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~~Aerojet-General~~ CORPORATION

AZUSA, CALIFORNIA

INFORMAL REPORT OF PROGRESS

Copy No.

25

11 January 1962

TO: Commanding General
Frankford Arsenal
Philadelphia 37, Pennsylvania

Attn: ORDBA, Dr. H. Glaser

SUBJECT: Investigation of Stress-Corrosion Cracking
of High-Strength Alloys

CONTRACT: DA-04-495-ORD-3069

PERIOD
COVERED: 1 November through 30 November 1961

This is the twelfth in a series of informal progress reports
submitted in partial fulfillment of the contract.

AEROJET-GENERAL CORPORATION

R. F. Kimpel
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Head, Metallics & Refractories Section
Research and Engineering Dept.
Structural Materials Division

NOTE: The information contained herein is regarded as preliminary
and subject to further checking, verification, and analysis.

I. OBJECTIVES

The objectives of this program are:

A. To study the susceptibility to stress-corrosion cracking of solid-rocket-motor case materials: e.g., Vascojet 1000, Type 300M, and Ladish D6AC alloy steels, AM355 and PH 15-7 Mo stainless steels, and B120VCA titanium

B. To study the environmental parameters, including the atmosphere both inside and outside the rocket case, that affect the rate and extent of stress corrosion

C. To determine the effect of material parameters (composition, strength level, microstructure, surface conditions, etc.) on the stress-corrosion process

D. To devise and evaluate techniques for preventing the stress-corrosion cracking of solid-rocket-motor case materials.

II. WORK PROGRESS

A. BENT-BEAM SPECIMENS

All of the environmental bent-beam stress-corrosion test data compiled to date are summarized in Table 1. These results reflect both completed tests and tests in progress. Six alloys are being evaluated in eleven different environments. Specimens of Ladish D6AC, Type 300M, and Vascojet 1000 alloy steels, AM355 and PH 15-7 Mo stainless steels, and B120VCA titanium alloy are being tested in air, distilled water, tap water, 0.25% sodium dichromate solution, 1% marquench salt solution, 3% sodium chloride solution, trichloroethylene, cosmoline, 4% soluble-oil solution, high humidity atmosphere, and solid propellant.

1. Air

No failures were observed with any of the specimens exposed to laboratory air. The duration of most of the exposure periods was 4 weeks. Some Ladish D6AC and PH 15-7 Mo specimens were exposed for over 17 weeks. Average air temperature in the laboratory was 75°F; the relative humidity averaged 50%.

2. Distilled Water

An environment of distilled water was found to be the most conducive to stress-corrosion cracking. At yield strengths ranging from 235,000 to 250,000 psi, Vascojet 1000 specimens failed in the shortest period of time, generally within a week. Specimens of Type 300M and Ladish D6AC alloys began to fail after 7 weeks of exposure. No failures were noted with the titanium or stainless steel alloys, even after 17 weeks of exposure.

3. Tap Water

Some failures were observed in a tap water environment; however, when compared to distilled water, the number of failures was smaller, and the time before failure was longer. Vascojet 1000 again was the alloy most susceptible to stress-corrosion cracking. The average times-to-failure for specimens with yield strengths ranging from 235,000 to 250,000 psi was 1 to 2 weeks for the Vascojet 1000 alloy, while there were no failures of the Type 300M or Ladish D6AC steels after more than 16 weeks of exposure. No failures were noted with the titanium or stainless steel alloys after the same exposure period.

4. Sodium Dichromate Solution

No failures were observed with specimens exposed to a 0.25% by wt sodium dichromate solution. Exposure times ranged from 3 to 15 weeks. This environment also inhibited surface corrosion on all of the alloys.

5. Marquench Salt Solution

No failures were observed with specimens exposed to a 1% by wt solution of Marquench salts (a mixture of nitrates and nitrites). Exposure times

ranged from 3 to 15 weeks. This environment also inhibited surface corrosion on all of the alloys.

6. Salt Solution

Stress-corrosion cracking of Vascojet 1000 steel occurred after an exposure time of 1 to 2 weeks in a solution of 3% by wt of sodium chloride. None of the other alloys failed in up to 15 weeks of exposure time. The one exception to this was the B120VCA titanium alloy; however, these failures were attributed to faulty specimens rather than to stress-corrosion cracking.

7. Trichloroethylene

Two specimens of one of the alloys tested failed in a tri-chloroethylene environment after exposure times ranging from 3 to 15 weeks. The alloy which failed was B120VCA titanium; these failures were attributed to faulty specimens rather than to stress-corrosion cracking.

