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SEACOAST STRESS CORROSION CRACKING OF ALUMINUM ALLOYS

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16. ABSTRACT

An investigation of the stress corrosion cracking resistance of high strength, wrought aluminum alloys in a seacoast atmosphere is presented, and the results are compared with those obtained in laboratory tests. Round tensile specimens taken from the short transverse grain direction of aluminum plate and stressed up to 100 percent of their yield strengths were exposed to the seacoast at Kennedy Space Center and to alternate immersion in salt water and synthetic seawater. Maximum exposure periods of one year at the seacoast, 0.3 or 0.7 of a month for alternate immersion in salt water, and three months for synthetic seawater are indicated for aluminum alloys to avoid false indications of stress corrosion cracking failure resulting from pitting. Correlation of the test results was very good among the three test media using the selected exposure periods. Therefore either of the laboratory test media is suitable for evaluating the stress corrosion cracking performance of aluminum alloys in seacoast atmosphere.

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INTRODUCTION

Considerable data have been generated at Marshall Space Flight Center (MSFC) on the stress corrosion cracking (SCC) of heat-treatable wrought products of the higher strength aluminum alloys because of the large volume of these products used in the Saturn family of vehicles and payloads. Initially the SCC data were obtained almost exclusively in 3.5 percent sodium chloride (salt water) alternate immersion tests (Method 823 of Federal Standard 151 b) with limited tests in MSFC outdoor atmosphere which is considered mildly industrial with very little chemical contamination [1]. SCC data for the higher strength aluminum alloys were generated more recently by alternate immersion (AI) in synthetic seawater (hereafter referred to as seawater) per ASTM D1141-52 using Method 823 [2]. Although the results obtained using these two laboratory test media vary considerably, they do not necessarily discredit the present SCC rating of aluminum alloys based mainly on AI in salt water and service experience.

SCC testing in a seacoast atmosphere was deemed necessary because space transportation systems will continue to be launched in the vicinity of the seacoast and it is imperative that the test medium reflect the conditions of the service environment. Seacoast testing at KSC was initiated in 1976 with the assistance of Mr. J. D. Morrison, TG-FLD22, KSC.

EXPERIMENTAL PROCEDURE

Most of the commercially available higher strength aluminum alloys were used in this seacoast SCC test. All test material was in the form of plate and consisted of alloys 2024-T351, 2024-T851, 2124-T851, 2048-T851, 2219-T87, 7049-T7351, 7050-T73651, 7075-T651, 7075-T7351, and 7475-T7351. Round tensile specimens taken from the short transverse grain direction and stressed in uniaxial tension were used exclusively. This was possible because all the material was 2 in. thick or thicker.

The specimens were strained with the aid of a stressing fixture to the desired stress levels (25 to 100 percent of their short transverse yield strengths). The ends of the specimens and the area of the stressing frames in contact with the specimens were coated with a neoprene cement (MSFC X94). After wiping with methanol, the specimen assemblies were placed in special exposure racks and exposed to the KSC seacoast atmosphere. The test site is located 120 to 130 ft from mean high tide and the specimens face the Atlantic Ocean at a 30 degree slope (Figures 1 and 2). A detailed description of the specimens, stressing frames and fixture, and method of loading the specimens are given in Reference 3.

Unstressed round tensile specimens were exposed along with the stressed specimens and removed from test after 15, 18, 24 and 38 months of exposure. The losses in load carrying ability of the exposed unstressed specimens were determined to ascertain the loss in strength resulting from corrosion during these test periods. Failed stressed specimens were removed at the time of failure, and all unfailed specimens were removed after 38 months. The losses in load carrying ability of the unfailed stressed specimens were also determined, and the results obtained were compared to those of the unstressed specimens. Most of the materials exposed at the seacoast were also tested by alternate immersion in salt water and in seawater using similar specimens and loading methods. This was done to compare the seacoast SCC results with those obtained in laboratory tests.

RESULTS AND DISCUSSION

The compositions of the aluminum alloys are given in Table 1 and all compositions were within specifications except for one lot of 2124-T851 which was slightly low in copper. The short transverse mechanical properties of the test materials are listed in Table 2. These properties were used to calculate the required strain for stressing the specimens and as a basis for calculating the loss in load carrying ability of exposed specimens.

The SCC results obtained at the seacoast were compared to those obtained in accelerated laboratory tests (AI in salt water and seawater). As may be noted in Table 3, the alloys in their highly SCC susceptible temper (2024-T351 and 7075-T651) failed after very short periods of exposure in all three test media. Alloys in their intermediate or high SCC resistant tempers failed in seacoast and salt water media after relatively long exposure periods, but none of these except 2024-T851 failed in seawater.

Pitting of the specimens occurred in all three media but was most severe and occurred earliest in salt water. The severity of pitting is illustrated in Table 4 and Figure 3 by losses in load carrying ability of the unstressed test specimens after various periods of exposure. These losses were calculated from the differences in their breaking strengths (breaking loads divided by cross-sectional areas before exposure) and the tensile strengths of the parent materials. There are several methods in which pitting can interfere with the interpretation of SCC test results.

Pitting of tension specimens with relatively small cross sections can reduce the effective cross-sectional areas and produce a net section stress significantly greater than the nominal gross section stress. This will result in SCC of specimens at an actual stress higher than the intended nominal test stress or fracture by mechanical overload of materials that are not susceptible to SCC. The problem associated with pitting can be combated by using a minimal exposure period and still maintain an adequate period for SCC evaluation of the material. This method is illustrated in Table 5 and Figure 4 in which failures of the test materials are compared after 12, 24 and 38 months at the seacoast; 0.3, 0.7, and 3 months in salt water; and 1 and 3 months in seawater. The results of all three test media are in better agreement if the shorter exposure periods are used for seacoast and salt water and the longer period for seawater. This agreement in SCC results among the three test media for selected exposure periods is shown in Table 6. The 0.7 month for 7XXX series aluminum alloys in salt water is recommended in ASTM G47-76 and 0.3 month for 2XXX series in salt water is presently being proposed for inclusion in this standard.

One year exposure was chosen for the seacoast at KSC to reduce the effect of pitting on SCC evaluation. A shorter exposure may be desirable because metallographic studies (both SEM and optical) failed to identify SCC as the major contributor to failure of the aluminum alloys with the exception of 2024-T351 and 7075-T651, although some failures occurred after only four months. Failure of the SCC resistant alloys (7049-T7351, 7050-T73651, 7075-T7351, and 7475-T7351) was reported by Kaiser [4] when highly stressed and exposed to the seacoast atmosphere at Daytona Beach, Florida for extended exposure periods. This agrees with the results obtained with these materials exposed to the seacoast at KSC. Kaiser did not present metallographic data to indicate the type and severity of corrosion of the failed specimens. Additional testing by the Aluminum Association, ASTM G1.06.91 Task Group is needed to ascertain the optimum exposure period for aluminum alloys in seacoast atmosphere and if, as believed, the optimum exposure period varies with location.

Tensile stress certainly had an effect on the load carrying ability of all the aluminum alloys after extended exposure at the seacoast. As shown in Table 7 and Figure 5, stress resulted in an increase loss in load carrying ability of all alloys and the loss increased with increasing stress. Even the alloys considered to possess very high resistance to SCC (2219-T87, 7049-T7351, 7075-T7351, 7475-T7351) suffered this increased loss in load carrying ability under stress. The phenomenon appears to result from mild intergranular and mixed mode cracking as shown in Figures 6 through 8. Although there was no significant difference in surface pitting between the stressed and unstressed specimens, the stressed specimens also suffered some intergranular and mixed mode cracking. The type and depth of attack of the unstressed test alloys after extended periods of exposure to KSC seacoast are illustrated in Figure 9. Very little if any published information is available pertaining to the effect of extended seacoast exposure on the corrosion of highly stressed subsized tensile specimens of aluminum alloys. Therefore a comprehensive comparison could not be made of these results at KSC with those obtained at other seacoast sites.

