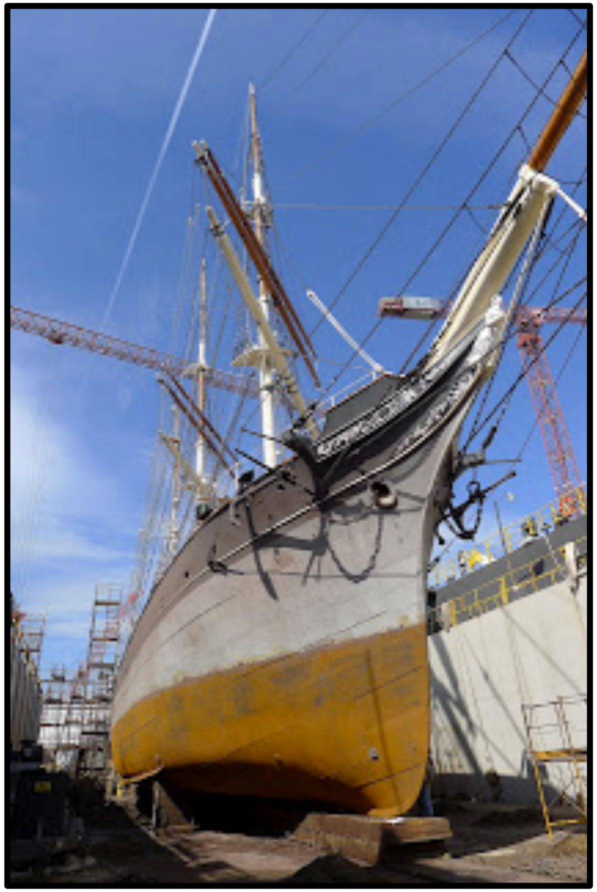
TALE OF A RIVET

ELISSA 2012-13

Hull & Deck Restoration

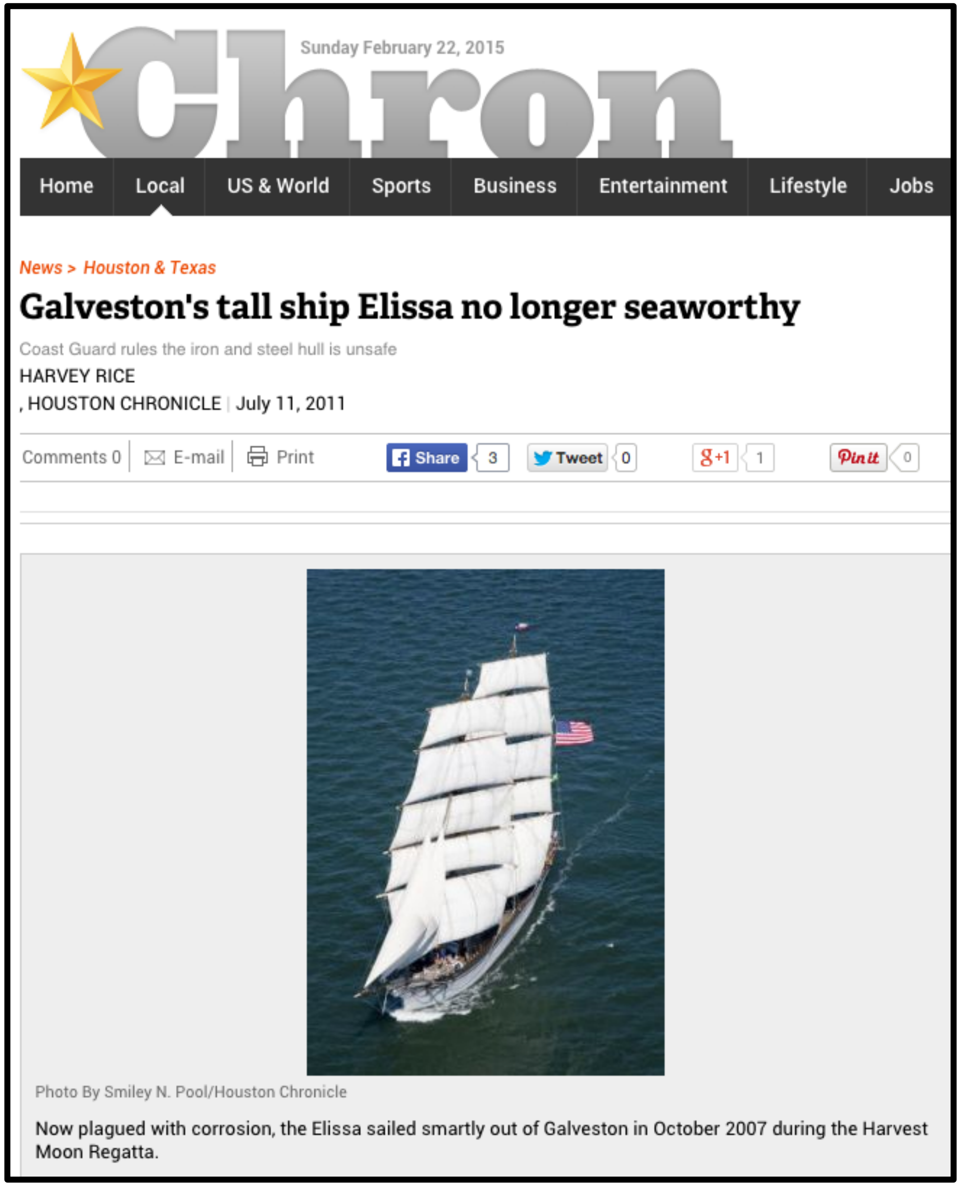
~ELISSA REDIVIVUS~
2012 RESTORATION



The decision as to how best to preserve, restore, or rehabilitate a vessel is a complex one that needs to take into account a wide range of factors. Most museum ships are stationary, either on shore or afloat; only a couple of museum ships are operational. A major benefit to keeping a preserved and historic vessel operational is that it allows it to be exhibited within its historical context of skills and craft.

Keeping a vessel operational significantly expands the scope of a museum by preserving the skills of operation and maintenance, in addition to helping maintain the artifact itself. The restoration, operation and maintenance of historic vessels require skills that are rare and no longer readily available off-the-shelf. Shipyard workers are no different and this refit will reintroduce them to riveting and to welding wrought iron to modern mild steel, and many other tasks that will be needed in the upcoming years to "Keep ELISSA Sailing."

By sailing annually, ELISSA is creating a supply of skilled and experienced square-rigged sailors that can help maintain and preserve ELISSA or go on to assist with other ships and projects. Sailing ELISSA is a vital part and a central component of the mission of TSM.



Chron

Sunday February 22, 2015

Home | Local | US & World | Sports | Business | Entertainment | Lifestyle | Jobs

News > Houston & Texas

Galveston's tall ship Elissa no longer seaworthy

Coast Guard rules the iron and steel hull is unsafe

HARVEY RICE

, HOUSTON CHRONICLE | July 11, 2011

Comments 0 | E-mail | Print | Share 3 | Tweet 0 | g+1 1 | Pin it 0

Photo By Smiley N. Pool/Houston Chronicle

Now plagued with corrosion, the Elissa sailed smartly out of Galveston in October 2007 during the Harvest Moon Regatta.

