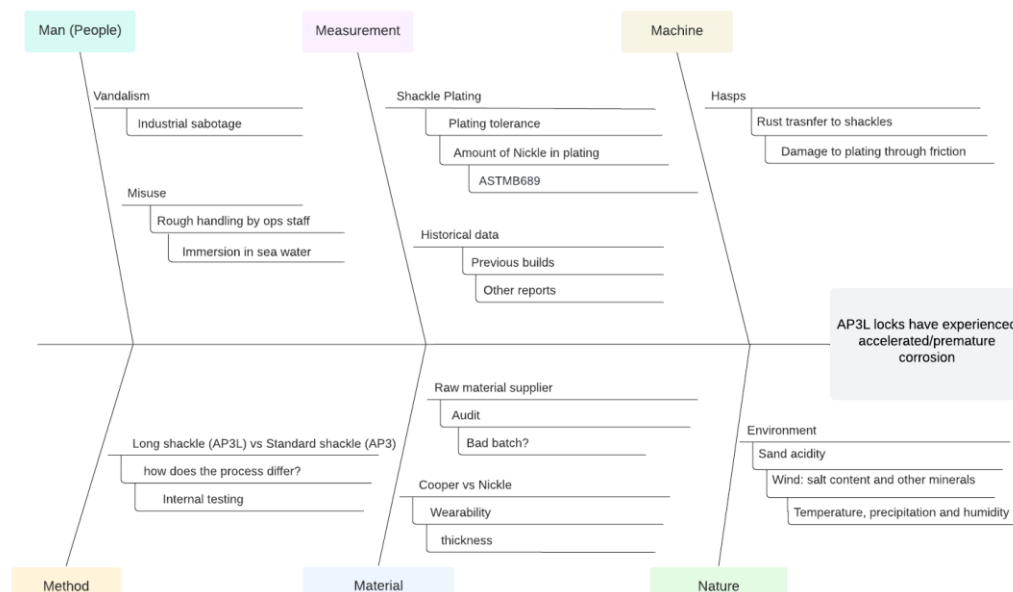


8D Report: Corrosion on AP3 with Long Shackles

0	Prepare Why does this problem require an 8D?	In response to a customer complaint, elevated levels of corrosion were observed on AP3 Long Shackle (AP3L) padlocks. While gradual corrosion is anticipated over time, particularly in coastal regions subjected to salty air, the extent of corrosion reported by the customer exceeded expectations.
1	Assemble Team Team should have the knowledge, skill, and authority to solve the problem and implement corrective actions.	Who is on the team: Jerod Klink, CTO Daniel Galeano, Product Management Adam Lucier, Product Development (Inertia – ODM partner) Goals & Objectives: Reproduce the issue. Determine the root cause, incidence, severity and implement preventive measures in future production.
2	Describe the Problem What is the problem? What is the problem scope? Why is this a problem? Who is affected? Who is not? What provides us with certainty?	A customer reported elevated levels of corrosion on 2% of AP3L padlocks deployed to coastal areas. While the majority exhibited cosmetic rust, 7% of the affected padlocks experienced mechanical malfunctions attributed to severe corrosion. 
3	Interim Containment What immediate actions do we take to contain the problem and limit impact?	• All padlocks identified in the reports were replaced, including those still operational but exhibiting cosmetic rust. • To ensure comprehensive coverage, the warranty for corrosion-related issues on deployed AP3L locks has been extended. • Production of long shackles in Build 9 was paused before assembly to implement corrective measures for subsequent production runs.
4	Identify Root Cause Use a 5-whys methodology, a fishbone diagram or other root cause process.	A fishbone methodology was employed to brainstorm and ascertain potential causes. This involved conducting measurements at third-party laboratories via electron microscope observation to validate the plating thickness and chemical composition of different padlock shackles, including samples from competing solutions.

	
5 Identify Solutions What are the possible solutions? Identify the best. Address the root cause. What Permanent Corrective Actions will we take?	After conducting fishbone analysis and reviewing the results, the proposed solution was to improve the plating process of the AP3L shackles by implementing a double dipping methodology, aiming to achieve the following: • Augmented nickel-plating thickness by a minimum of 5.5 μm • Enhanced plating tolerance through the introduction of an extra plating layer • Improved coating distribution to ensure comprehensive protection of all shackle surfaces by adjusting the dipping angle during the second coating process.
6 Validation Verify that the solution is working as expected. Check for undesirable side-effects.	• 196-hour salt-spray test was conducted, simulating 8 years of mild outdoor exposure. A comparison between the enhanced plating and the original coating confirmed the increased resistance to corrosion, yielding successful results, as demonstrated below in the images below. • Validated plating properties as designed and expected with electron microscope observation. 10 samples with original plating and 10 samples with the enhanced plating were tested in a 196-hour salt-spray test. <u>Original Plating Results</u> as supplied prior to January 2024  Original Plating: BEST  Original Plating: WORST <u>Enhanced Plating Results</u> shipping January 2024  Enhanced Plating: BEST  Enhanced Plating: WORST • The supplied shackles with the original plating showed too much variation in corrosion performance, where some of the locks with original plating were not up to the demands of the environment. • The worst sample with the enhanced process reports better results than the best sample in the old process.

7	Prevention What improvements in systems and processes will prevent this and similar problems from recurring?	Enhanced quality processes have been implemented to: • Verify shackle plating specifications in each production batch • Conduct audits of shackle and raw material suppliers • The production process has been revised to adopt the new shackle plating as the standard.
8	Congratulate the Team	Team disbanded and resolution complete on: November 10th, 2023.

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