

Dr. Fastener

Red and White “Rust” and Other Questions Related to Salt Spray Testing

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Q1

Sometimes I see a part print that refers to the part needing to resist white or red rust for a specified number of hours. What does this print requirement mean?

Anytime that you see a requirement that states a part must go a specified number of hours before exhibiting white or red “rust”, it is communicating the minimum required outcome of some form of accelerated corrosion test. In most cases, that test will be a Neutral Salt Spray Test.

Q2

What is a Neutral Salt Spray Test?

A: Salt spray testing was developed over a hundred years ago. It is a severe test that pits parts against a heated mist that is, by weight, 5% salt and 95% deionized water. We all recognize through personal experience that things corrode more quickly in a saltwater environment. Therefore, that is what this test was designed to simulate. In the early days, the percentage of salt was very high, while modern day test procedures have significantly lowered it to 5% by weight salt. Although that may not sound like a lot, keep in mind that the average percentage of salt in sea water is about 3.5%. It is called a “neutral” salt spray test because the salt solution is prepared to be pH balanced between about 6.5 and 7.2, which is generally considered to be neutral or in other words neither acidic nor basic. In a salt spray test, test samples are placed inside a chamber where temperature and salt mist composition are carefully controlled. The environment is highly corrosive, and parts may begin to corrode very quickly, thus producing a genuine accelerated corrosion test.

Q3

What is the difference between White Rust and Red Rust?

Although it is routinely referred to as “white rust”, this is slightly misleading. This powdery white substance that forms on some parts in the salt spray chamber is actually a form of zinc salt. It is primarily zinc hydroxide that forms on newly galvanized steel surfaces that are exposed to moisture and oxygen. It is, in fact, a corrosion product that results from the depletion of the protective zinc coating. Red rust is the reddish-brown corrosion product (Fe_2O_3) that forms when steel is exposed to moisture and oxygen. Thus, **the white rust is exclusively a corrosion product of zinc plating and the red rust of the base steel. Parts that have platings or coating devoid of zinc would not be expected to exhibit white rust.** However, on parts that do have platings and coatings containing zinc, the white rust requirement will always be lower than the red rust requirement because the zinc components in the plating or coatings sacrifice prior to the base metal.

Q4

What does it mean that parts achieve the specified number of hours?

A: Again, the test is designed to keep parts exposed to a continual salt spray mist. The test chamber is normally only opened once a day to add or remove test samples and to monitor the test itself. This is normally for only about fifteen to thirty minutes a day. Test samples that are in the chamber are reviewed for the beginning of white or red rust. The first appearance of

these corrosion products is noted. Test samples remain in the test chamber until the minimum number of hours without exhibiting white or red rust is satisfied. If the parts are able to endure the chamber without developing red or white rust in the specified minimum time requirements, then the parts pass the test.



Q5

What happens if a part passes one of the corrosion product requirements but not the other?

In short, **if the part has a zinc derivative coating, then it must pass both the white and red rust requirements to pass the test.** For example, let's say that the print specification was for 24 hours to white rust and 72 hours to red rust. Further, let's say the parts formed white rust at 32 hours and red rust at 60 hours. Although the parts met the white rust requirement, they did not meet the red rust requirement and thus, failed the test.

Q6

Must a plating or coating specification require white and red rust limits?

Not necessarily. Remember that white rust is actually a zinc salt. Therefore, it will not form in the absence of zinc, so that platings and coatings which do not contain zinc will not produce white rust. However, even if the part has a plating or coating containing zinc, the specification may not always call out a white rust requirement. Usually they do, but it is not mandated, especially if the designer is only concerned about the ultimate corrosion of the base steel layer.

Q7

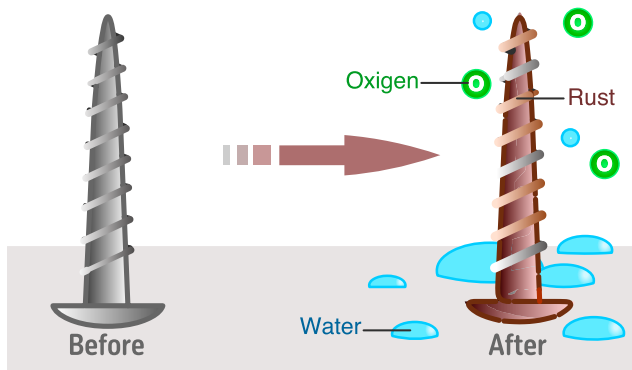
Is there a difference between white rust and the white haze that many parts develop during salt spray testing?

A: Yes, the white haze is essentially just a light surface deposit of salt from the salt mist. White rust is quite distinctive from this grayish-white haze. White rust is usually bright white and powdery in form. Whereas the white haze will generally be relatively consistent across the entire part, white rust, like red rust forms only where active corrosion is taking place, and will, thus, be relatively localized.

Q8

How many days, months, or years of corrosion protection will we get relative to a salt spray hour on parts in the real world?

No one knows. There is no correlation between a specified number of salt spray hours and how long the actual part will endure its environment before forming white or red rust. In fact, it is quite possible that a part will start to corrode in the field relatively quickly even if it is specified with a high level of salt spray hours. Thus, there is no real relevancy to the salt spray test with respect to actual real-world performance. **Generally speaking, it is likely, although not guaranteed, that a plating or coating specified with more salt spray hours will endure longer in the real world than one with fewer salt spray hours, but no designer or manufacturer can know for sure.**



Q9

I have seen some standards refer to “significant surfaces”- what does this mean?

Certain locations on a part might be more vulnerable than others to quickly form corrosion products. For example, sharp corners and the tips of threads may experience handling damage or lower amounts of plating and coating build-up than continuous flat surfaces like the top of the head or an unthreaded shoulder. In such cases, the standards might be written to identify the areas on the part that are expected to perform at the level written in the standard. These are called significant surfaces. If the standard addresses significant surfaces, it will identify which ones they are and provide guidance whether or not the salt spray hour requirements only apply to these surfaces. **It is important to understand if the standard narrows performance to only significant surfaces because, if it does, white or red rust formation on non-significant surfaces should not be grounds for test failure.**

Q10

Are there other accelerated corrosion tests?

Yes, although Neutral Salt Spray is clearly the most popular and utilized of the accelerated corrosion tests. **In the automotive world, cyclic testing is gaining popularity and entails a special test chamber that exposes parts to iterative cycles of heat, humidity, and salt spray.** These tests are not necessarily any more predictive of real-life performance.

Wrap-up

Accelerated Corrosion testing is a complicated and often controversial topic. It is important, therefore, for fastener manufacturers and suppliers to understand how requirements and test methodology is addressed in the standards, so that they can properly educate their customer on what to expect from these tests. ■