July 11, 2011 - Houston Chronicle

Electrolytic corrosion resulting from Hurricane Ike

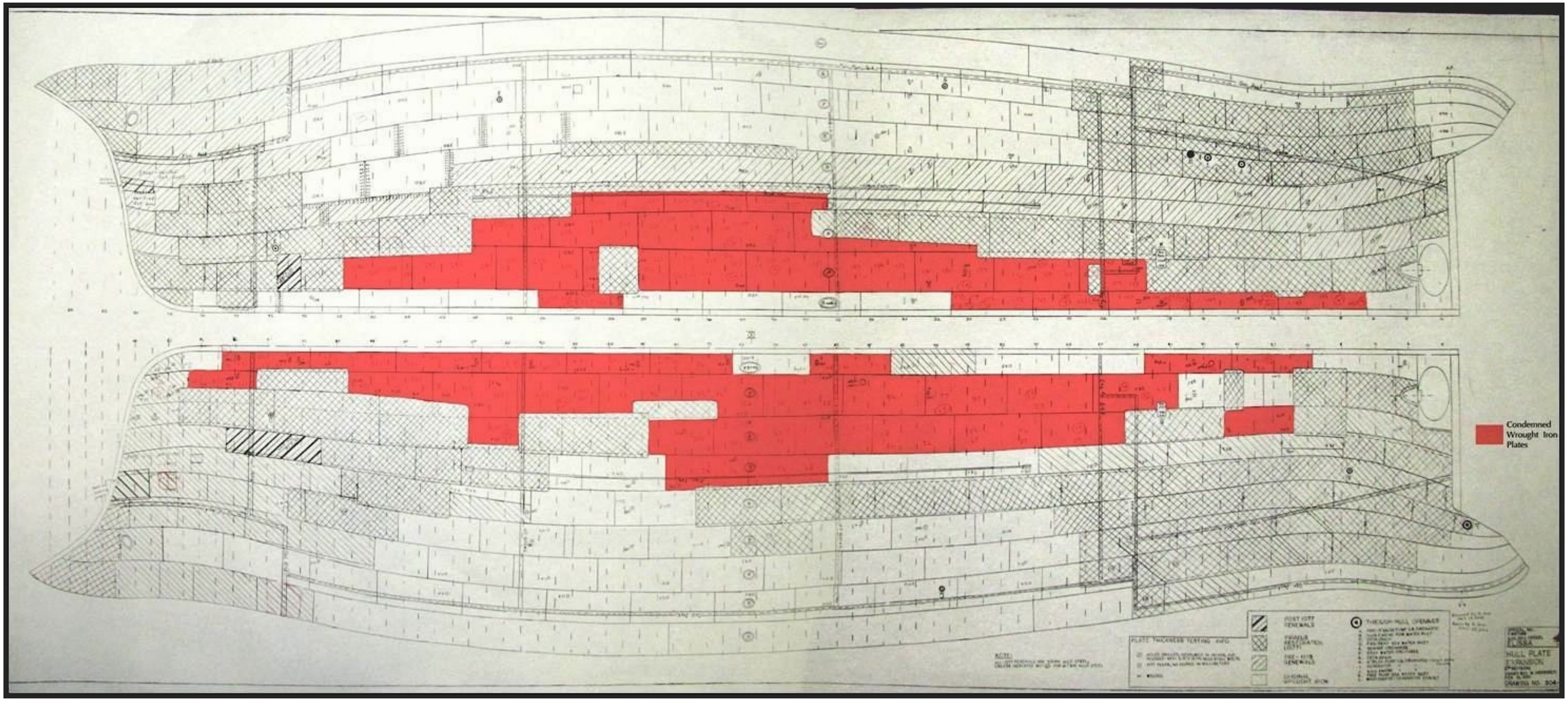
Will she sail again?

U.S. Coast Guard regulations require that ELISSA is dry-docked twice every five years, which has been done religiously since 1981.

When the ship was hauled in early January 2011, the first sign of a problem was the disappearance of over one dozen of the 55 sacrificial zinc anodes on her underwater body. This rate of deterioration was never before at any of her numerous prior dry dockings.

After removing the marine growth, more problems surfaced -- problems that had never been seen before. Inspectors found many small pits (some of which penetrated entirely through the hull), as well as numerous wasted rivets (another first). It was determined that what happened to ELISSA's hull was severe electrolytic corrosion and that it taken place since the last dry-docking in January 2008.

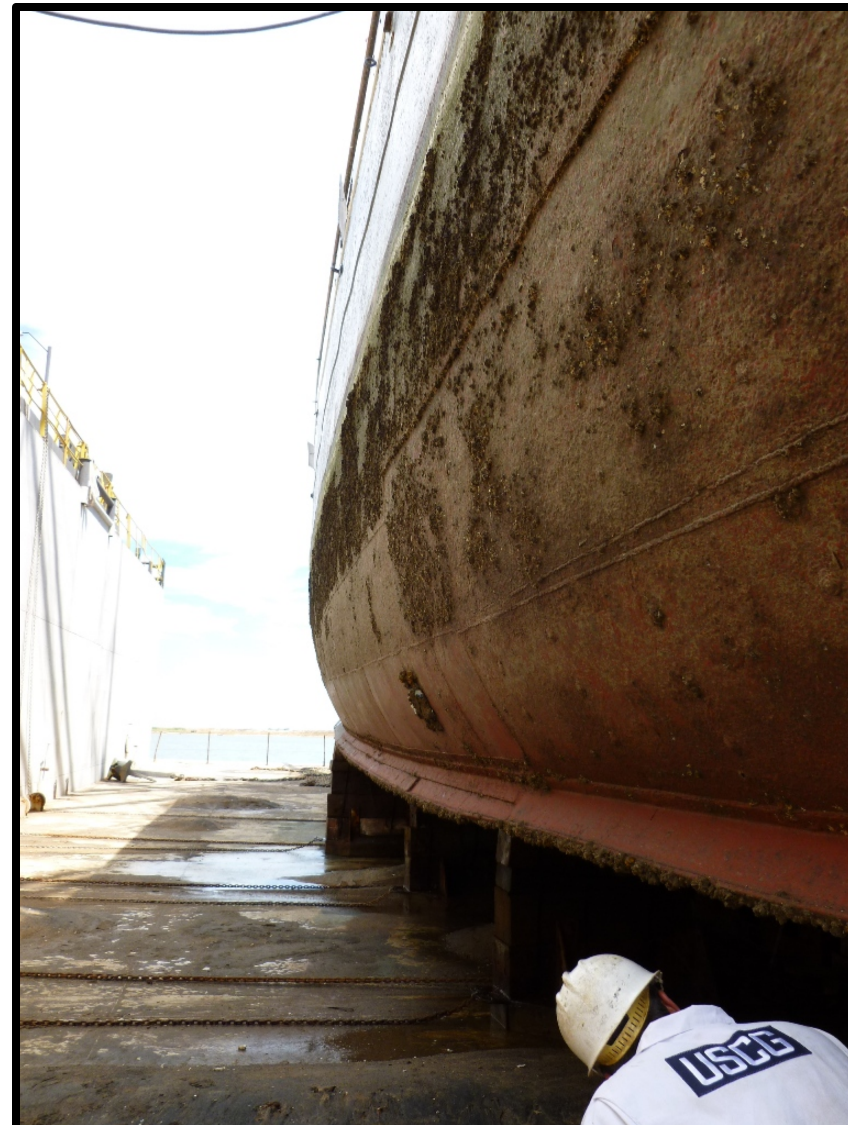
A successful claim was filed with FEMA for 1.45 million and after additional fundraising of over 1 million, ELISSA was dry-docked in September 2012 for an almost five month long repair.



The Coast Guard directed us to renew 51 hull plates
(red areas on hull plate expansion diagram).

Bollinger Shipyard Texas City
September 10, 2012.

First look 9/10/2012.



The 40,000 psi cleaned the iron and steel shell plating exceptionally well and revealed the areas of corrosion first discovered at last year's dry-docking. It exposed some further areas of corrosion that were not exposed at last year's dry-docking, when we used a less aggressive and less costly method.

The concentrated pressure of 20 tons on an area no larger than a postage stamp revealed areas of electrolytic corrosion not uncovered during the prior dry-docking in 2011.

Extensive survey of hull with
USCG in attendance.

The photo above is another one of the areas of corrosion that was discovered during Elissa's last dry docking. This is in welded steel plate renewal done 30 years ago in Greece and will be repaired with a welded insert. Inserts are a repair that is considered permanent and stout.

The minimum area to be removed for an insert is 18" x 18" inches and it must span a frame. Even though this hole is the size of your fingernail, an insert of 18" x 18" will be necessary to repair the corrosion damage.

Not only was the hull plate attacked by the electrolytic corrosion - rivets fell equal prey.

Here is an example of the corrosion of the rivet points on the hull plate that will need to be either drenched or renewed with new rivets.

Another type of damage is the delamination of some of the wrought iron plate. Wrought iron is not homogeneous like steel and is formed with layers of iron and slag. Corrosion has attacked this section of plate and delaminated it requiring another type of repair - clad welding. Clad welding is where a puddle of steel is welded into the void. If the divot or void is too large, an insert may be required.

All these repair scenarios may be suggested by us or the yard, but the Coast Guard has the final say as to whether we can use an insert versus just clad welding a repair. Clad welding is a lot less expensive.