The results of this investigation, employing three test media, were in agreement with ASTM proposed standard [5] that alloys 2219-T8, 7049-T73, 7075-T73, and 7475-T73 possess very high resistance to SCC ("A" rating) and 2024-T8 and 2124-T8 possess high resistance to SCC ("B" rating). Alloys 2048-T8 and 7050-T736 exhibited very high resistance to SCC in this investigation (no SCC failures even when stressed to 100 percent of the yield strength) but were classified as high resistant alloys ("B" rating) in the proposed standard. This is not too surprising because the results were obtained from a single lot of 2048-T8 and from only two lots of 7050-T736, and the SCC resistance among lots of these alloys and alloys 2024-T8 and 2124-T8 is known to vary. Because of this inconsistency among lots, the alloys were assigned a "B" rating in the proposed ASTM Standard and were placed in Table II of MSFC Spec 522 [6].

CONCLUSIONS

The results obtained in this investigation reveal that:

1) A 1 yr exposure period is recommended for SCC testing of high strength aluminum alloys at the KSC seacoast site because pitting corrosion after extended exposure interferes with the interpretation of SCC test results.

2) Correlation of the SCC test results among the three test media was very good when based on 12 months exposure to KSC seacoast, 0.3 or 0.7 month exposure to AI in salt water, and 3 months exposure to AI in synthetic seawater. Therefore, either of these laboratory test media is suitable for evaluating the SCC performance of the high strength aluminum alloys in seacoast atmosphere.

3) Aluminum alloys 2048-T851, 2219-T87, 7049-T7351, 7050-T73651, 7075-T7351, and 7475-T7351 exhibited very high resistance to SCC with no SCC failure at tensile stresses of 75 or 100 percent of their short transverse yield strengths. These results are based on limited lots of plate and may not be representative of other lots or forms.

4) Alloys 2024-T851 and 2124-T851 exhibited moderate resistance to SCC with failures occurring when stressed to 75 percent of their yield strengths, and 2024-T351 and 7075-T651 were highly susceptible to SCC.

5) Tensile stress resulted in a loss in load carrying ability of the alloys and the loss increased with increasing stress after extended exposure to the seacoast at KSC.

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5. Standard Classification Of The Resistance To Stress Corrosion Cracking Of High-Strength Aluminum Alloys. Proposed ASTM Standard By Joint Task Group Under The Jurisdiction of ASTM Committee G-1.

6. Marshall Space Flight Center: Design Criteria For Stress Corrosion Cracking. MSFC-SPEC-522A, November 18, 1977.

TABLE 1. CHEMICAL COMPOSITION OF TEST ALLOYS

Alloy	Identity[a]	Weight Percent							
		Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
2024-T351	10 cm (MS)	0.16	0.39	4.4	0.58	1.6	0.02	0.15	0.04
2024-T851	6.4 cm (KA)	0.11	0.37	4.1	0.61	1.6	0.02	0.18	0.04
2124-T851	5 cm (RM)	0.06	0.12	3.6[b]	0.68	1.5	0.05	0.07	0.02
2124-T851	6.4 cm (KA)	0.07	0.17	3.8	0.63	1.4	0.01	0.06	0.03
2124-T851	10 cm (KA)	0.05	0.15	4.3	0.61	1.4	0.01	0.02	0.02
2048-T851	5 cm (RM)	0.05	0.12	3.6	0.52	1.4	-	-	-
2219-T87	5 cm (MS)	-	0.20	6.0	0.30	0	0	0	0.08
7049-T7351	7.6 cm (KA)	0.06	0.10	1.6	-	2.5	0.14	7.7	0.02
7050-T73651	5 cm (AC)	0.06	0.07	2.1	0.01	2.3	-	6.1	0.03
7050-T73651	7.6 cm (KA)	0.06	0.11	2.2	-	2.2	0	6.2	0.02
7075-T651	6.4 cm (MS)	-	0.30	1.5	0.07	2.2	0.30	5.6	-
7075-T7351	6.4 cm (AC)	0.11	0.27	1.7	0.08	2.6	0.19	5.8	0.04
7075-T7351	7.6 cm (KA)	0.14	0.16	1.4	-	2.4	0.20	5.7	0.03
7475-T7351	5 cm (AC)	0.06	0.12	1.3	0.02	2.1	0.19	5.3	0.02
7475-T7351	7.6 cm (KA)	0.06	0.10	1.5	-	2.2	0.20	6.0	0.02

a. Source and plate thickness
AC - Alcoa
KA - Kaiser
MS - MSFC
RM - Reynolds

b. Below minimum

TABLE 2. SHORT TRANSVERSE MECHANICAL PROPERTIES

Alloy	Identification	Tensile Strength MPa	Tensile Strength ksi	Yield Strength MPa	Yield Strength ksi	Percent Elongation
2024-T351	10 cm, MSFC	405	59	305	44	4.0
2024-T851	6.4 cm, Kaiser	460	67	430	62	3.0
2124-T851	5 cm, Reynolds	460	67	420	61	7.0
2124-T851	6.4 cm, Kaiser	430	62	405	59	2.0
2124-T851	10 cm, Kaiser	420	61	395	57	5.0
2048-T851	5 cm, Reynolds	455	66	420	61	2.5
2219-T87	5 cm, MSFC	460	67	365	53	3.5
7049-T7351	7.6 cm, Kaiser	485	70	405	59	6.5
7050-T73651	5 cm, Alcoa	495	72	420	61	8.5
7050-T73651	7.6 cm, Kaiser	475	69	405	59	6.5
7075-T651	6.4 cm, MSFC	505	73	450	65	3.0
7075-T7351	6.4 cm, Alcoa	455	66	405	59	2.5
7075-T7351	7.6 cm, Kaiser	415	60	350	51	4.0
7475-T7351	5 cm, Alcoa	490	71	405	59	14.0
7475-T7351	7.6 cm, Kaiser	440	64	370	54	4.5

Average of three specimens

TABLE 3. COMPARISON OF SCC RESULTS OF ALUMINUM ALLOYS EXPOSED TO THE SEACOAST AND AI IN SALT AND SEA WATER[a]

