



Alloys Used in an Aerospace Launch Environment

Rust 2003

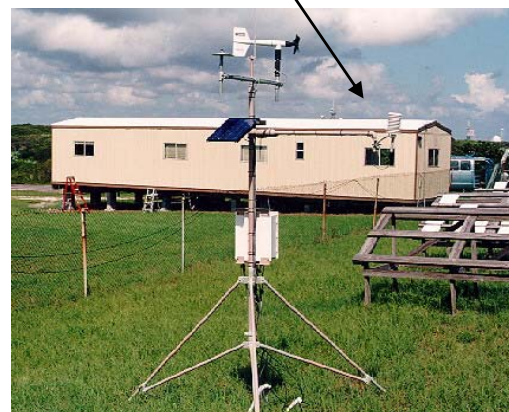
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KSC Beach Corrosion Test Site

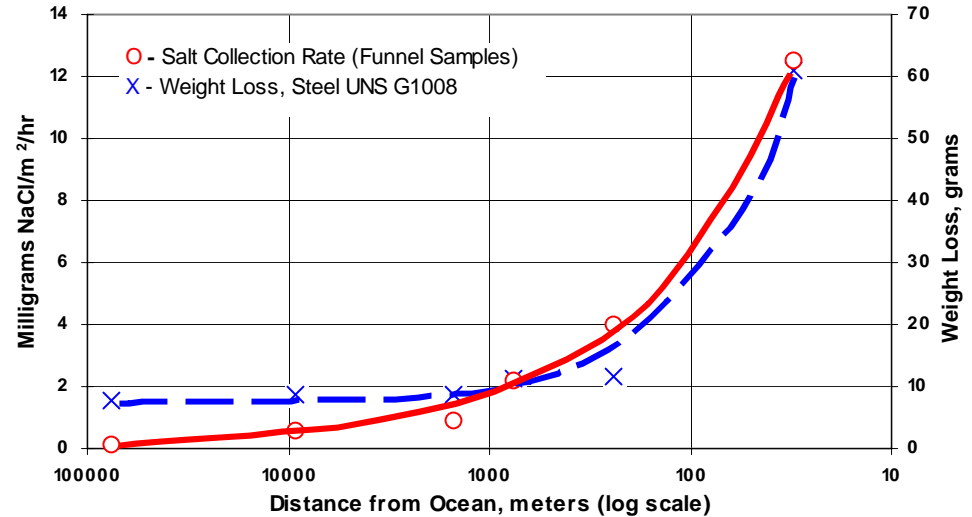
- Site actively maintained for over 35 years.
- Historical database is very helpful for evaluation of new materials.
- Side-by-side commercial coating test and evaluation is conducted for inclusion in NASA coating standards.
- Site instrumented for complete weather information.
- On-site laboratory performs real time atmospheric and immersion corrosion investigations.
- Network connectivity is available for data acquisition and real time video by the internet.





KSC Beach Corrosion Test Site

Location	Type Of Environment	$\mu\text{m}/\text{yr}$	Corrosion rate (a) mils/yr
Esquimalt, Vancouver Island, BC, Canada	Rural marine	13	0.5
Pittsburgh, PA	Industrial	30	1.2
Cleveland, OH	Industrial	38	1.5
Limon Bay, Panama, CZ	Tropical marine	61	2.4
East Chicago, IL	Industrial	84	3.3
Brazos River, TX	Industrial marine	94	3.7
Daytona Beach, FL	Marine	295	11.6
Pont Reyes, CA	Marine	500	19.7
Kure Beach, NC (80 ft. from ocean)	Marine	533	21
Galeta Point Beach, Panama CZ	Marine	686	27
Kennedy Space Center, FL (beach)	Marine	1070	42



- **ASM documented this site as one of the most corrosive naturally occurring environments.**



Corrosion Resistant Tubing Materials

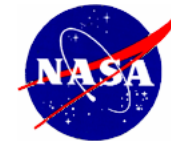
- **304 stainless steel tubing is susceptible to pitting corrosion and stress corrosion cracking (SCC).**
- **Tubing replacement hopes to:**
 - **Increase service lifetime**
 - **Improve safety**
 - **Diminish maintenance costs**
 - **Reduce downtime losses**