There are certainly a lot of varying and different textures and colors on ELISSA.

Here are holes from electrolytic corrosion just abaft the forward collision bulkhead of ELISSA. I had hoped for an insert repair in several areas, but USCG required the entire A & B strake to be renewed - a very expensive endeavor.

Panel cut out for USCG to test the composition and integrity of the original Lowmoor wrought iron.

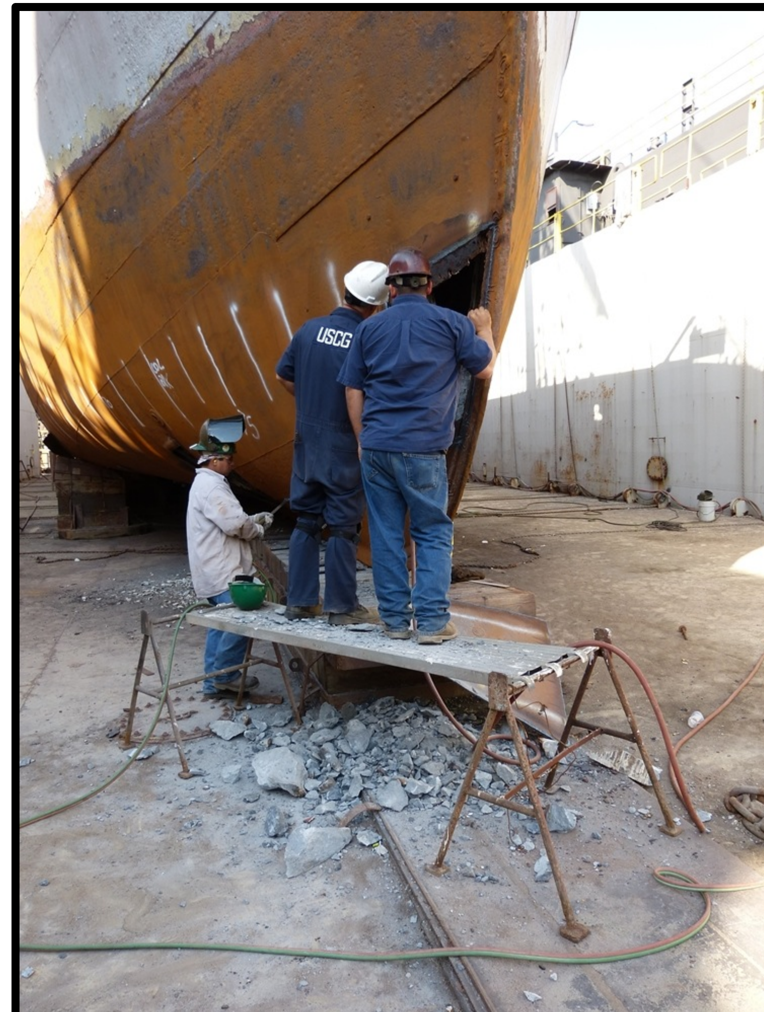
Inboard side of cut out test panel placed on the dry dock floor. This section was later radiographed after the composition test.

Marking cropping out lines on condemned plate.

September 20, 2012
First cuts…of many more.

Cropping out bad plate for renewal. This cut is at frame 63 - 66 port side. Frames are numbered forward from the stern post.


75


USCG

After 135 years ~ Is the hull plating still thick enough?

Any plate found to be wasted more than 25% of original thickness is marked for renewal.

Original garboard is 9/16” (0.563)

We were successful in saving 95% of the garboard plating - we did crop 4" of the garboard strake at frames 69 to 73 on the starboard side of the ship. I was very happy to see over 3/8" late thickness at the cut. The original scantlings for the shell plate at the garboard near the bow is 7/16" - so we have suffered very little wastage at this plate. Unfortunately the electrolytic corrosion does not care if the plate is thick or thin and will attack both with equal vigor.

The cropped garboard plate showing the concrete and butt plate.

The cropped garboard plate near the stern showing the concrete and butt plate, and wash plates with limber holes in the frames. Note the shaping of the concrete to direct water to the limber holes.

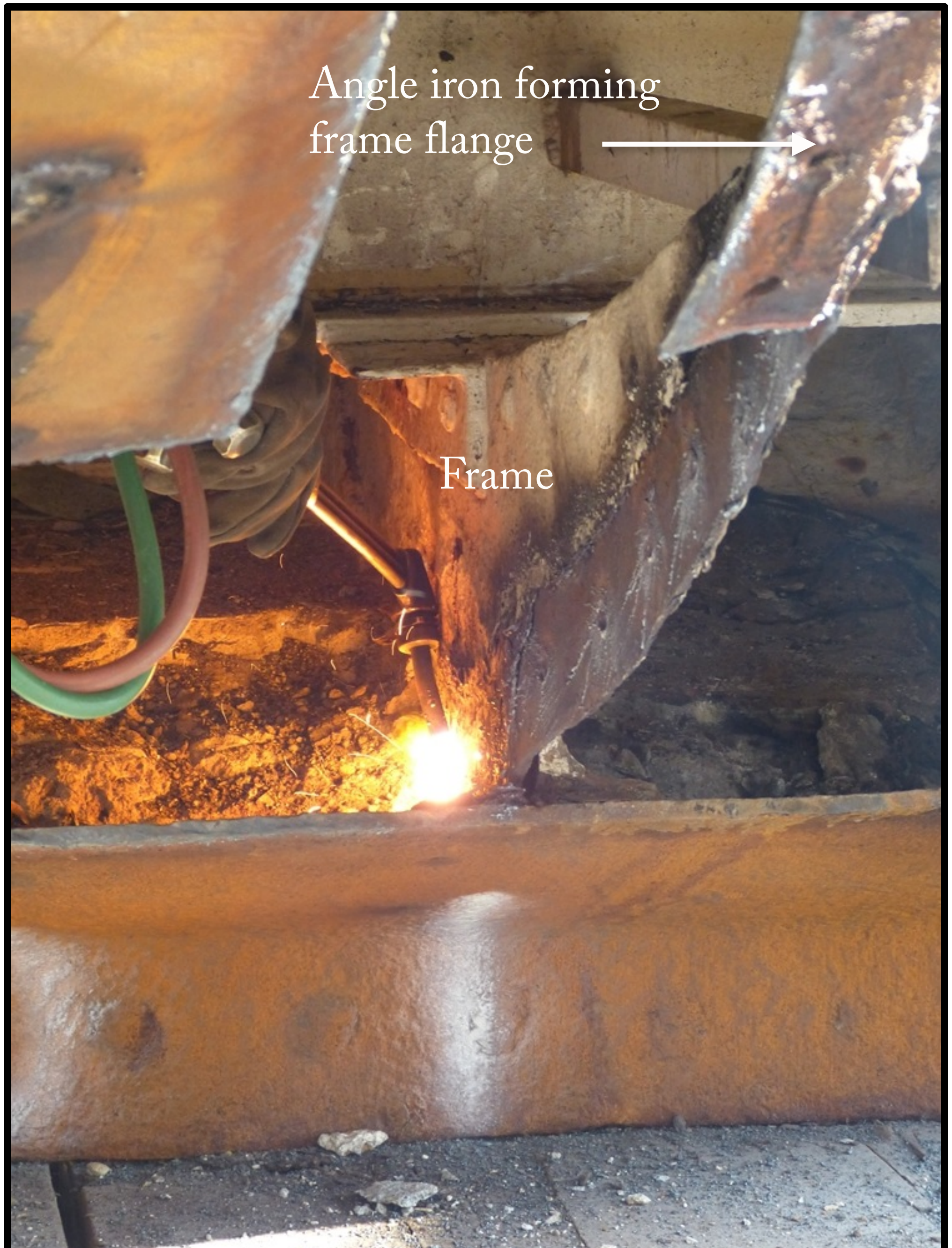
A good welder can wash off a plate and barely
mark the frame underneath.

The framing at frames 63- 66 appeared sound, but the plate was still too thin at about 1/4”

A beautiful original frame from 1877 Aberdeen, Scotland and the yard of Alexander Hall & Co.

It is always difficult to gage what amount of cropping back will result in thick enough plate. When the plating in question is steel plate from the Greek restoration or Galveston first restoration, it is not a difficult decision. When it is the original historic wrought iron plate, the decision is more difficult, but in the end - it is whatever is best for the safe operation of the ship and her company

Marking a corner radius.



