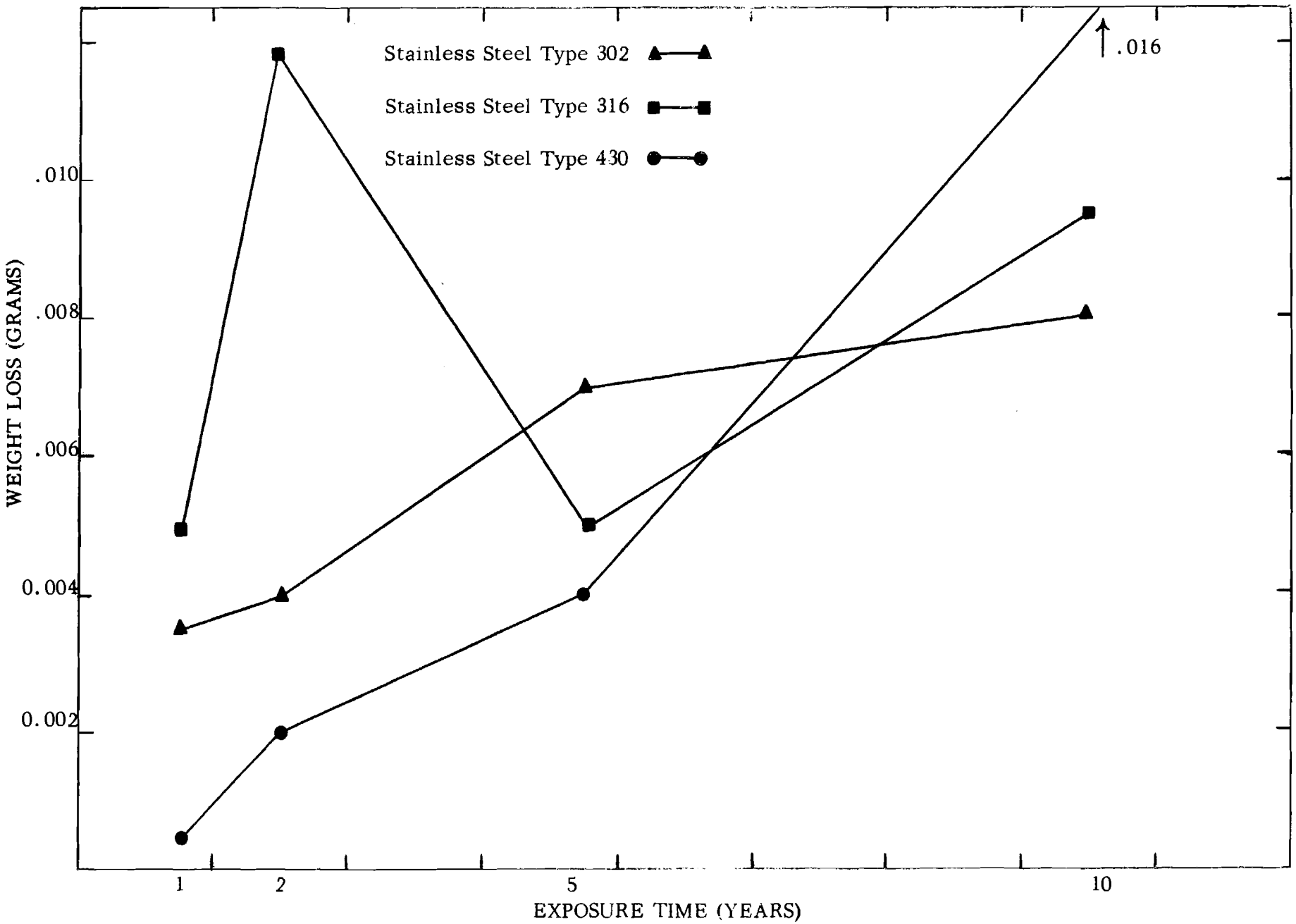


FIGURE 19

ATMOSPHERIC CORROSION OF STAINLESS STEELS AT SITE NO. 8 (TRAIL)