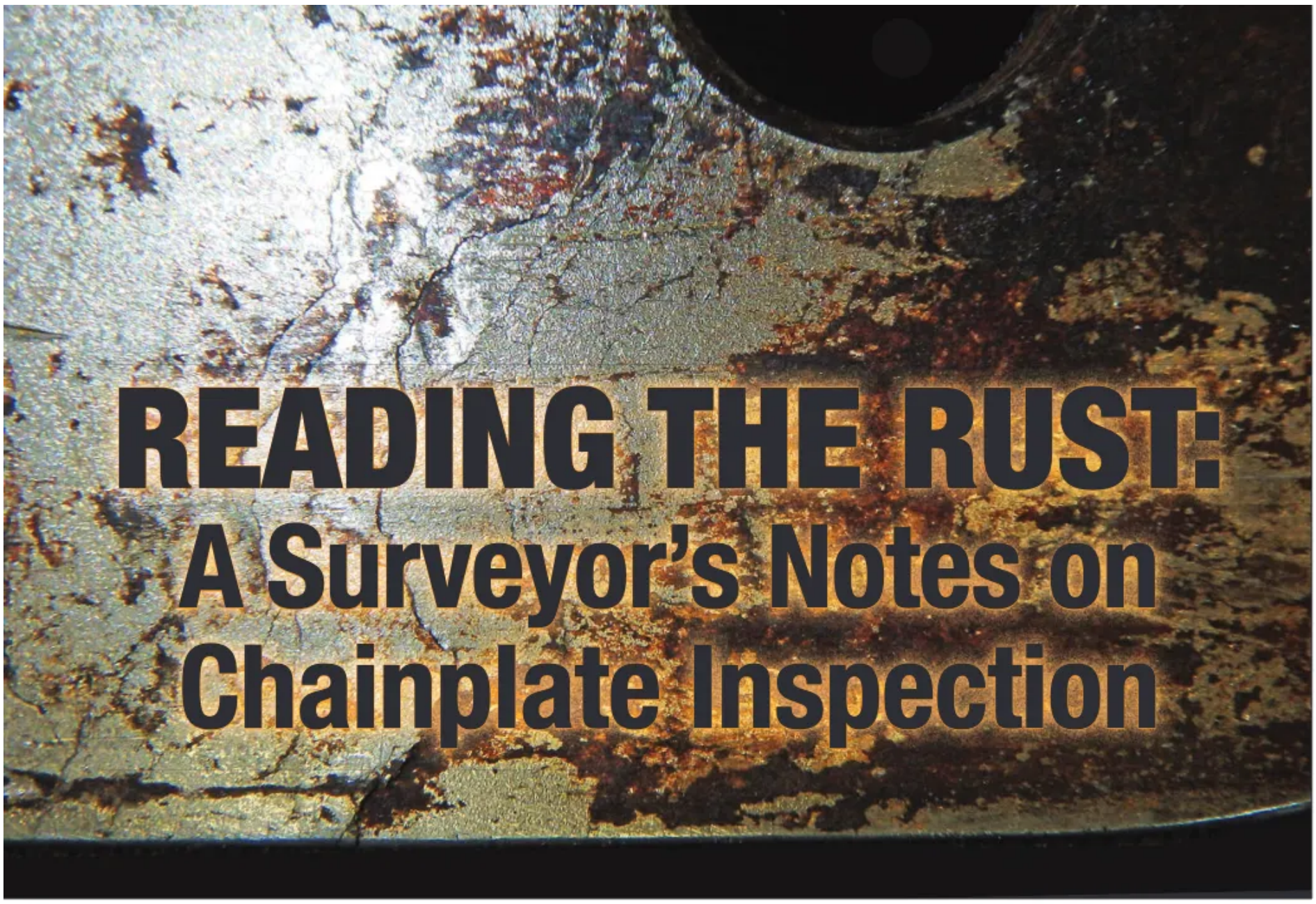


READING THE RUST: A Surveyor's Notes on Chainplate Inspection

Catastrophic rig failures are frequently the result of detectable and avoidable flaws in worn or corroded metal chainplates. When in doubt, remove them for thorough inspection and possible replacement.