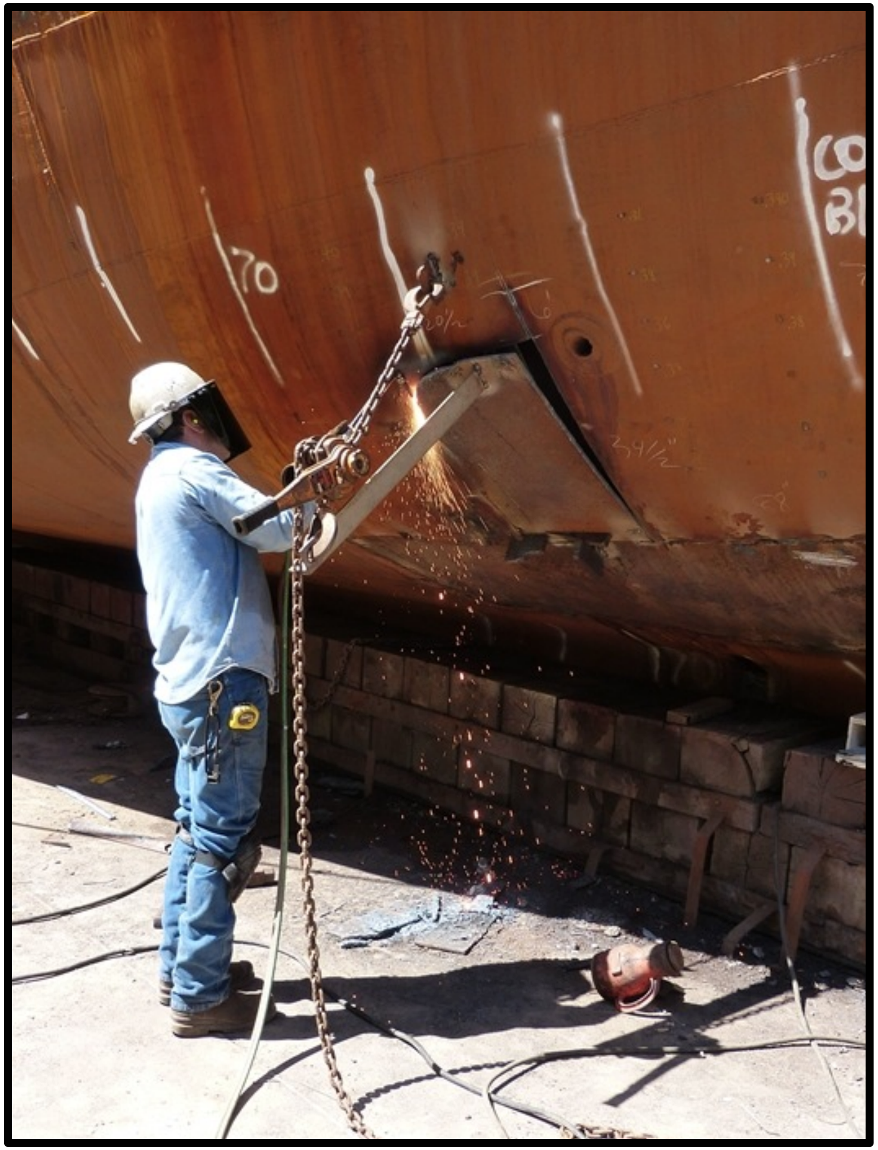
Cut out frame flange for renewal.

New frame flange section.

Renewed frame flange section.

Fitting new plate insert section. Most of the hull plate renewals involved entire or large sections of A & B strakes and not smaller insert plates like the one above.

Constant inspection by
USCG inspectors.



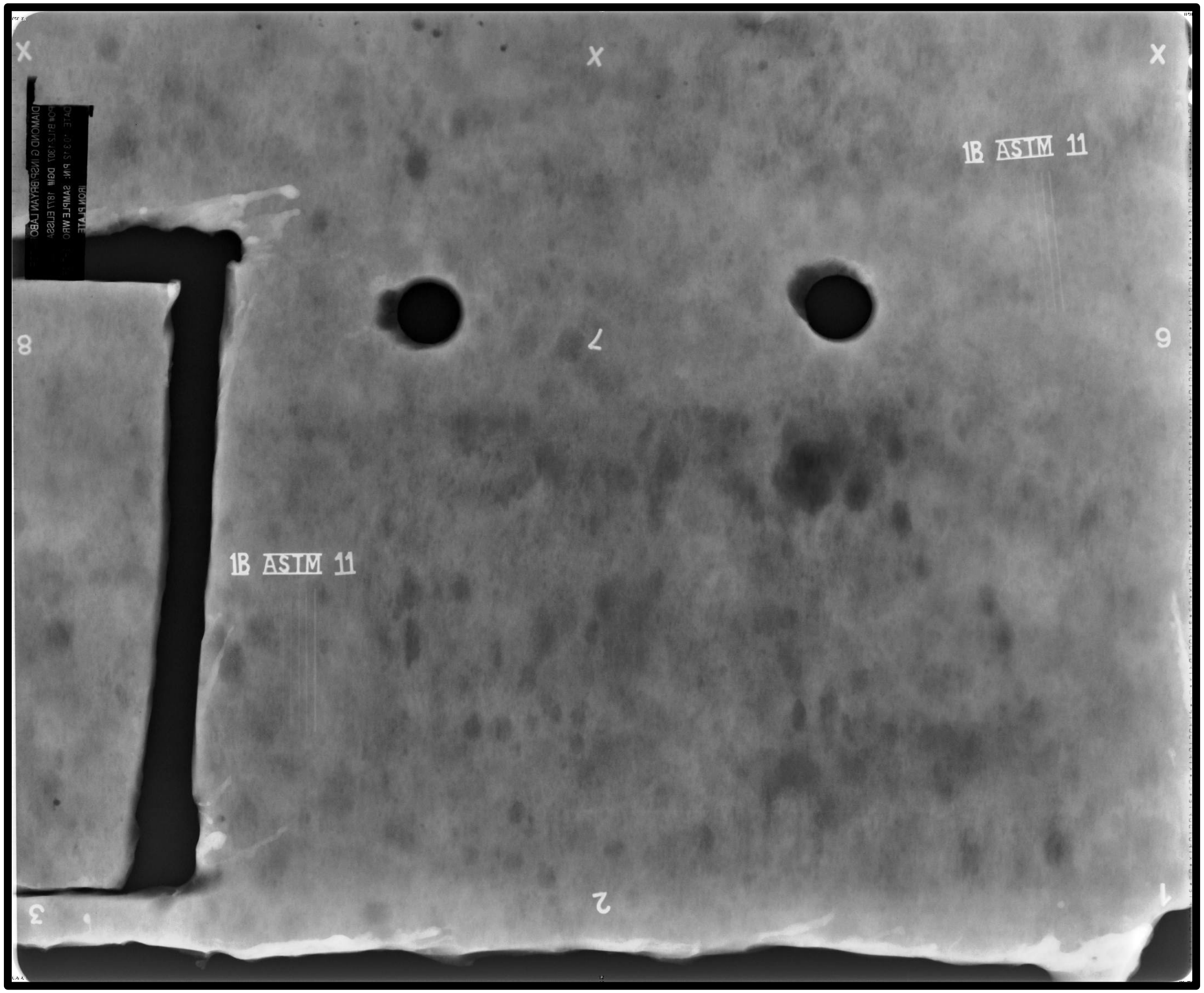
Shaping a plate to fit the complex curves of the hull.

Inspecting x-rays of test plate section that was cropped out at the beginning of project.

It turned out to be a lot more difficult than anyone imagined to write up a specification and protocol for radiography of the historic iron plate. Since the plate has naturally occurring silica in the form of slag layers, the x-ray may show hidden patches of corrosion that are actually just slag lines.

Todd Grove, long time ELISSA volunteer and President ABS Technical Services and his colleagues from ABS worked on writing a specification and went as far afield as contacting a professor from the Colorado School of Mines as well as an iron expert in Yorkshire, England.

X-ray of test plate.



Dark spots are areas of pitting.

Measuring depth of pits.