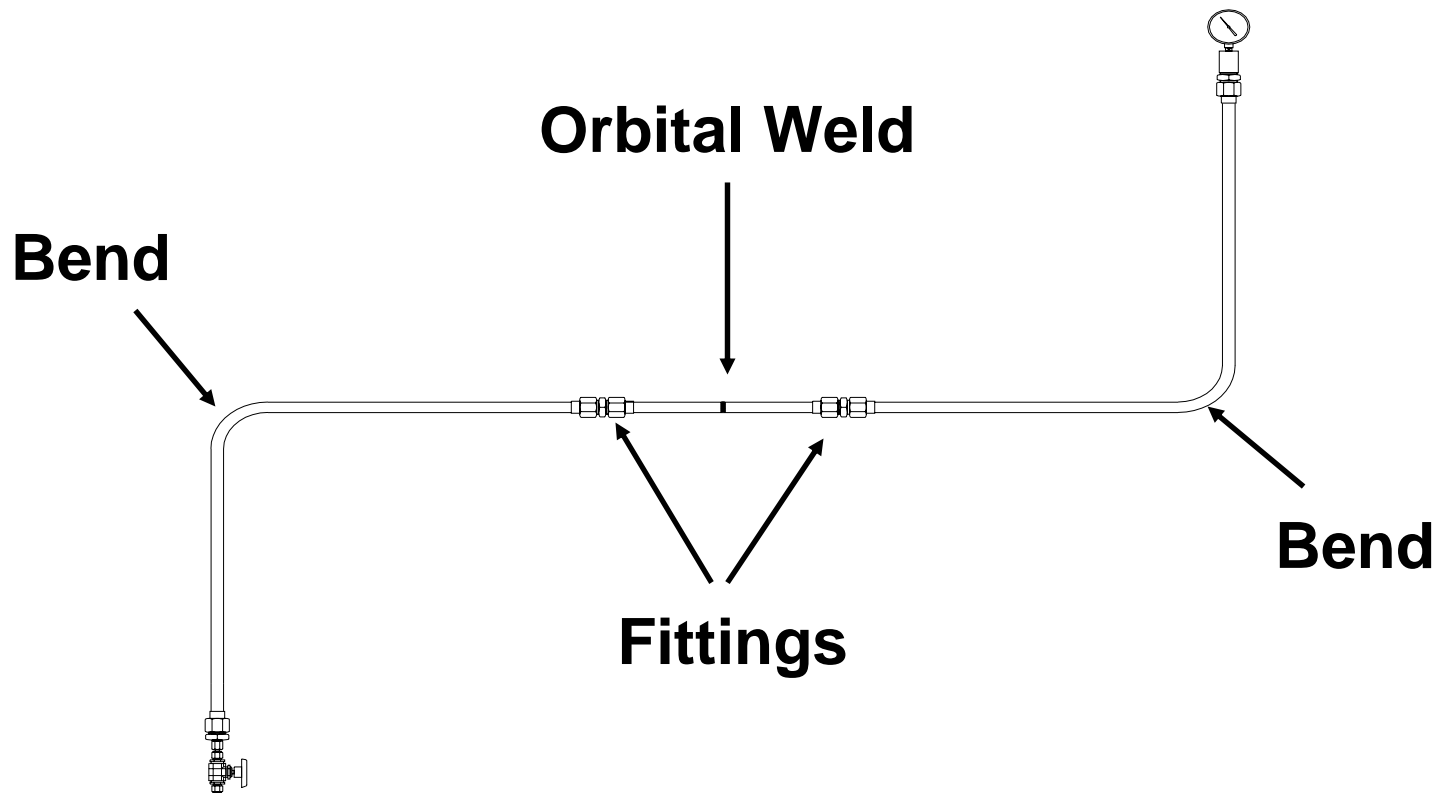


Tubing Materials Investigated

Material	Class
254 SMO	Austenitic stainless steel
304L	Low carbon austenitic stainless steel
C-2000	Nickel-chromium-molybdenum alloy
317L	Molybdenum-containing austenitic stainless steel
AL6XN	Superaustenitic stainless steel
316L	Molybdenum-bearing austenitic stainless steel
2205	Ferritic-austenitic (duplex) stainless steel
C276	Nickel-molybdenum-chromium-iron-tungsten alloy
625	Austenitic nickel-bases super alloy
AL29-4C	Superferritic stainless steel
2507	Ferritic-austenitic (duplex) stainless steel