Text and photographs by Dylan Bailey

Most yacht surveyors have experienced some variation of this scenario: During lunch at a favorite restaurant in St. Augustine, Florida, our waitress, knowing I am a marine surveyor, asked if I would talk with her boyfriend, the restaurant owner, about the chainplates on his sailboat. She had just helped him sail his 1978 Cheoy Lee yawl from St. Petersburg to St. Augustine, and the passage hadn't gone smoothly. On the Gulf of Mexico, with idyllic 10–15 knots of wind and small seas, the port midship chainplate broke and pulled up through the deck. Then the wooden mainmast crashed down, damaging the deck. As the boat owner later told me, "My girlfriend or my other crew could have been terribly hurt." Fortunately everyone was fine, and they continued on their way after lashing what was left of the rig to the deck.

At his request I visited the boat to inspect the remaining chainplates. As I had feared, they appeared to be original and in need of replacement. The fact that they had been painted over and rust stains were visible was a red flag, but to an owner who's under the common misconception that stainless steel is indestructible and lasts forever, this appeared as nothing more than staining. After my visual inspection I recommended that the chainplates be removed; and their removal revealed corrosion a lot more serious than surface staining.

In every sailboat more than 25–30 years old—and all too frequently on boats as new as 15—I find at least one corroded or cracked chainplate. The worst chainplate corrosion tends to be on boats used most of the year, in areas of salt water and mild temperatures, where environmental conditions are conducive to corrosion and deferred maintenance.

***Above**—Stainless steel is not flawless. Close inspection of aging chainplates reveals that deferred maintenance and hard use have allowed pitting and corrosion, which can weaken these essential rig attachment points.*
***Facing page**—Chainplate removal is often the only way to show the full extent of corrosion where the plate passes through the deck or registers against the hull or a bulkhead.*

On most sailboats built in the past 40 years, chainplates are stainless steel, a metal particularly vulnerable to stress cracks and crevice corrosion. Stress cracks can be visible above deck, while crevice corrosion, caused by a lack of oxygen over an extended period of time and exposure to salt water, is commonly found where chainplates pass through the deck and are fastened against the hull and bulkheads. (For more on stainless steel, see Steve D'Antonio's "The Power and Peril of Stainless," *Professional Boat-Builder* No. 146.)

During surveys, particularly of older, mostly wooden boats, I sometimes encounter bronze chainplates. While I've never seen them fail, they are vulnerable to age and wear and should be closely inspected. I've also seen a recent trend of titanium as a material for replacement chainplates (see the **sidebar** on page 54). And on high-performance sailboats, carbon fiber integral to the hull's laminate structure is increasingly being used for chainplates.

Conventional stainless steel chainplates are installed by a variety of methods:

- bar stock passing through the deck and through-bolted to a knee or bulkhead
- external-mounted bar stock through-bolted to the hull
- bar stock or a combination of rod and bar stock embedded in the fiberglass hull laminates
- deck fittings connected with a tie-rod to a lower fitting either bolted to a structural member or glassed to the hull.

As sailboats age, all stainless rigging fittings become potential problems, but chainplates present the most common problems on the boats I survey and are the most frequently overlooked by surveyors and riggers. Part of this comes from confusion over who is responsible for these essential rig attachment points. Many surveyors will say, "Chainplates are part of the rigging. I recommend a rigger inspect them." Just as many riggers assure me, "They are part of the hull; the surveyor should inspect them." I agree with both assertions. Not only are chainplates part of the hull that the rigging attaches *to*, because they are attachment points I also consider them to be part of the rigging as well. Riggers *and* surveyors alike need to pay close attention to them. In addition, any employee working in a service yard has a role to play. I remember working in boatyards and spending days or weeks on a single sailboat. Wouldn't I have been the perfect person to notice any telltale sign of corrosion? I saw signs of water intrusion, repaired the damaged varnish, replaced caulking around deck penetrations, but never thought to inspect the actual chainplates. Like many of those working in yards 20 years ago, I didn't know any better. I was among those who believed that stainless steel was impervious to corrosion.

My thinking changed 10 years ago when I started reading about and seeing the results of chainplate failures. Now I see chainplates as everyone's responsibility. The risk of total rig failure is too high for any marine professional to ignore. For riggers, chainplate inspections need to be part of any rig inspection. Riggers should not assume that if a sailboat has been recently surveyed, the marine surveyor inspected the chainplates. Even

The surveyor should not rely on the boat owner to hire a rigger for an inspection, even if that is the surveyor's written recommendation.