Results of chemical composition analysis of a sample of wrought iron. The results were as follows:

In addition to pure iron -

Carbon- .013
Manganese- .11
Silicon- .20
Phosphorus- .062
Sulfur- .021
Nickel- .04
Molybdenum- .006
Copper- .06

Using radiograph to identify suspect areas of test plate.

Test coupon of new steel plate welded to original 1877 iron plate sample to test weld integrity by pulling to destruction.

A certified shipyard welder was further required to weld up a test coupon to ensure they could safely join modern steel to 135 year old wrought iron.

Concrete removed from below tail shaft.

Original 1877 wrought iron plate - A strake at frame 55
– note clean white 1877 Portland cement.

Rust stained concrete is material that was renewed during various repairs over the years.

White concrete is “original” Portland cement” applied during construction in 1877.

After 135 years under concrete, the rivet heads are still as perfect as the day they were driven.

"A" strake starboard side

Rivets from 1877 ~ still in good condition

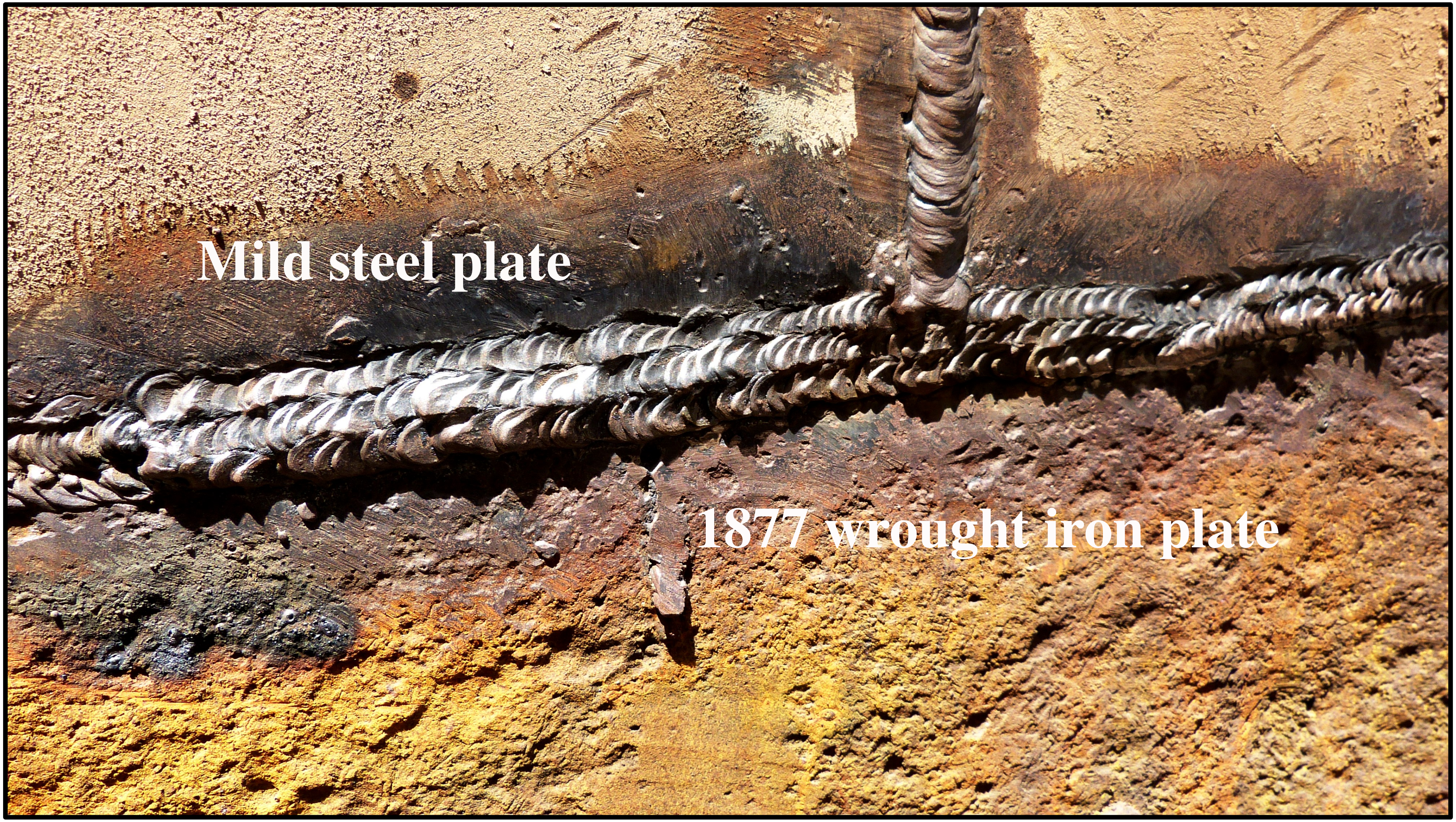
Always vigilant and looking for potential problems.

Offering up new plate by using chain falls to pull plate into position for mark up and fit up.

30 ton hydraulic jacks pushing plate against frames for a tight fit.

Renewed starboard hull plate on A & B strake
looking forward.

Renewed starboard hull plate on “A” & “B” strake looking aft.



Example of welds. Special welding protocols were developed to weld modern steel to 1877 wrought iron.

Breaking out concrete ~ over 22,000 lbs. was removed.

Concrete dust was everywhere below decks!

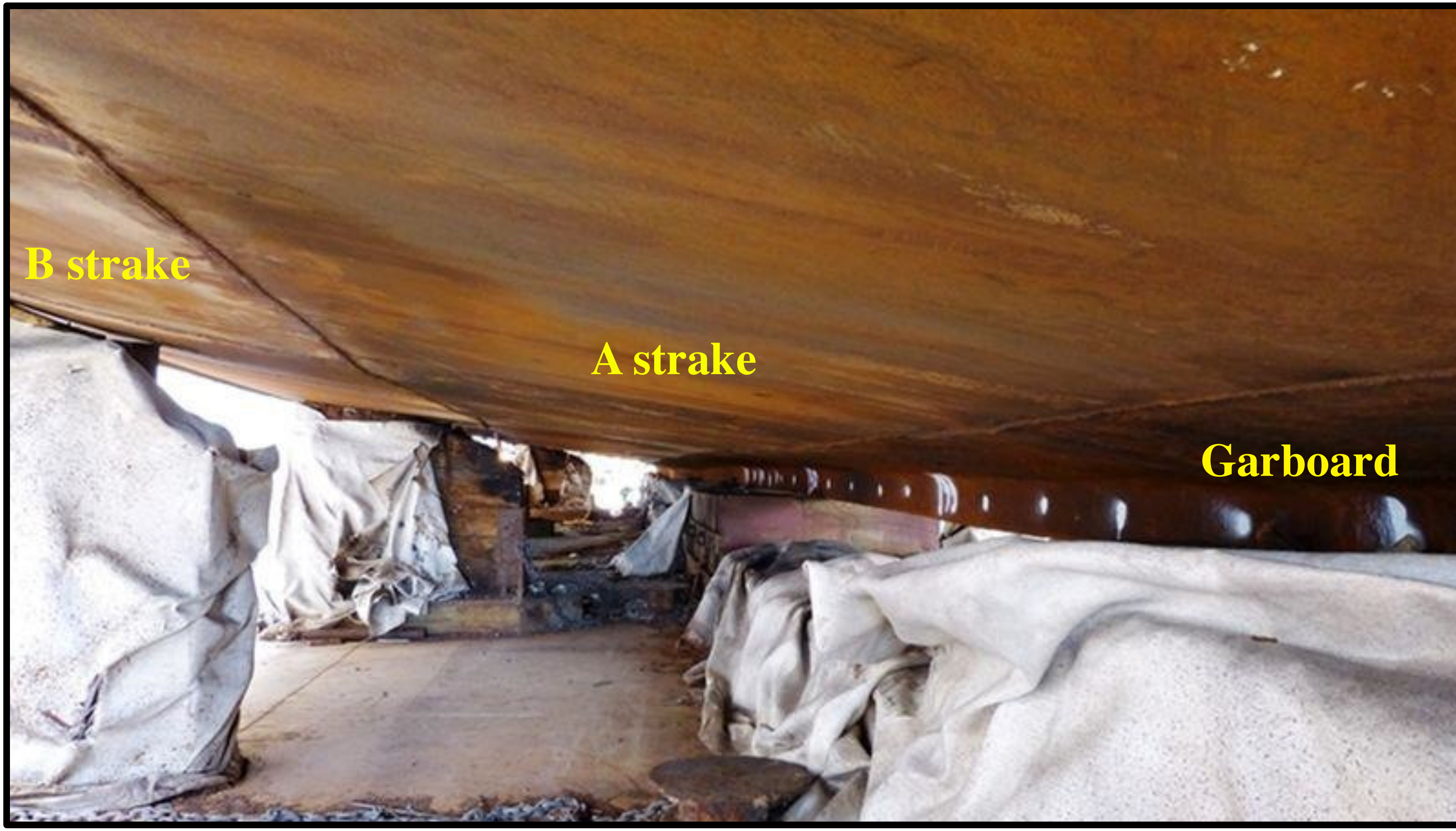
One of the many hoppers loaded with concrete
removed from the bilge.