Identity	Applied Stress MPa	ksi	%YS	Seacoast F/N Time (Mo)	AI Salt Water F/N Time (Mo)	AI Sea Water F/N Time (Mo)
				2024-T351		
10 cm (MS)	75	11	25	4/5 0.1,0.3,12,16	4/6 0.4,0.8,1.3,1.5	[illegible]/3 0.1,0.2,1.2
	150	22	50	5/5 0.1(5)	5/5 0.1(4),0.8	3/3 0.1(3)
				2024-T851		
6.4 cm (KA)	215	31	50	0/5	3/3 0.5,0.7,0.8	1/3 2.5
	320	46.5	75	5/5 4.5,5,10,22	3/3 0.3,0.5,0.5	3/3 2.3,2.3,2.5
				2124-T851		
5 cm (RM)	215	31	50	0/5	3/3 1.4,2.6,2.6	0/3
	320	46.5	75	1/5 5	3/3 0.2,0.9,0.9	0/3
6.4 cm (KA)	205	29.5	50	0/4		
	305	44	75	4/5 4.5,5,12		
10 cm (KA)	200	28.5	50	0/5		
	295	43	75	0/5	2/2 0.9,1.0	0/3
				2048-T851		
5 cm (RM)	210	30.5	50	0/5	2/3 1.3,3	0/3
	315	46	75	3/5 27,28,29	3/3 0.4,1.4,1.4	0/3
				2219-T87		
5 cm (MS)	275	40	75	2/5 25,25	3/17[b] 0.7,0.8,0.9	0/4
	365	53	100	5/5 5,13,14,14,14	0/6[b]	0/3[b]
				7049-T7351		
7.6 cm (KA)	205	29.5	[illegible]	0/8		
	305	44	75	3/8 28,28,30	2/3 1.7,1.8	0/3
	405	59	100	7/8 14,16,20(3)36,38	3/3 1.5,1.6,1.7	0/3
				7050-T73651		
5 cm (AC)	210	30.5	50	0/8	0/3	0/3
	315	46	75	0/8	2/3 2.9,2.9	0/3
	420	61	100	2/8 28,34	3/3 2.9(3)	0/3
7.6 cm (KA)	180	26	45	0/8		
	265	39	65	1/8 27	2/3 1.8,2.1	0/3
	345	50	85	0/8	3/3 1.8,2.6,2.6	0/3

TABLE 3. COMPARISON OF SCC RESULTS OF ALUMINUM ALLOYS EXPOSED TO THE SEACOAST AND AI IN SALT AND SEA WATER[a] (Continued)

Identity	Applied Stress MPa	ksi	%YS	Seacoast F/N Time (Mo)	AI Salt Water F/N Time (Mo)	AI Sea Water F/N Time (Mo)
				7075-T651		
6.4 cm (MS)	110	16	25	5/5 [illegible].2(4),0.6	9/9 0.1(3),0.2(4),0.5,0.8	9/9 0.1(4),0.2(4),0.3
	220	32	50	4/4 0.1(4)	6/6 0.1(5),0.2	6/6 0.1(6)
				7075-T7351		
6.4 cm (AC)	205	29.5	50	0/8		
	305	44	75	0/8		
	405	59	100	2/7 25,35		
7.6 cm (KA)	210	30.5	60	0/8		
	300	43	85	0/8	2/3 1.5,2.1	0/3
	350	51	100		1/3 2.8	0/3
	405	59	115	0/8		
				7475 T7351		
5 cm (AC)	305	44	75	0/5	1/3 2.9	0/3
	405	59	100	0/5	2/3 1.7,2.9	0/3
				7475 T7351		
7.6 cm (KA)	185	27	50	0/7		
	280	40.5	75	0/8	0/3	0/3
	370	51	100	0/8	1/3 2.6	0/3

F/N Ratio of number of specimens that failed to number exposed.

AC Alcoa, KA Kaiser, MS MSFC, RM Reynolds

Note. (a) Total exposure was until failure or 38 months (18 months for 2024 T351 and 7075 T651) for seacoast and three months for AI in Salt and Sea Water.

(b) Total exposure of one month

TABLE 4. PERCENT LOSS IN LOAD CARRYING ABILITY OF UNSTRESSED ALUMINUM ALLOYS

Alloy	Months in Test Seacoast[a] 15	24	38	Months in Test Alt Salt Water[b] 0.5	1.0	3.0	Months in Test Alt Sea Water[b] 1.0	3.0
2024-T351	23,22,29[c]			35	55	87	10	15
2024-T851	20,23		21,27	30	50	75	-	15
2124-T851	5,11,11	10,11,17	4-17(6)	14	23		12	15
2048-T851	8,11,11		13,17					
2219-T87	20,25		19	-	-	70	N	15
7049-T7351	5,8		8,12,12	4	10	35		15
7050-T73651	8,8,11	9,9,15	10-15(5)	9	20	38	8	10
7075-T651	41,45[c]			20	25	45	10	15
7075-T7351	15,16,16	9,10	7-18(7)	5	10	30	N	N
7475-T7351	4,7,10	5,10,12	10-17(5)	4	8	30	N	3

Note: a. When the number of specimens measured exceeded four, the range in percent loss is given and the number of specimens is shown in parenthesis.

b. The percent loss is an average of three specimens.

c. Based on 18 months total exposure.

TABLE 5. COMPARISON OF SCC RESULTS BASED ON SELECTED EXPOSURE PERIODS IN SEVERAL TEST MEDIA

Stress % YS	Seacoast 12 mo	Seacoast 24 mo	Seacoast 38 mo	AI Salt Water 0.3 mo	AI Salt Water 0.7 mo	AI Salt Water 3 mo	AI Sea Water 1 mo	AI Sea Water 3 mo
				2024-T351				
25	3/4	4/4[a]	[a]	0/6	1/6	4/6	2/3	3/3
50	5/5	5/5[a]	[a]	4/5	4/5	5/5	3/3	3/3
				2024-T851				
50	0/5	0/5	0/5	1/3	2/3	3/3	0/3	1/3
75	4/5	5/5	5/5	1/3	3/3	3/3	0/3	3/3
				2124-T851				
50	0/14	0/14	0/14	0/3	0/3	3/3	0/3	0/3
75	5/15	5/15	5/15	1/3	1/3	3/3	0/3	0/3
				2048-T851				
50	0/5	0/5	0/5	0/3	0/3	2/3	0/3	0/3
75	0/5	0/5	3/5	0/3	1/3	3/3	0/3	0/3
				2219-T87				
75	0/5	0/5	2/5	0/17	1/17	3/17[b]	0/4	0/4
100	1/5	5/5	5/5	0/6	0/6	0/6[b]	0/3	[b]

Failure Ratio

TABLE 5. COMPARISON OF SCC RESULTS BASED ON SELECTED EXPOSURE PERIODS IN SEVERAL TEST MEDIA (continued)

Failure Ratio								
Stress % YS	Seacoast 12 mo	24 mo	38 mo	Al Salt Water 0.3 mo	0.7 mo	3 mo	Al Sea Water 1 mo	3 mo
				7075-T651				
25	5/5	5/5[a]	a	7/9	8/9	9/9	9/9	9/9
50	4/4	4/4[a]	a	6/6	6/6	6/6	6/6	6/6
				7049-T7351				
75	0/8	0/8	3/8	0/3	0/3	2/3	0/3	0/3
100	0/8	5/8	7/8	0/3	0/3	3/3	0/3	0/3
				7050-T73651				
65	0/8	0/8	1/8	0/3	0/3	2/3	0/3	0/3
75	0/8	0/8	0/8	0/3	0/3	2/3	0/3	0/3
85	0/8	0/8	0/8	0/3	0/3	3/3	0/3	0/3
100	0/8	0/8	2/8	0/3	0/3	3/3	0/3	0/3
				7075-T7351				
85	0/8	0/8	0/8	0/3	0/3	2/3	0/3	0/3
100	0/7	0/7	2/7	0/3	0/3	1/3	0/3	0/3
115	0/8	0/8	0/8					
				7475-T7351				
75	0/13	0/13	0/13	0/6	0/6	1/6	0/6	0/6
100	0/13	0/13	0/13	0/6	0/6	3/6	0/6	0/6

a. 18 months total exposure

b. One month total exposure

TABLE 6. COMPARISON OF SCC RESULTS SHOWING AGREEMENT AMONG THE TEST MEDIA AT SELECTED EXPOSURE PERIODS

	Failure Ratio[a]			
Stress % YS	Seacoast 12 Mo	AI Salt Water 0.3 Mo	AI Salt Water 0.7 Mo	AI Sea Water 3 Mo
		2024-T351		
25	3/4	0/6		3/3
50	5/5	4/5		3/3
		2024-T851		
50	0/5	1/3		1/3
75	4/5	1/3		3/3
		2124-T851		
50	0/14(3)	0/3		0/3
75	5/15(3)	1/3		0/3
		2048-T851		
50	0/5	0/3		0/3
75	0/5	0/3		0/3
		2219-T87		
75	0/5	0/17		0/4
100	1/5	0/6		
		7075-T651		
25	5/5		8/9	9/9
50	5/5		6/6	6/6
		7049-T7351		
75	0/8		0/3	0/3
100	0/8		0/3	0/3