***1**—Take photographs with a camera set on macro and then magnify them on a computer screen to reveal cracks missed by a visual inspection in the field. **2**—Remove surface rust with a nylon scouring pad to show any underlying pits and cracks. **3**—Small cracks or rust blooms on the edges of a plate likely indicate greater problems between the stainless steel and the hull. **4**—A chainplate may appear sound at the rig attachment point but be entirely destroyed under the deck where moisture was held against it without oxygen.*

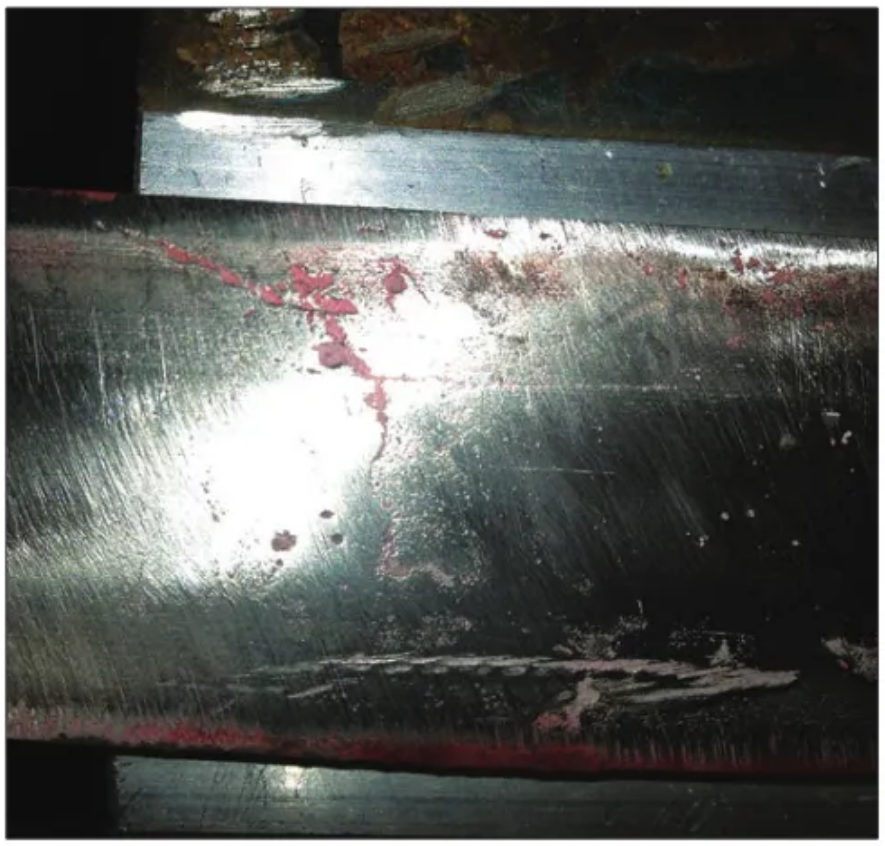
though I agree with recommending that a rigger inspect chainplates and other rigging parts of a sailboat, I also believe the marine surveyor should pay close attention to all accessible rigging components. The surveyor should not rely on the boat owner to hire a rigger for an inspection, even if that is the surveyor's written recommendation. In places where masts are unstepped and the boat derigged at the end of each sailing season, I recommend that the boatyard's rigger perform a full rigging survey, including the chainplates, on all sailboats.

Anyone working on sailboats should be aware of the signs of water intrusion in chainplate areas belowdecks. If the chainplates are visible from below, look for signs of corrosion, rust, or rust stains. On deck, be aware of cracked or missing caulk around chainplates' entries into the deck, and any rust or corrosion visible on the chainplate. When these signs are evident, notify the boat owner that a close inspection requires pulling the chainplates.

Inspection Techniques

Visual. The following inspection can be performed by riggers, surveyors, and boatyard staff. Start on deck and visually inspect all chainplates, regardless of the metal. On sailboats more than 20 years old, I frequently find cracks and corrosion on the chainplates above decks. Where you see rust, remove it with a nylon scouring pad (Scotch-Brite), and then inspect the chainplate closely through a magnifying glass for signs of crevice corrosion (pitting) and stress cracks. Take photos with a camera set on macro, and view the images later on a computer screen or tablet. I have found cracks in an image magnified on a screen that I missed when I was on the boat. Pay close attention to exterior-mounted chainplates where they are fitted against the hull; corrosion will often develop there, concealed between the plate and the hull. Small cracks or rust blooms will be visible on the sides or edges of the chainplates.