A typical frame bay and the concrete. The concrete served to allow water to drain through the limber holes in the frames and to serve as chafe protection from the abrasive action of salt water constantly washing over the iron plating - year after year.

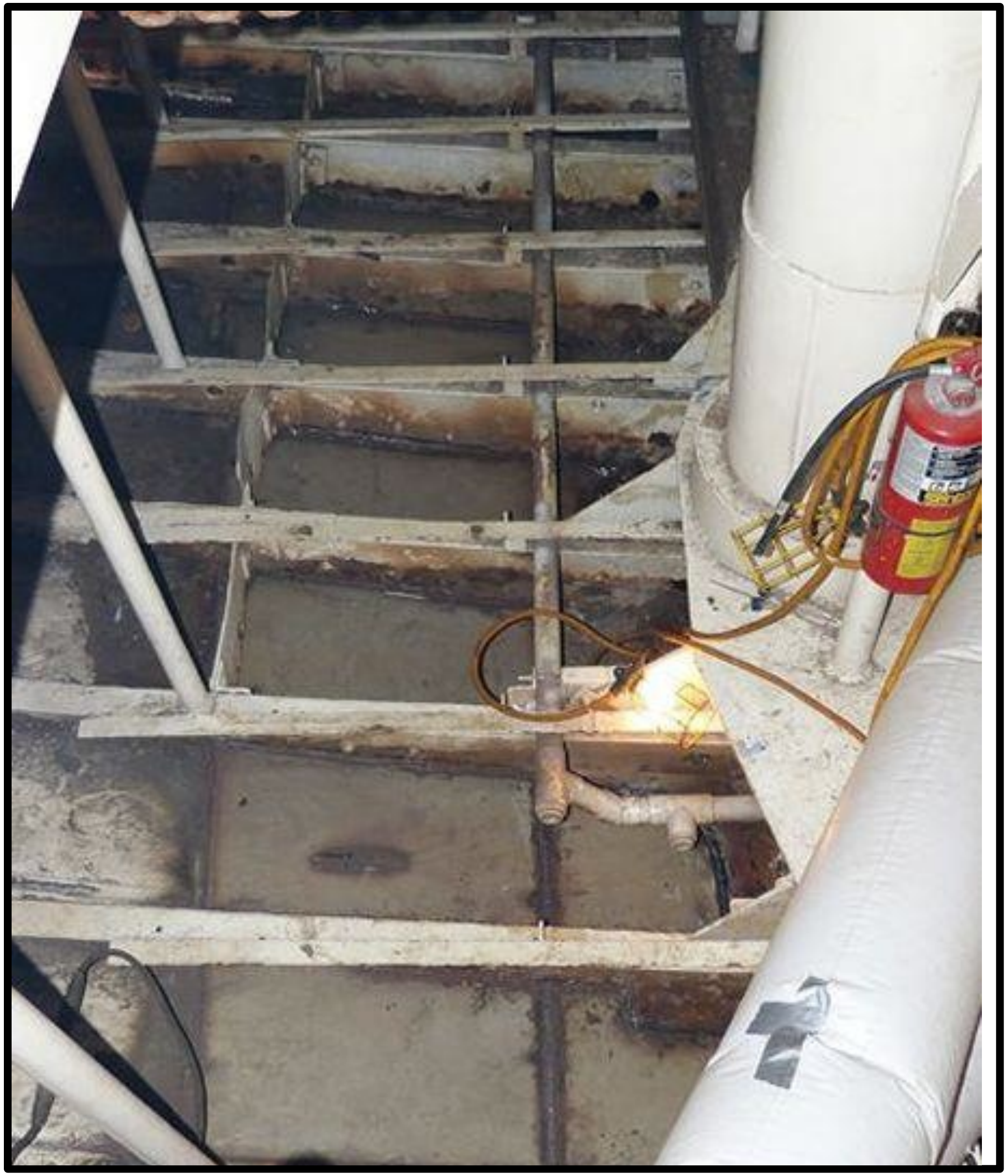
A butt plate in perfect condition after 135 years.

Trimming plate during fit up.

Shipfitters and welders needed to
be limber to weld up
plate in tight and cramped spaces

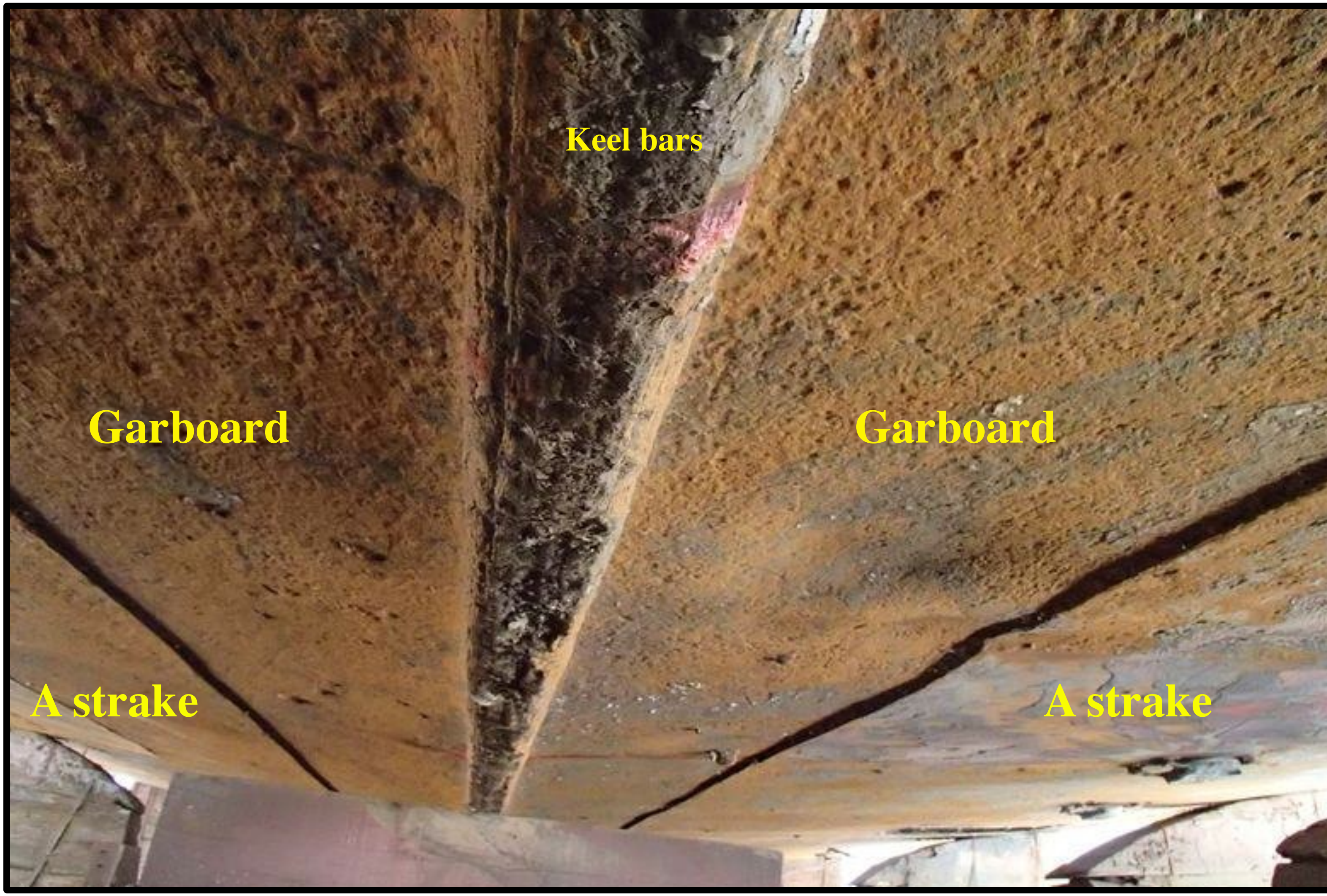


A & B strake renewed in 1/2” A-30 mild steel plate from stem to stern



Interior view of renewed hull plate on starboard side of foremast step.