TABLE 6. COMPARISON OF SCC RESULTS SHOWING AGREEMENT AMONG THE TEST MEDIA AT SELECTED EXPOSURE PERIODS (Continued)

Stress % YS	Seacoast 12 Mo	AI Sea Water 0.3 Mo	AI Sea Water 0.7 Mo	AI Sea Water 3 Mo
		<u>7050-T73651</u>		
65	0/8(2)		0/3	0/3
75	0/8(2)		0/3	0/3
85	0/8(2)		0/3	0/3
100	0/8(2)		0/3	0/3
		<u>7075-T7351</u>		
85	0/8(2)		0/3	0/3
100	0/7(2)		0/3	0/3
115	0/8(2)			
		<u>7475-T7351</u>		
75	0/13(2)		0/6	0/6
100	0/13(2)		0/6	0/6

a. Results are from a single lot of plate unless indicated by a number in parenthesis.

TABLE 7. EFFECT OF STRESS ON LOSS IN LOAD CARRYING ABILITY AFTER THIRTY EIGHT MONTHS EXPOSURE TO KSC SEACOAST

Alloy	Identity	Stress (% Y.S.)	Percent Loss in Load Carrying Ability		
			Range	Average	No. of Specimens
2024-T851	6.4 cm (KA)	0	21,27	24	2
		50	12-76	44	5
2124-T851	5 cm (RM)	0	14,17	16	2
		50	24-25	33	4
		75	39-46	42	3
	6.4 cm (KA)	0	4,6	5	2
		50	19-24	22	4
	10 cm (KA)	0	12,16	14	2
		50	23-36	29	5
		75	26 73	44	5
2048-T851	5 cm (RM)	0	13,17	15	2
		50	28 35	31	4
2219 T87	5 cm (MS)	0	19	19	1
		75	34 84	55	3
7049-T7351	7.6 cm (KA)	0	8 12	11	3
		50	9 25	18	7
		75	33 51	40	3
7050-T73651	5 cm (AC)	0	10,15	13	2
		50	12 23	17	7
		75	12 39	20	8
		100	23 52	33	5
	7.6 cm (KA)	0	11 14	13	3
		45	14 17	16	7
		65	14 24	19	7
		85	13 60	38	5
7075-T7351	6.9 cm (AC)	0	7-18	14	3
		50	23 35	26	7
		75	17 28	21	4
		100	30 55	40	5
	7.6 cm (KA)	0	10,10	10	2
		60	12 26	18	6
		85	15 37	25	8
		115	23 40	30	6
7475 T7351	5 cm (AC)	0	10 16	14	3
		75	11 25	20	4
		100	20 31	24	3
	7.6 cm (KA)	0	10,17	14	2
		50	10 26	19	5
		75	4 18	11	7
		100	13 18	12	6

AC Alcoa, KA Kaiser, MS MSFC Stock, RM Reynolds

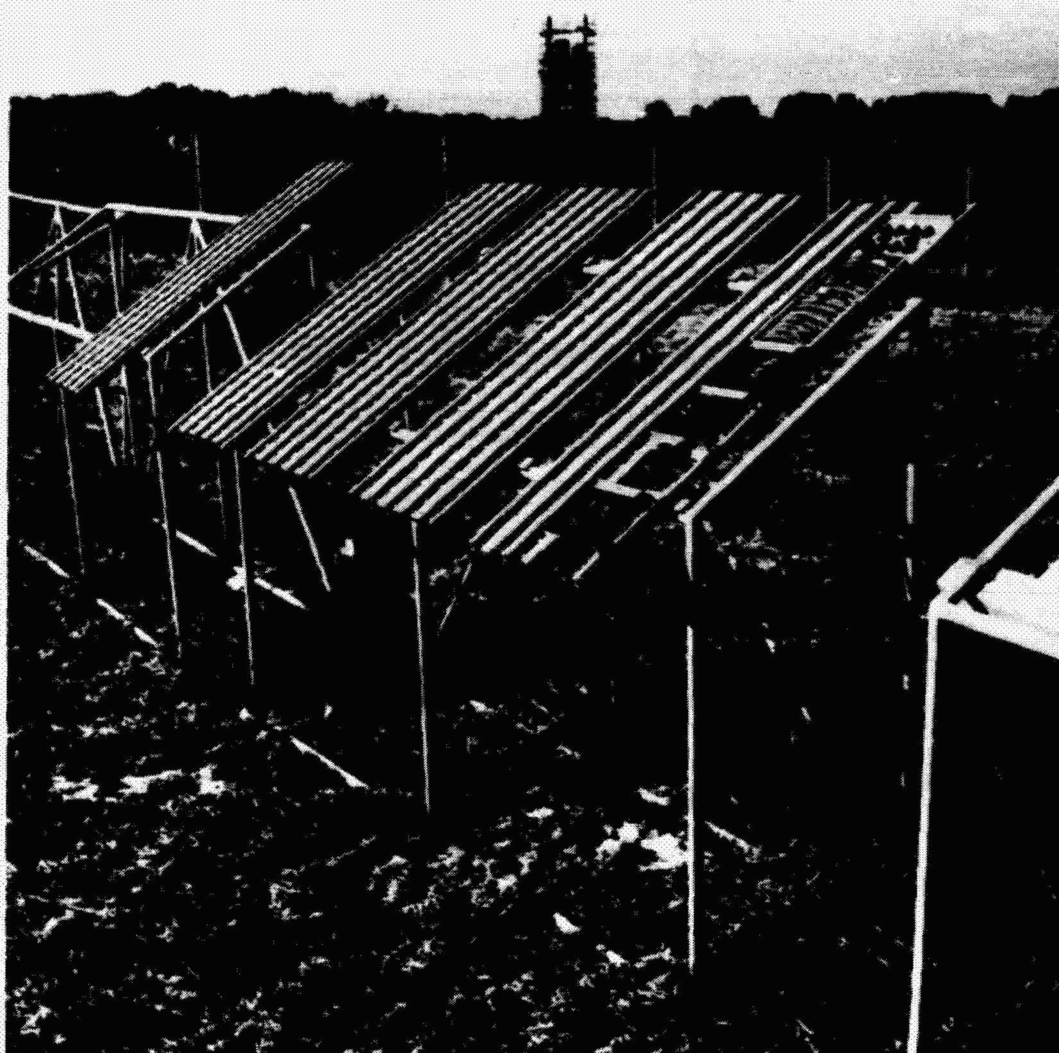

Figure 1. Exposure racks at KSC seacoast with the SCC test specimens in the frames.