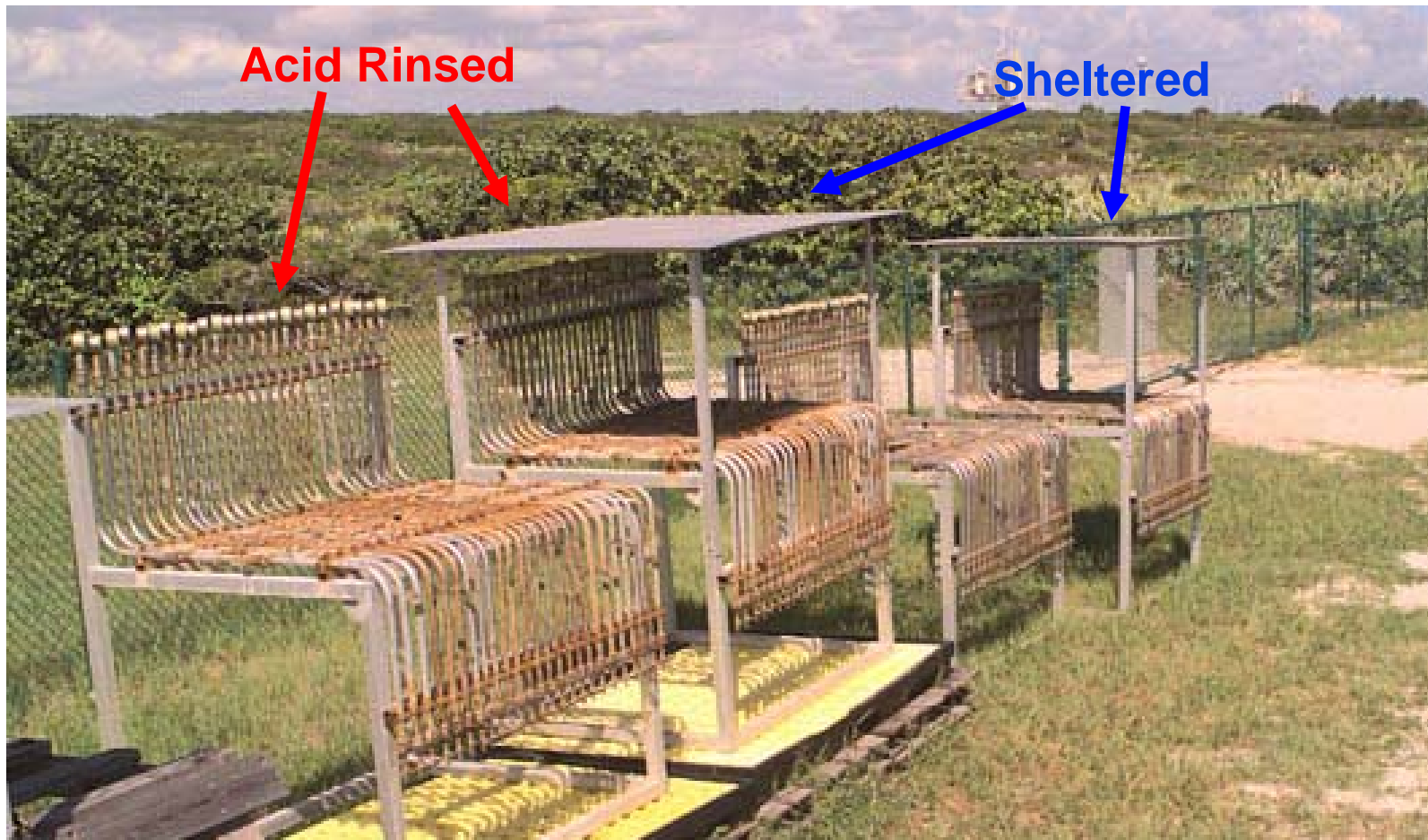


Fabrication of Tubing Samples





Exposure Conditions

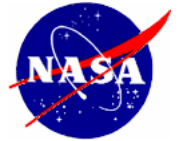




Results of Environmental Exposure

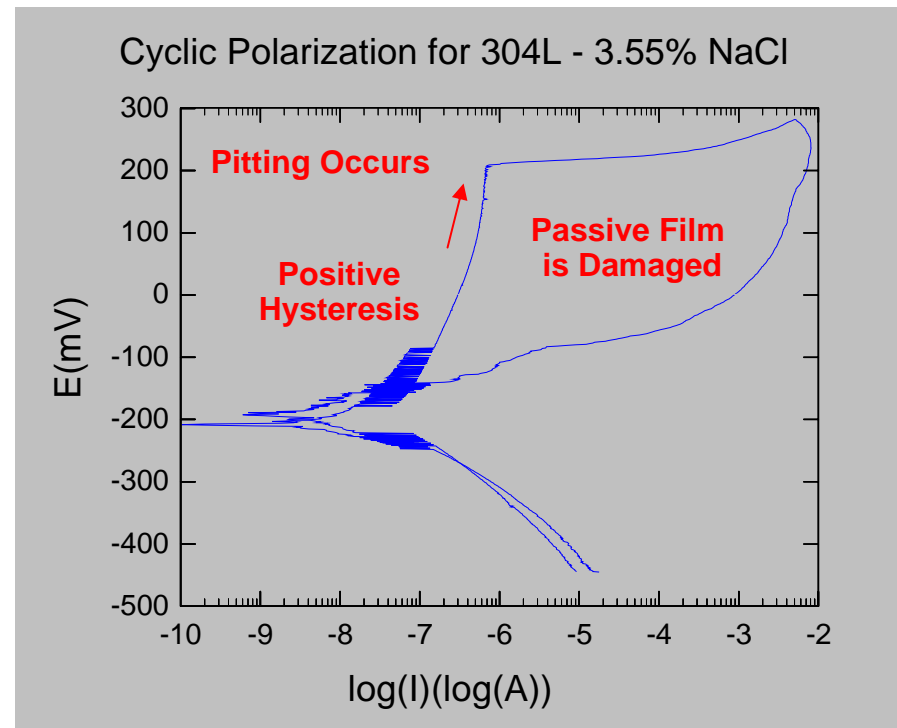
- **304L and 316L displayed inadequate corrosion resistance in the KSC launch environment**
- **Pitting corrosion caused both the 304L and 316L alloys to leak in less than 2 years**
- **The AL6XN alloys displayed improved corrosion resistance in the KSC launch environment**





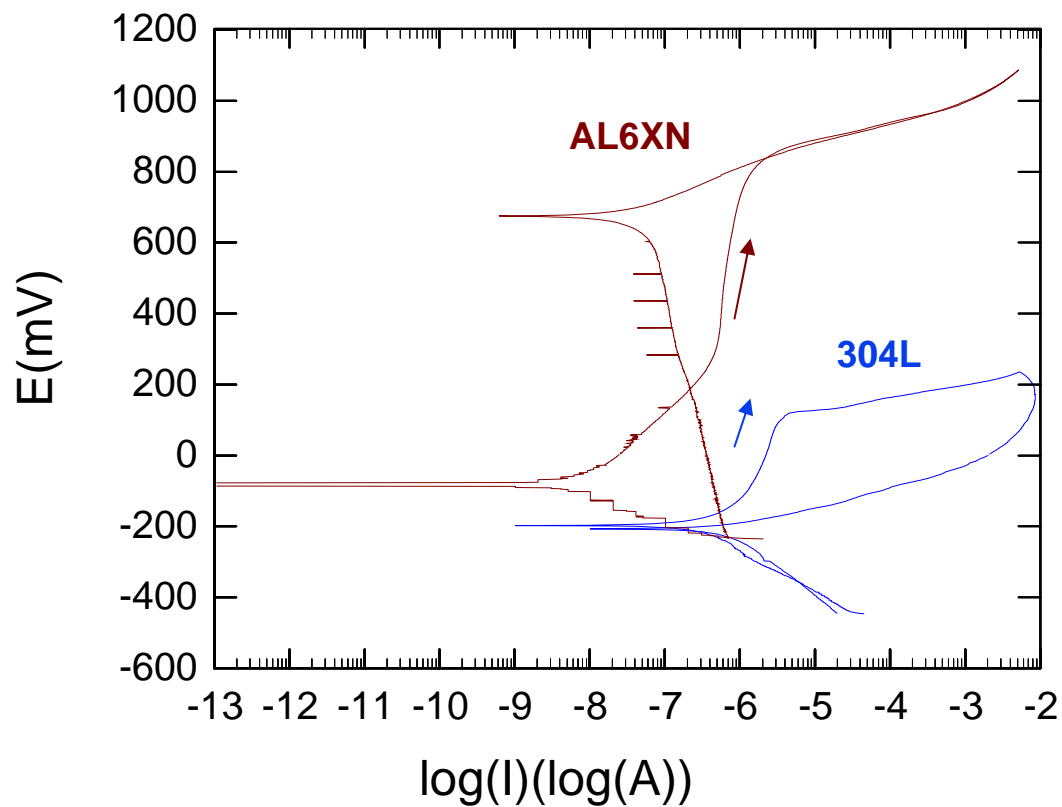
Electrochemical Investigation of the Corrosion Behavior of Metal Alloys in the STS Launch Environment

- DC and AC electrochemical methods of analysis were used in conjunction to atmospheric exposure
- Marine and launch pad conditions were simulated
- A correlation between the electrochemical and atmospheric exposure at the beach corrosion test site was made





Cyclic Polarization Scans of 304L and AL6XN (3.55% NaCl and 0.1N HCl)





Conclusions

- Alloy qualification is still in progress
- AL6XN was chosen as the replacement alloy



Corrosion Technology **Testbed**

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KSC Web Site

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