8. Cosmoline

All specimens tested in E. F. Houghton's Cosmoline 377, a water-displacing rust preventive, passed exposure periods of 3 to 15 weeks without failure.

9. Four Percent Soluble-Oil Solution

No failures were encountered with any of the specimens tested in a 4% by volume aqueous solution of Chevron's soluble oil. Exposure periods ranged from 3 to 15 weeks.

10. High Humidity

An atmosphere of 100% humidity at 190°F, caused no failure in specimens of PH 15-7 Mo stainless steel in a period of 16 weeks, and AM355 in 2 weeks. Ladish D6AC specimens showed failure times of 1 to 2 weeks at the higher strength levels and no failures in 26 weeks at lower strength levels. Type 300M steel specimens began to fail in less than a week.

11. Solid Propellant

Selected specimens of each alloy were bonded with a solid propellant and subjected to long-term storage at both ambient temperature and at 180°F. Since the testing in this environment has just been initiated, no data is available at this time.

B. U-BEND SPECIMENS

All the environmental U-bend stress-corrosion test data compiled to date are summarized in Table 2. U-bend specimens of Ladish D6AC, Type 300M, and Vascojet 1000 alloy steels are being tested in distilled water, tap water, 0.25% sodium dichromate solution, 1% Marquench salt solution, 3% sodium chloride solution, trichloroethylene, Cosmoline, and 4% soluble-oil solution.

1. Distilled Water

As with the bent-beam specimens, a distilled-water environment was found to be the most aggressive. In the yield strength range of 235,000 to 250,000 psi, Vascojet 1000 specimens failed in about 1 week, while Type 300M and Ladish D6AC specimens failed in 2 to 4 weeks. Failures of all three alloys were observed at the 200,000 psi yield strength level; these failures occurred in 16 to 24 weeks.

2. Tap Water

Failures at the higher strength levels were observed at about the same time they occurred in distilled water. However, at lower strength levels, no failures were recorded in this environment after 24 weeks of exposure.

3. Sodium Dichromate Solution

No failures were observed with any of the specimens tested in an environment containing sodium dichromate.

4. Marquench Salt Solution

No failures were observed with any of the specimens tested in a marquench salt solution environment.

5. Salt Solution

A salt solution environment was about equally as aggressive as was the distilled water. However, the Ladish D6AC alloy was slightly more resistant, since no failures were observed at the 200,000 psi yield strength level after 24 weeks of exposure.

6. Trichloroethylene

Specimens of all 3 alloys at the higher strength levels failed in this environment after about seven weeks. No failures have occurred at the lower strength levels after 24 weeks of exposure.

7. Cosmoline

No failures were observed in the case of specimens tested in a cosmoline environment.

8. Four Percent Soluble-Oil Solution

No failures were observed with any of the specimens tested in a 4% soluble-oil solution.

III. FUTURE WORK

The following future work is planned:

- A. Continuation of the tests already in progress
- B. Completion of the environmental stress-corrosion testing with bent-beam specimens of all the candidate alloys which have been bonded with solid propellant at ambient and at elevated temperatures
- C. Environmental stress-corrosion testing of welded bent-beam specimens of Ladish D6AC, Type 300M, and Vascojet 1000 alloy steels, and B120VCA titanium alloy, in distilled water, tap water, salt water, and high humidity
- D. Screening and evaluation of protective coatings for preventing or minimizing stress-corrosion cracking.