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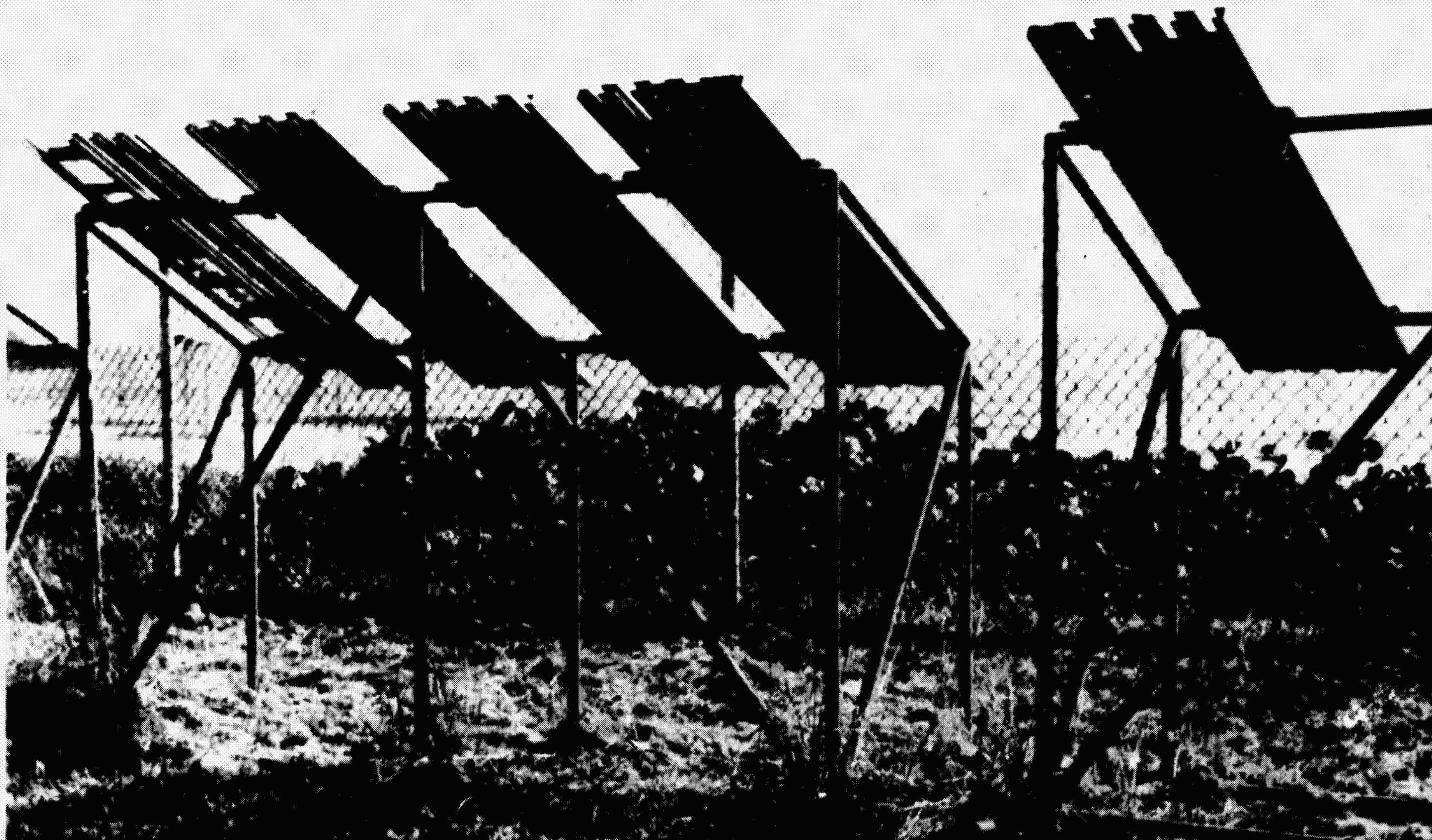


Figure 2. Exposure racks at KSC showing location in respect to the Atlantic ocean.

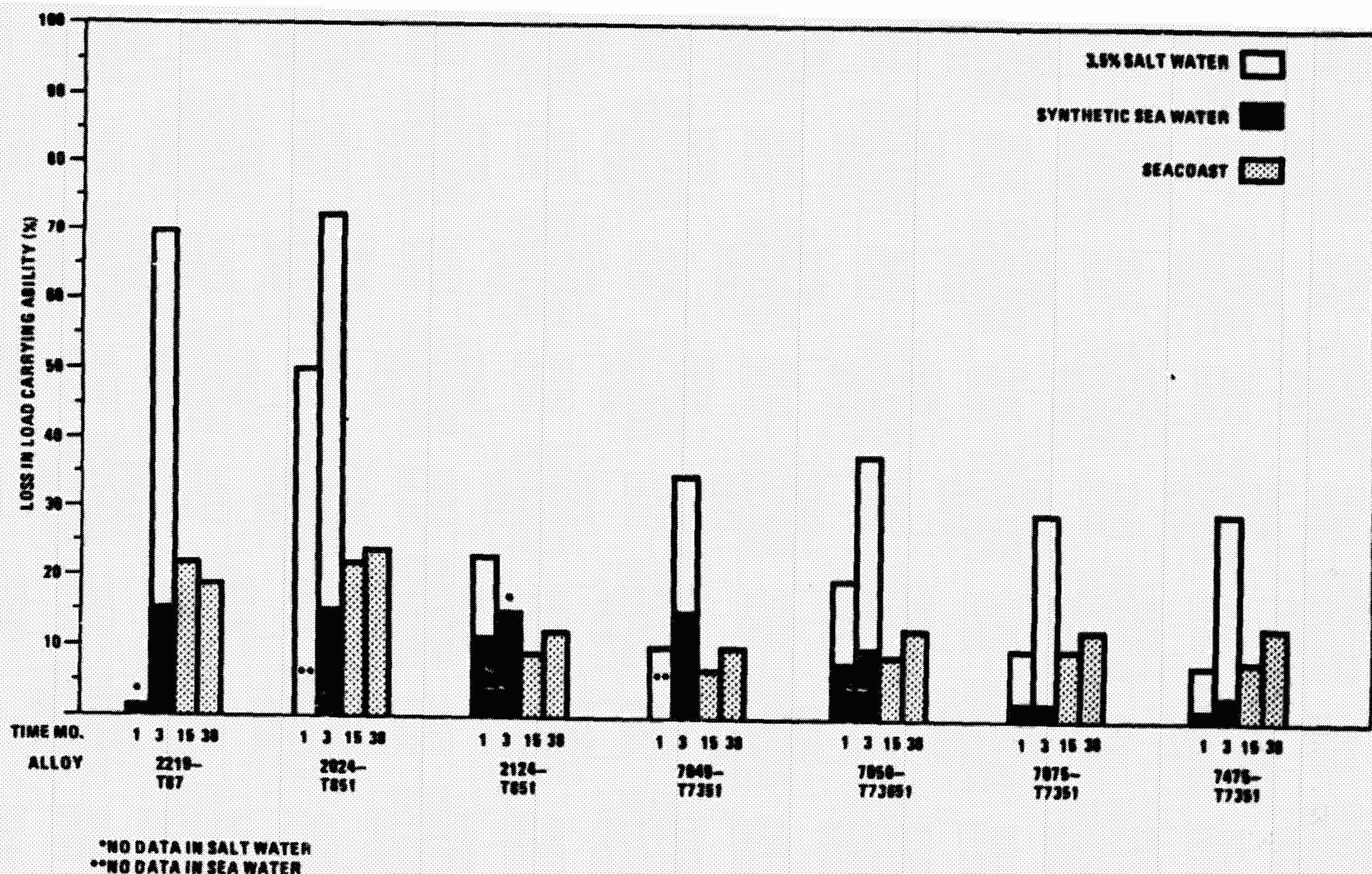


Figure 3. Loss in load carrying ability of unstressed SCC specimens.