Below the deck, signs of water intrusion are the easiest things to spot. To do a thorough inspection, you'll need to remove any cabinetry that conceals the chainplates and can be removed with screwdrivers. Some boats have easily removable inspection covers that permit access to critical hardware like chainplates. If access is not easy enough to allow for a visual inspection belowdecks during a survey, the surveyor's report



***Left**—For rod attachments, in addition to inspecting the plate that affixes to the hull, sight down the rod itself for signs of corrosion.* ***Above**—Dye-penetrant testing requires thorough cleaning of the metal before applying dye and developer to expose the smallest cracks and pits.*

should reflect that. And if you see signs of water intrusion, such as staining, or if the chainplates have not been pulled in 10 years, you should recommend their removal for closer inspection.

If you are able to gain access to the section of the chainplates below-decks, then the inspection process is the same as above deck. However, lighting and visibility are often poor down below. You'll need flashlights, and a camera is helpful in those hard-to-reach areas (for more on illumination for surveyors, read "Seeing in the Dark," PBB No. 158, page 48). Even if you find no cracks or corrosion on the sides of a chainplate, the edges warrant close inspection. As with chainplates mounted on the outside of the hull, discussed above, corrosion will often develop on the backsides of chainplates that register against a bulkhead or hull below-decks, and show signs on the sides.

Probably the area of greatest risk for chainplate failure is neither above nor below deck but precisely where a chainplate penetrates the deck. Here, water collects and persists, the fitting may be subjected to bending stresses, and the area remains stubbornly out of sight. Of course, without pulling the chainplates it's impossible to determine their condition in these vulnerable areas. But a visual inspection is a start and better than no inspection at all.

I have also observed frequent failures at the area just below the deck. On some sailboats, this area is covered by trim, which conceals signs of corrosion that might have prompted earlier chainplate replacement. Another relatively common area of failure is at any bolt hole in the chainplate, above or below deck.

If any cracks, pitting, or heavy corrosion are visible above or below deck, the afflicted chainplates need to be replaced. I stress to my customers that to allow for close inspection, *all* stainless steel chainplates should be pulled by backing out fasteners and completely removing the plates from the hull. I don't agree with the school of thought that only one chainplate needs to be pulled for inspection, and the condition of the other fittings can be inferred from that single inspection.

For U-bolts and rod attachments, look at the edges of the backing of the U-bolt chainplate for signs of corrosion. Sight down along the rod, keeping an eye out for crevice corrosion. Inspect the attachment point to the hull, and where the fitting is glassed into the hull, for signs of rust weeping and any cracks in the fiberglass.

Dye-penetrant testing. If all chainplates are pulled and reveal no visible cracks or corrosion, then you should subject them to dye-penetrant testing to confirm the absence of cracks. Dye-penetrant testing is a three-part process of applying cleaner, dye, and developer to a surface. First, remove any rust from the chainplates and apply the dye. Follow the directions on the can for dry times. Remove the dye with a clean rag; then apply the developer. When the developer is applied, any cracks will become visible. I always take photos of cracks or pitting found in this inspection (for more on dye-penetrant testing, see "Correcting Flawed Forestay Chainplates," PBB No. 157, page 112).

Chainplates embedded in glass laminate adhered to the hull present some inspection challenges that mechanically fastened surface-mounted versions do not. You should still carry out a visible inspection where possible, looking for signs of water intrusion. Sometimes these signs will be visible downstream of where the chainplate is located in the laminate as the moisture runs down the hull surface.

If you identify any water intrusion, the chainplates should be removed.

***Left**—Thermal imaging reveals moisture trapped around a chainplate glassed into the fiberglass hull. The result means the chainplate must be removed and replaced. **Right**—The inside surface of the same section of hull reveals no visual sign of the likely chainplate corrosion.*

Thermal imaging. It's difficult to see a chainplate that's enshrouded in fiberglass and resin. This is where non-destructive testing helps. About two years ago, the technical director of BoatU.S. asked me if thermal imaging would help determine the condition of embedded chainplates. Although I hadn't tried that particular application of thermal imaging at the time, it seemed to work in finding trapped moisture, which is the real problem for embedded chainplates. If there is salt water around stainless steel without oxygen, then there will be corrosion and degradation.