TABLE 1

BENT-15AM 9

Alloy	Yield Strength 0.2% Offset psi x 10 ⁻³	Air		Distilled Water		Tap Water		0.25% Na ₂ Cr ₂ O ₇ Soln.		1% Marquench Salt Soln.		Envir
		No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	3%
Ladish D6AC	197.5	3	NF-28**	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	222.5	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	222.5	-	-	-	-	-	-	-	-	-	-	-
	222.5	-	-	-	-	-	-	-	-	-	-	-
	235.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	235.0	3	NF-121	2	NF-104	3	NF-104	3	NF-104	3	NF-104	3
	235.0	-	-	3	NF-121	3	NF-121	-	-	-	-	-
	235.0	-	-	1	103.8	-	-	-	-	-	-	-
	252.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	252.0	3	NF-121	2	NF-121	3	NF-104	3	NF-104	3	NF-104	3
	252.0	-	-	1	84.0	3	NF-121	-	-	-	-	-
	252.0	-	-	1	95.8	-	-	-	-	-	-	-
	252.0	-	-	1	113.0	-	-	-	-	-	-	-
	252.0	-	-	1	118.7	-	-	-	-	-	-	-
Type 300M	196.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	213.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	213.0	-	-	-	-	-	-	-	-	-	-	-
	213.0	-	-	-	-	-	-	-	-	-	-	-
	233.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	233.0	-	-	1	NF-121	3	NF-121	-	-	-	-	-
	233.0	-	-	1	84.0	-	-	-	-	-	-	-
	233.0	-	-	1	112.0	-	-	-	-	-	-	-
Vascojet 1000	194.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	212.0	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	237.5	3	NF-28	1	7.6	1	15.7	3	NF-21	3	NF-21	1
	237.5	-	-	1	7.8	1	14.7	-	-	-	-	1
	237.5	-	-	1	7.9	1	15.7	-	-	-	-	1
	240.0	3	NF-28	1	1.8	1	3.7	3	NF-21	3	NF-21	1
	240.0	-	-	1	3.7	1	3.8	-	-	-	-	1
	240.0	-	-	1	4.3	1	9.7	-	-	-	-	1
AM355	199.0(T)***	3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49	3
	250.0(L)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	250.0(L)	-	-	3	NF-121	3	NF-121	-	-	-	-	-
	278.5(L)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	278.5(L)	-	-	3	NF-121	3	NF-121	-	-	-	-	-
PH 15-7 Mo	197.5	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3
	237.0	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3
	237.0	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3
B120VCA Titanium	137.5(L)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	137.5(T)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	1
	139.5(T)	-	-	-	-	-	-	-	-	-	-	1
	139.5(T)	-	-	-	-	-	-	-	-	-	-	1
	145.5(T)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	145.5(T)	-	-	-	-	-	-	-	-	-	-	-
	149.0(L)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	158.0(L)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	166.0(T)	3	NF-28	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3
	166.0(T)	-	-	3	NF-121	3	NF-121	-	-	-	-	-

* Stressed to 75% of the 0.2% offset yield strength.

** NF-28 - No failure in 28 days.

*** L longitudinal, T transverse.

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TABLE 1

BENT-BEAM STRESS-CORROSION TEST DATA*

Environment															
Distilled Water		Tap Water		0.25% Na ₂ Cr ₂ O ₇ Soln.		1% Margueneh Salt Soln.		3% NaCl Soln.		Trichloroethylene		Cosmoline		4% Soluble-Oil Sol	
No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
2	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104
3	NF-121	3	NF-121	-	-	-	-	-	-	-	-	-	-	-	-
1	103.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
2	NF-121	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104
1	84.0	3	NF-121	-	-	-	-	-	-	-	-	-	-	-	-
1	95.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	113.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	118.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
1	NF-121	3	NF-121	-	-	-	-	-	-	-	-	-	-	-	-
1	84.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	112.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
1	7.6	1	13.7	3	NF-21	3	NF-21	1	6.9	3	NF-21	3	NF-21	3	NF-21
1	7.8	1	14.7	-	-	-	-	1	10.0	-	-	-	-	-	-
1	7.9	1	15.7	-	-	-	-	1	10.1	-	-	-	-	-	-
1	1.8	1	2.7	3	NF-21	3	NF-21	1	1.2	3	NF-21	3	NF-21	3	NF-21
1	3.2	1	8.8	-	-	-	-	1	1.7	-	-	-	-	-	-
1	4.3	1	9.7	-	-	-	-	1	6.7	-	-	-	-	-	-
3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-121	3	NF-121	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-121	3	NF-121	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109
3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109
3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	1	NF-21	2	NF-21	3	NF-21	3	NF-21
-	-	-	-	-	-	-	-	1	0.004	1	3.4	-	-	-	-
-	-	-	-	-	-	-	-	1	0.03	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
-	-	-	-	-	-	-	-	-	-	1	0.9	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21
3	NF-121	3	NF-121	-	-	-	-	-	-	-	-	-	-	-	-

ngth.

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HEAT-TREAT STRESS-CORROSION TEST DATA*