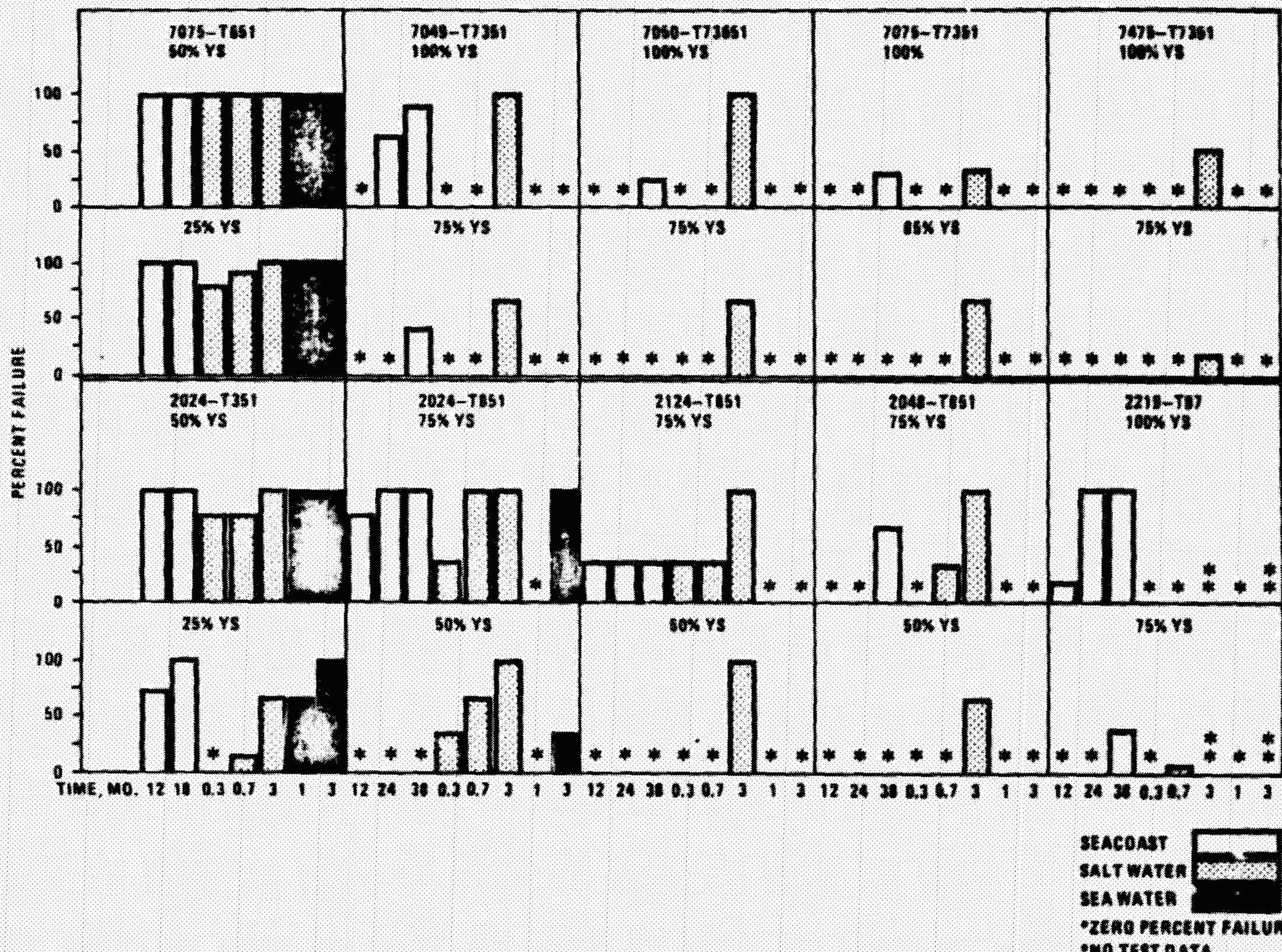


Figure 4. Comparison of SCC results based on selected exposure periods in several test media.

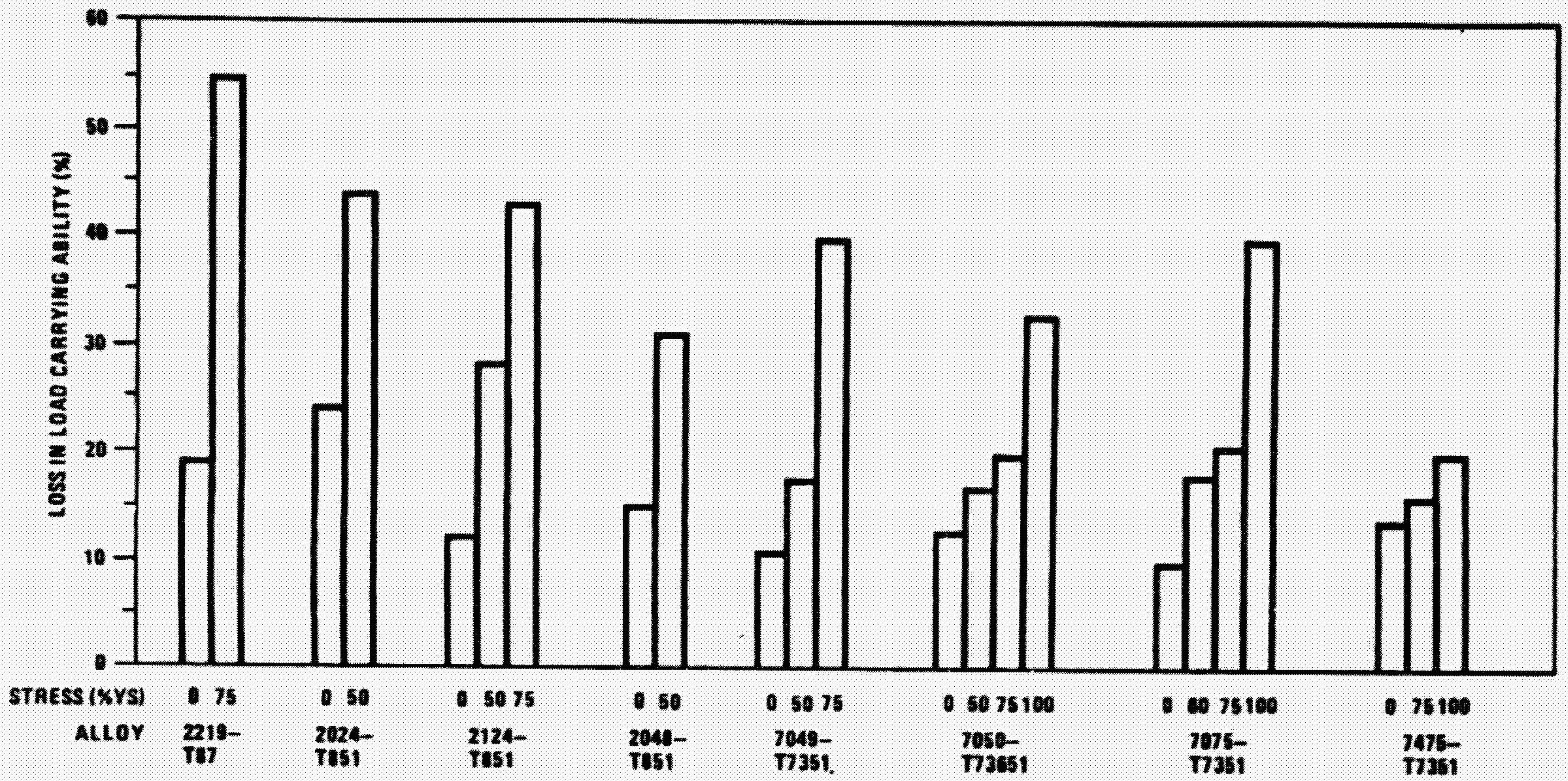
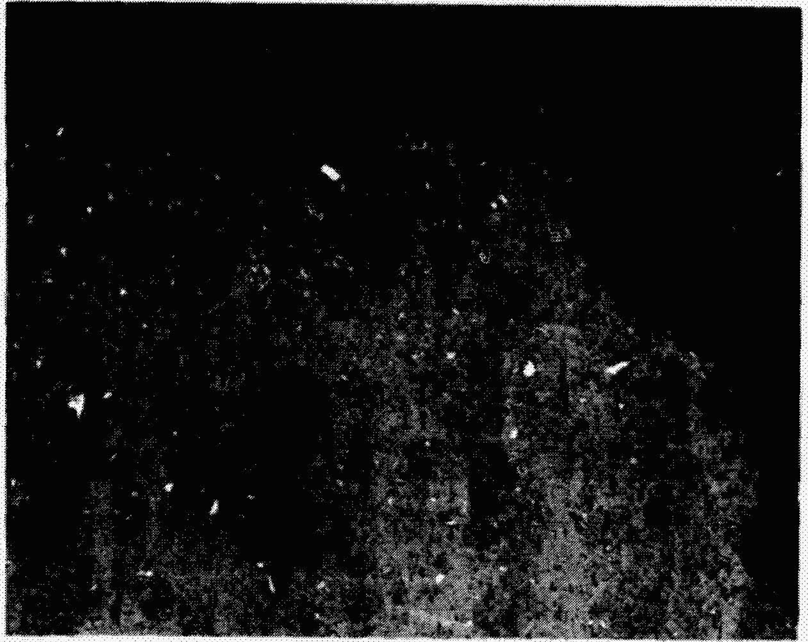