Bent stem/keel after 136 years service and a couple of groundings.

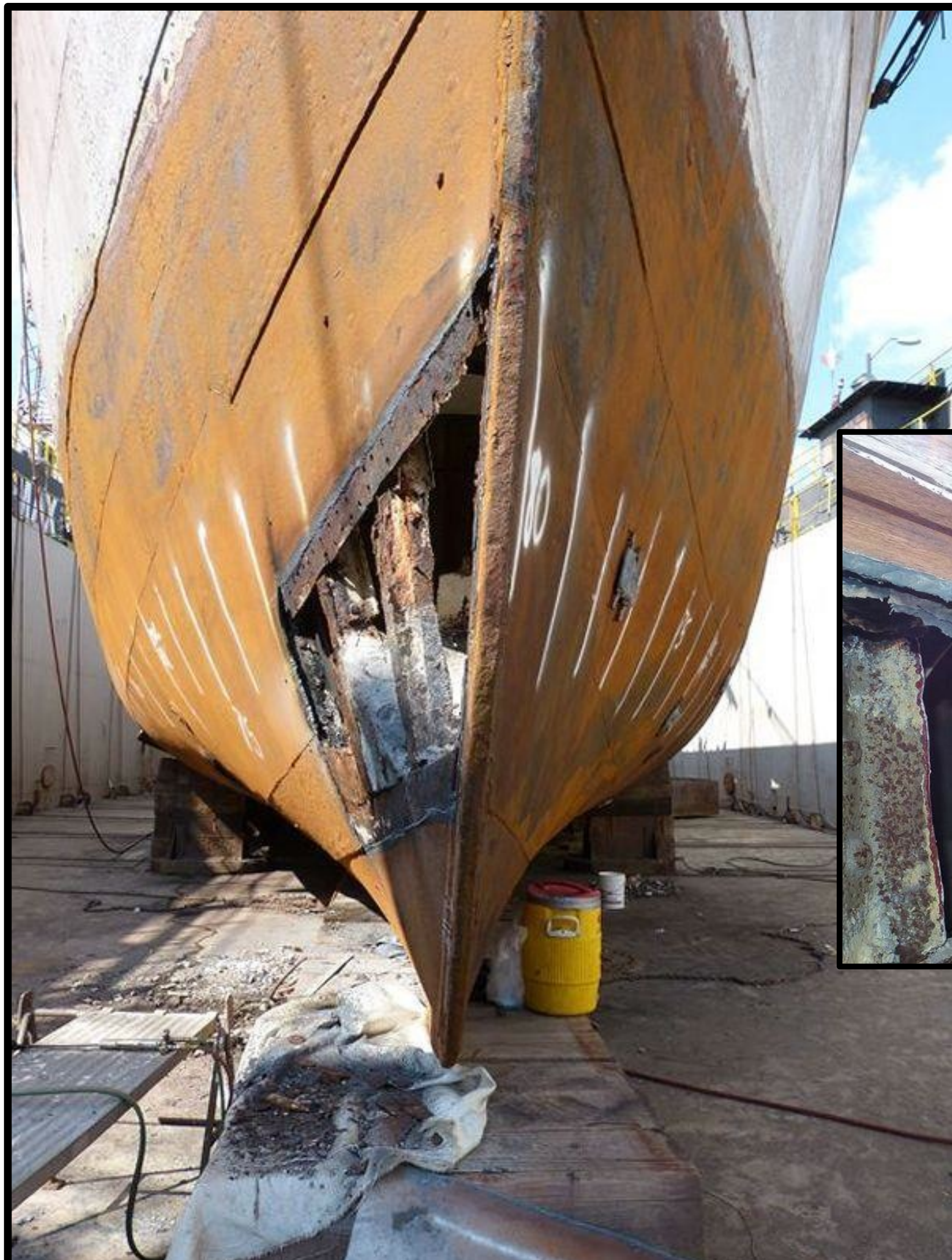


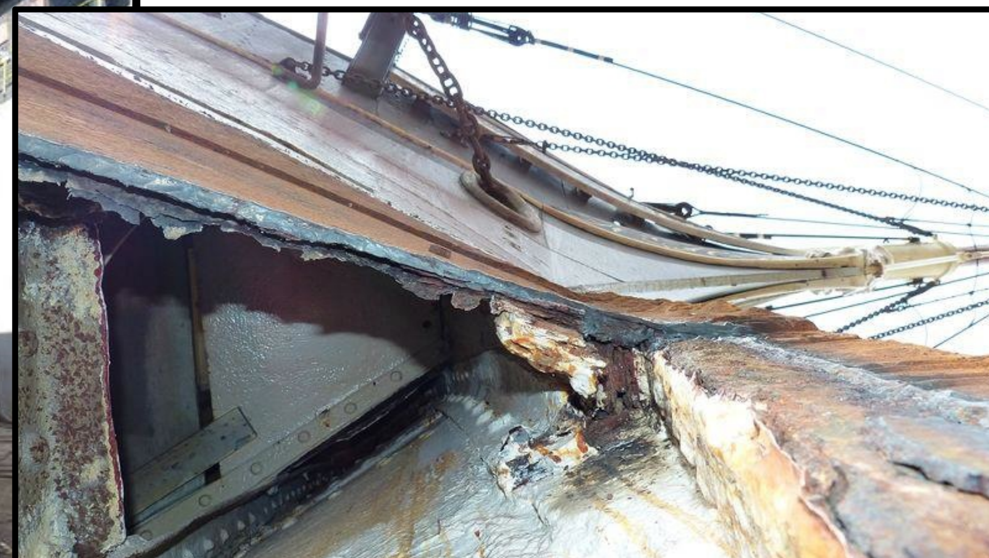
ELISSA's keel is 3 iron bars sandwiched between the port & starboard garboard plating and then through riveted together.
note: dent from grounding in early 1900's

Stern post and propeller aperture.

Notice the layering and tree bark like appearance of the 1877 wrought iron..

Washing off rivets and burning through hull plate. The wedges assisted in prying back the plate enough to knock out the rivet heads. This was done to facilitate a welded to rivet transition.