Environment													
.25% Na ₂ Cr ₂ O ₇ Soln.		1% Marquench Salt Soln.		3% NaCl Soln.		Trichloroethylene		Cosmoline		4% Soluble-Oil Soln.		High Humidity	
No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-181
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	1	NF-181
-	-	-	-	-	-	-	-	-	-	-	-	1	57.0
-	-	-	-	-	-	-	-	-	-	-	-	1	61.7
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	1	23.0
3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	1	23.2
-	-	-	-	-	-	-	-	-	-	-	-	1	26.7
-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	1	5.7
3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	3	NF-104	1	7.0
-	-	-	-	-	-	-	-	-	-	-	-	1	14.2
-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-15
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	1	NF-15
-	-	-	-	-	-	-	-	-	-	-	-	1	3.9
-	-	-	-	-	-	-	-	-	-	-	-	1	6.9
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	1	2.7
-	-	-	-	-	-	-	-	-	-	-	-	1	3.9
-	-	-	-	-	-	-	-	-	-	-	-	1	4.8
-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
3	NF-21	3	NF-21	1	6.9	3	NF-21	3	NF-21	3	NF-21	-	-
-	-	-	-	1	10.0	-	-	-	-	-	-	-	-
-	-	-	-	1	10.1	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	1	1.2	3	NF-21	3	NF-21	3	NF-21	-	-
-	-	-	-	1	1.7	-	-	-	-	-	-	-	-
-	-	-	-	1	6.7	-	-	-	-	-	-	-	-
3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49	3	NF-49	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-15
-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-112
3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-112
3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-109	3	NF-112
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
3	NF-21	3	NF-21	1	NF-21	2	NF-21	3	NF-21	3	NF-21	-	-
-	-	-	-	1	0.004	1	5.4	-	-	-	-	-	-
-	-	-	-	1	0.03	-	-	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	2	NF-21	3	NF-21	3	NF-21	-	-
-	-	-	-	-	-	1	0.9	-	-	-	-	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	3	NF-21	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-

3

Table 1

TABLE 2

U-BEND STRESS-CORROS.

Alloy	Yield Strength 0.2% Offset psi x 10 ⁻³	Distilled Water		Tap Water		0.25% Na ₂ Cr ₂ O ₇ Soln.		1% Marq Salt 8
		No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens
Ladish D6AC	197.5	1	NF-170*	2	NF-170	2	NF-170	2
		1	167.6	-	-	-	-	-
	222.5	1	137.3	2	NF-170	2	NF-170	2
	222.5	1	141.7	-	-	-	-	-
	235.0	1	20.2	1	NF-170	1	NF-170	2
	235.0	1	32.9	1	33.3	-	-	-
	252.0	1	18.4	1	28.9	2	NF-170	1
Type 300M	252.0	1	22.4	1	39.9	-	-	-
	196.0	1	NF-170	2	NF-170	2	NF-170	2
	196.0	1	111.7	-	-	-	-	-
	213.0	1	18.4	2	NF-170	2	NF-170	2
	213.0	1	34.9	-	-	-	-	-
	233.0	1	14.9	1	22.4	2	NF-170	2
	233.0	1	34.9	1	29.1	-	-	-
Vascojet 1000	194.0	1	NF-170	1	140.7	2	NF-170	2
	194.0	1	140.7	1	163.4	-	-	-
	212.0	1	14.7	1	60.4	2	NF-170	2
	212.0	1	141.7	1	69.4	-	-	-
	240.0	1	4.4	1	7.4	2	NF-170	2
	240.0	1	11.4	1	19.5	-	-	-

* NF = No failure in 170 days.



U-BEND STRESS-CORROSION TEST DATA

Environment										
Cr ₂ O ₇ Soln.	1% Marquench Salt Soln.		3% NaCl Soln.		Trichloroethylene		Cosmoline		4% Soluble-Oil Soln.	
Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)	No. of Specimens	Time to Failure (Days)
NF-170	2	NF-170	2	NF-170	2	NF-170	2	NF-170	2	NF-170
-	-	-	-	-	-	-	-	-	-	-
NF-170	2	NF-170	2	NF-170	2	NF-170	2	NF-170	2	NF-170
-	-	-	-	-	-	-	-	-	-	-
NF-170	2	NF-170	1	62.4	2	NF-170	2	NF-170	2	NF-170
-	-	-	1	116.3	-	-	-	-	-	-
NF-170	1	NF-170	1	18.5	1	NF-170	2	NF-170	2	NF-170
-	-	-	-	-	1	46.9	-	-	-	-
NF-170	2	NF-170	1	NF-170	2	NF-170	2	NF-170	2	NF-170
-	-	-	1	149.4	-	-	-	-	-	-
NF-170	2	NF-170	1	11.3	1	49.9	2	NF-170	2	NF-170
-	-	-	1	40.9	1	56.1	-	-	-	-
NF-170	2	NF-170	1	11.3	2	NF-170	2	NF-170	2	NF-170
-	-	-	1	26.3	-	-	-	-	-	-
NF-170	2	NF-170	1	NF-170	2	NF-170	2	NF-170	2	NF-170
-	-	-	1	49.9	-	-	-	-	-	-
NF-170	2	NF-170	1	15.7	2	NF-170	2	NF-170	2	NF-170
-	-	-	1	53.3	-	-	-	-	-	-
NF-170	2	NF-170	1	4.3	1	46.9	2	NF-170	2	NF-170
-	-	-	1	6.8	1	46.9	-	-	-	-

2

Table 2