Figure 5. Effect of stress on loss in load carrying ability after 38 months exposure to KSC seacoast.



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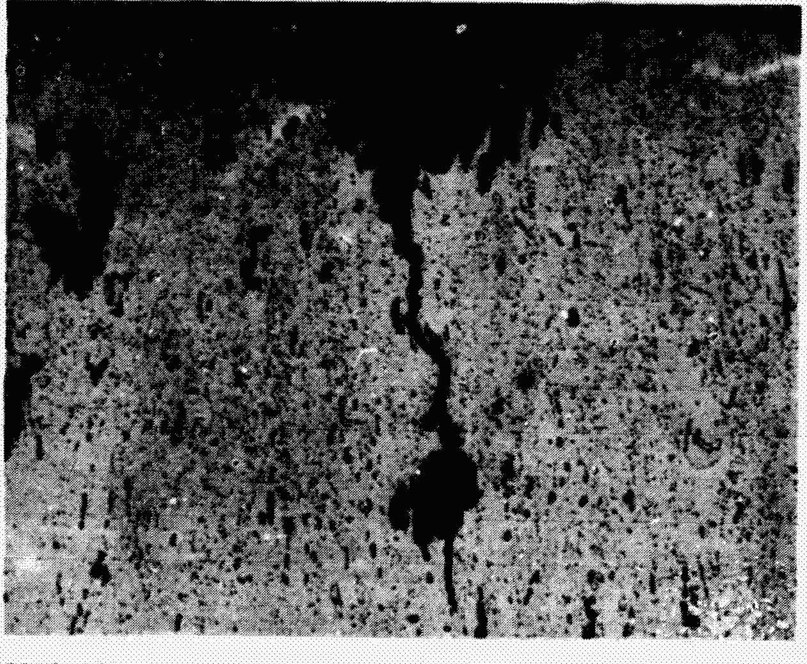
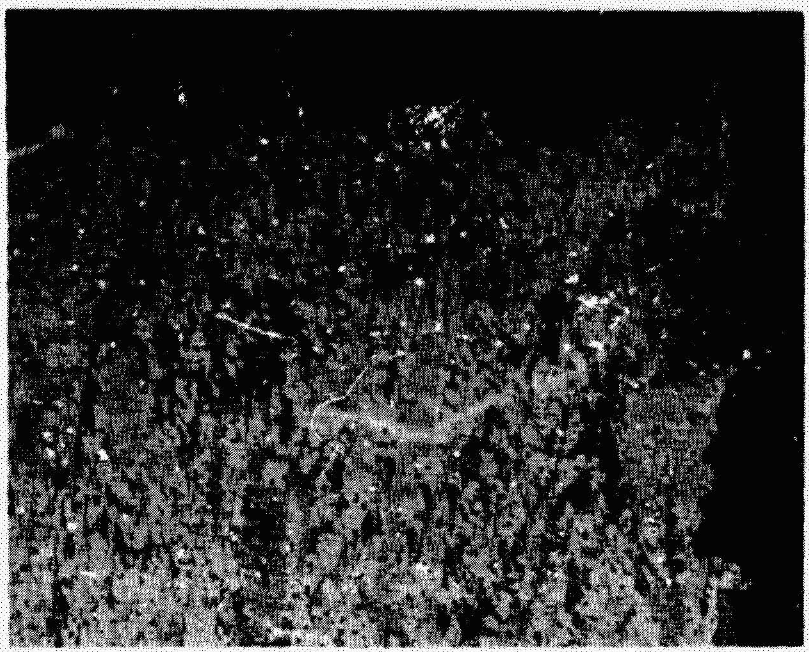


M80-018 200X

Figure 6. Photomicrographs showing the pitting and mixed mode cracking of 2219-T87 stressed to 100% Y.S. and exposed to KSC seacoast.



