

8D Report: Water Ingress

0	Prepare Why does this problem require an 8D?	Two customers in the same specific geography reported extreme levels of unexplained product failure (up to 30%). 25% of the failures exhibit obvious signs of water ingress. Given that our locks are designed and intended to be used outdoors, we are concerned to see water in the locks.
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, Director of Customer Experience Konrad Hammel, Director of Hardware Engineering 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 certainty?	The customer started reporting 30% AP3 failures 4 months after successfully deployed padlocks. 25% of these failures were characterized by ‘padlock doesn’t close’, while also exhibiting signs of water ingress after inspection. The problem has been identified in applications with high access frequency (> 5 accesses per day) in areas with high humidity (>95%) and rain.
3	Interim Containment What immediate actions do we take to contain the problem and limit impact?	We have replaced the AP3 padlocks in distributor inventory where this problem seems to be prevalent. We have also halted the production of AP3 Build 9 prior to assembly so that we can address this issue in subsequent production.
4	Identify Root Cause Use a 5-whys methodology, a fishbone diagram or other root cause process.	Why did a recently deployed AP3 stop working? <i>Because users couldn’t close them as the shackle did not relock when pushed down.</i> Why didn’t the AP3 shackle relock when pushed down? <i>Because the motor sensor was damaged.</i> Why was the AP3 motor sensor damaged? <i>Because water ingress had damaged the sensor through corrosion.</i> Why did water leak inside the AP3 padlock? <i>Due to capillary effect at the base of the AP3 shackle. Minimal water ingress could take place if the shackle is opened several times a day while enough water is accumulated at the base of the shackle.</i> Why was this not qualified earlier? <i>The water-resistance design was focused on the padlock in a locked state. The design didn’t originally consider the water-resistance of the padlock when opening/closing.</i> We remember that this occurrence of quality issues is limited to a specific couple of customers in one geography. While we follow this process, we don’t know why this set performed worse.

5	Identify Solutions What are the possible solutions? Identify the best. Address the root cause. What Permanent Corrective Actions will we take?	An additional rain hat seal has been designed to avoid water ingress due to capillary effect. We could send a service notice to our customers advising that they should brush or absorb any standing water at the shackle before opening a lock. We could drill new drainage holes that would minimize the chance of standing water at the shackle rain hat. We decided to go with the rain hat seal with confidence that it will solve this issue because it is a solution that can be implemented during the manufacturing process. We could not guarantee that customer would remove standing water from the padlock, and we run the risk of drain holes becoming plugged with debris negating the effect.
6	Validation Verify that the solution is working as expected. Check for undesirable side-effects.	The following tests have been performed successfully to re-validate the IP rating of AP3 padlocks with the added rain hat seal. - Humidity testing using an aggravated cycle (MIL-STD-810G 507.5) - Salt spray with 240hrs exposure at 5% concentration - IP66 - IPX8 Additional water pooling tests were carried to reproduce water ingress due to capillary effects, and to validate effectiveness of additional rain hat seal.
7	Prevention What improvements in systems and processes will prevent this and similar problems from recurring?	Additional rainhat seal is expected to eliminate water ingress due to capillary effects. Half of build 9 will be produced with the seal and half without. Sera4 has full tracking on which units have the seal, so we will have real-world data to verify that this solution improved real-world quality and reliability of AP3.
8	Congratulate the Team	Additional rainhat seal is still undergoing and will be included in build 9.

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