To inspect embedded chainplates employing thermal imaging, the boat

Stainless Steel versus Titanium

Confronted with the need to replace chainplates, the surveyor must consider what material would best serve the owner and the boat. In the current market, with the price of titanium becoming increasingly affordable, the question comes down to whether this corrosion-resistant, super-strong metal is a good option for your customer. When replacing chainplates in the past, I have chosen stainless steel, largely because of price and my access to the fabrication shop of my boatbuilder father, Howdy Bailey, where the job can be done quickly and well. In practical terms, it is possible to replicate any chainplate, and it's easy to control the quality of the fabrication. For the boatyard with an in-house fabrication shop, this would be the most affordable option for the boat owner. For the boatyard that must rely on an outside fabrication shop, then titanium should be considered. Of course, ultimately it is the boat owner's decision.

Here is a comparison of the cost of polished 316 stainless steel and polished titanium. *—Dylan Bailey*

Whitby 42 Chainplate Cost Comparison

	Cost for polished 316 stainless	Cost for polished Grade 5 titanium
Width: 1¾" (44mm) Thickness: ⅜" (9.5mm) Length: 17" (432mm)	$334	$217.55
Mounting fasteners	$13.20	$90
Total cost	$347.20	$307.55

Pearson 530 Chainplate Cost Comparison

	Cost for polished 316 stainless	Cost for polished Grade 5 titanium
Width: 3" (76mm) Thickness: ⅜" Length: 26" (660mm)	$1,055	$1,152.98
Mounting fasteners	$20.20	$125
Total cost	$1,075.20	$1,277.98

***Left**—This price comparison of a simple upper-shroud chainplate for a 1980s Brewer-designed Whitby 42 indicates that titanium (in this case) can be a slightly less-expensive replacement material than polished stainless steel, and it's practically immune to corrosion in the marine environment. However, the more complicated a chainplate is to fabricate, the higher titanium's labor and cost will become, outstripping the cost of a stainless steel model of equal complexity.*
***Right**—Comparing the price of materials for a more complicated staysail chainplate fabricated from multiple parts for a 1980s Pearson 530 confirms this.*

A hairline crack found on the back of this stainless steel chainplate led the author to cut the chainplate in half, revealing that more than 50% of its thickness had been severely depleted by corrosion.

should be imaged from the exterior, and the interior where possible. First, heat is applied to the interior of the boat, and the imaging is conducted on the exterior of the hull. Second, if you are able to gain clear access to the hull sides in way of the chainplates from the boat's interior, imaging can be conducted there by allowing the exterior of the hull to warm by solar loading. To do this, the boat should be placed at a north–south axis to allow both sides of the hull to warm from the sun as it travels through its arc. If thermal imaging detects anomalies indicating trapped moisture, the chainplate should be removed. Likewise, if signs of corrosion or cracks are sighted, then the chainplates will need to be removed. The photograph above shows an embedded chainplate with hairline cracks on the backside, where it was up against the hull. The chainplate was cut in half at one crack to show how much metal was depleted by corrosion.

Chainplate Replacement

If you determine that six of the eight chainplates need to be replaced, I recommend that you urge your customer to replace *all* the chainplates and their fasteners. Those two remaining old chainplates probably won't last as long as the six replacements.

The specific details and challenges of chainplate removal and replacement are worthy of their own repair article, but I want to touch on them here, because they will be important to the surveyor for the course of action he or she might advise. Exterior chainplates are the easiest to remove and replace, and embedded chainplates the most difficult.

It is important to make an effort to improve the chainplates' installation. Materials to consider for replacement chainplates are polished 316 stainless steel or titanium. If you suggest using titanium, the seal where the chainplate passes through the deck needs to be maintained. Although, titanium is immune to corrosion, water intrusion will still damage and weaken wood bulkheads below deck. With that in mind, it is essential that any exposed core material where the chainplates penetrate the deck is effectively removed and the remaining edges are appropriately closed out and sealed with epoxy. All fastener holes should also be sealed with epoxy for a long-lasting repair. PBB

About the Author: *Dylan Bailey has spent the past 30 years working in the marine industry and is the principal surveyor at NDT Yacht (St. Augustine, Florida), which specializes in nondestructive testing.*