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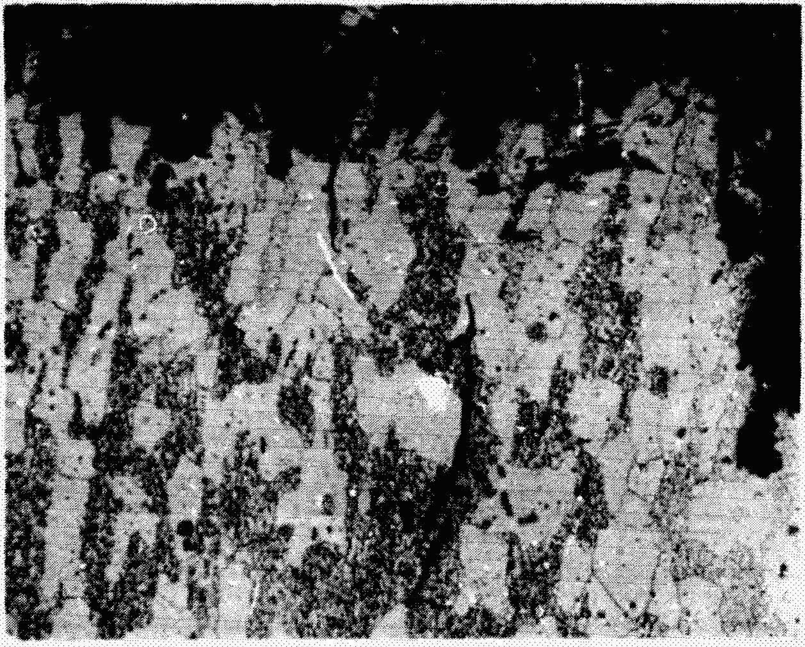
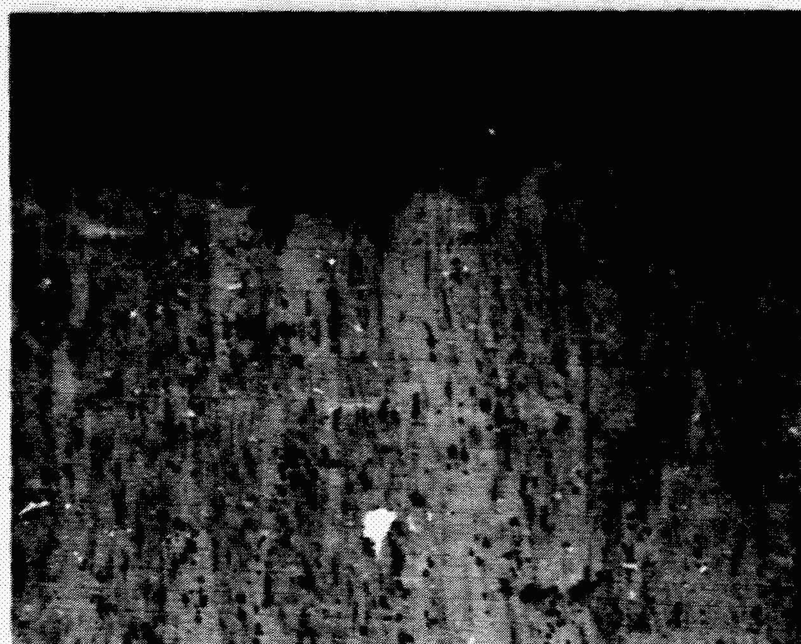
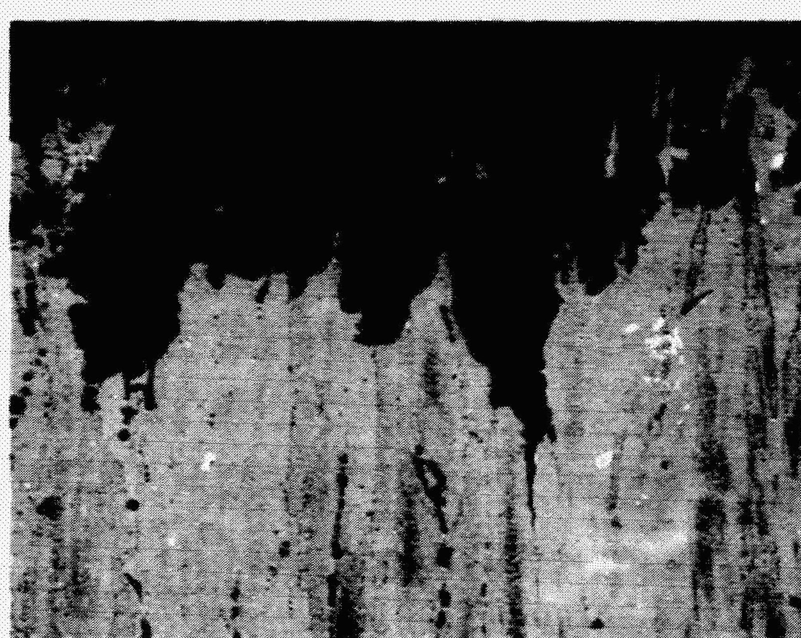


M80-036 200X

Figure 7. Photomicrographs showing the pitting and mixed mode cracking of 7050-T73651 stressed to 100% Y.S. and exposed to KSC seacoast.

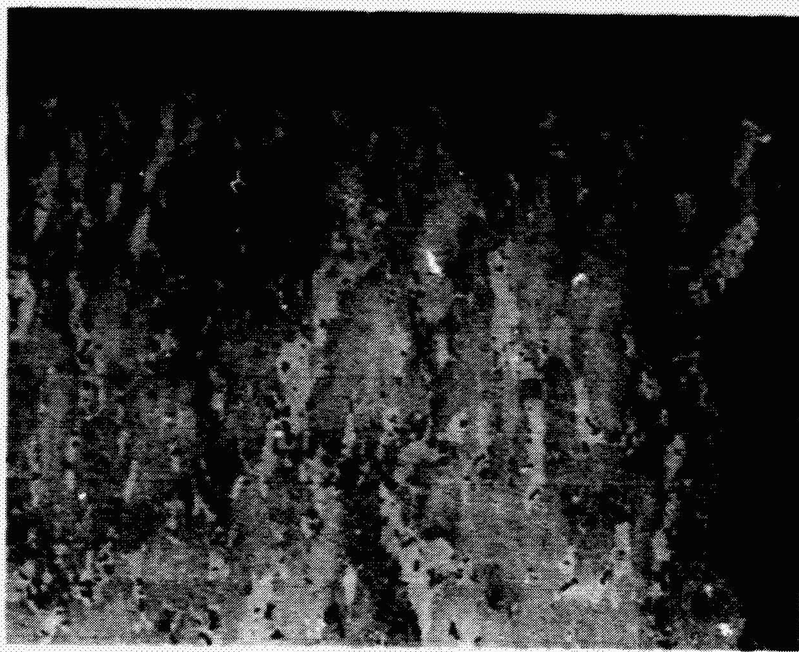


M80-1010 50X

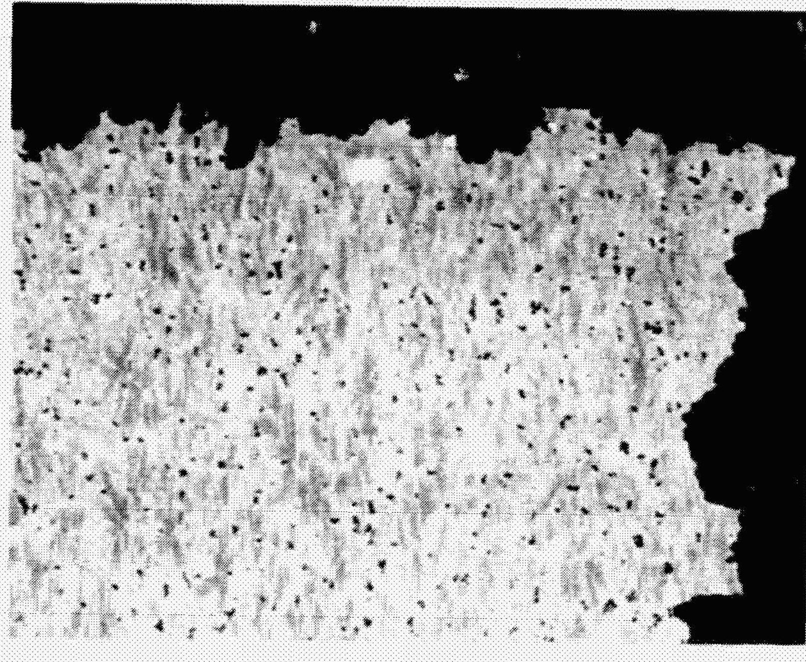


M80-039 200X

Figure 8. Photomicrographs showing the pitting and mild intergranular cracking of 7075-T7351 stressed to 100% Y.S. and exposed to KSC seacoast.



M80-002 2124-T851 50X



M80-008 7075-T7351 50X

Figure 9. Photomicrographs showing the pitting corrosion of two unstressed aluminum alloys exposed to KSC seacoast.

APPROVAL

SEACOAST SCC OF ALUMINUM ALLOYS

By

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The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

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