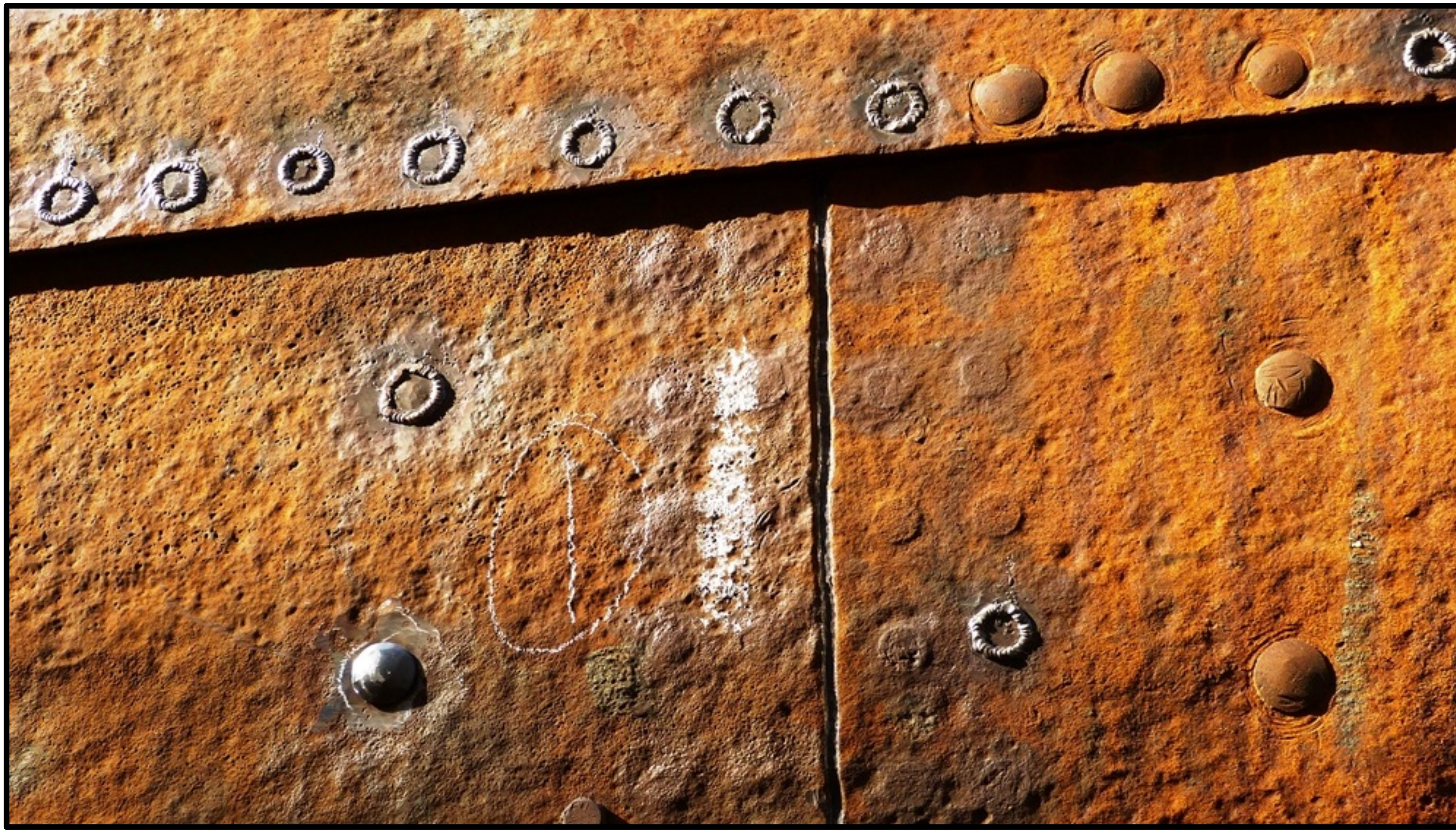


Cropped iron hull plating to be used in a future display at
Texas Seaport Museum.

Relieving cuts made in the new plate to help ensure internal stresses created by welding are released and not locked into the plate.


Butt weld ok
2
←63"→

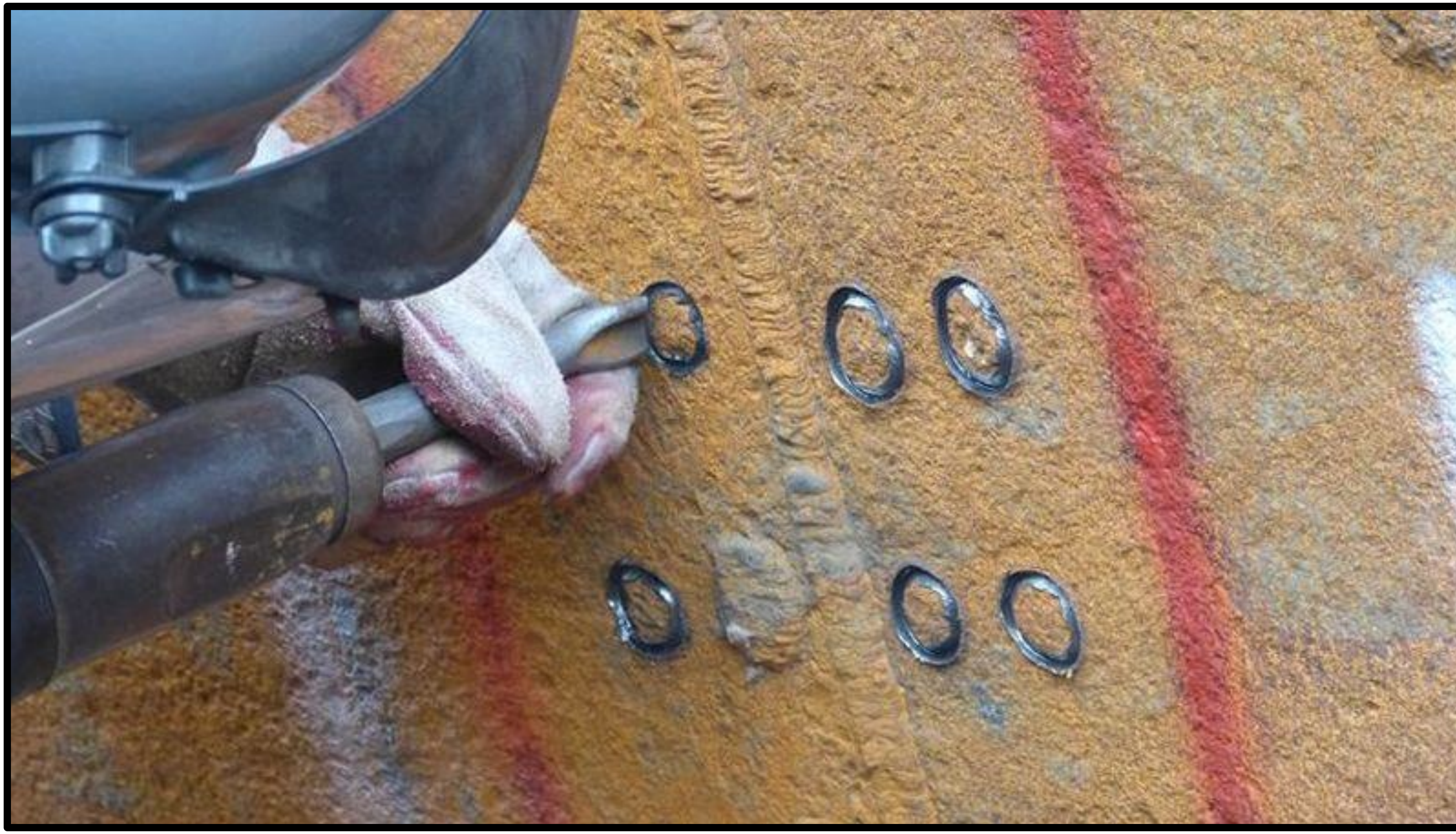
Towards the end of plate renewals and the commencement of riveting.
In all, almost 1800 sq. ft. of hull plate was renewed.



Rivet Repairs

The Rivet Gang from the Great Lakes.

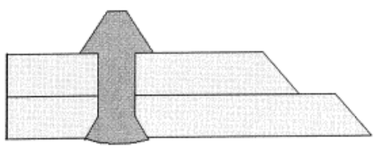
First thing was to complete a rivet inspection of the entire ship.



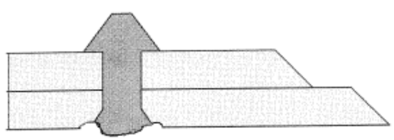
“Frenching” rivet repair ~ step one. Frenching a rivet is an accepted USCG repair to damaged rivets. The use of clad welding onto the rivet point is a bad practice and to be avoided.

A majority of the rivets on ELISSA are repairable by using a repair called “frenching”, according to Terry Jagielski of Hansen Industries in Toledo, Ohio (an expert in rivet repairs). Rivets that had to much of their point corroded needed renewal.

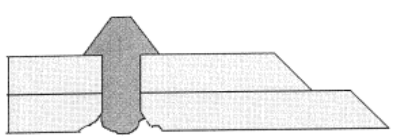
The rivet repairs and any renewals will follow the guidelines outlined in the Coast Guard's NVIC 7-01



Example A. A typical, sound rivet the point completely fills the countersink. The head is flush with the plate. If rivet has small leak, Bobbing may be an acceptable repair.



Example B. The point has begun to deteriorate and does not completely fill the countersink. Enough of the rivet remains in the countersink to hold the rivet tight, so no need to be replaced yet. The rivet may leak so a French and Weld may be an acceptable repair.



Example C. The rivet point no longer fills the countersink and is not holding the plates tight, The rivet will leak. The plates are susceptible to shearing force and the rivet may pop out resulting in joint failure. Replacement is the only acceptable repair.

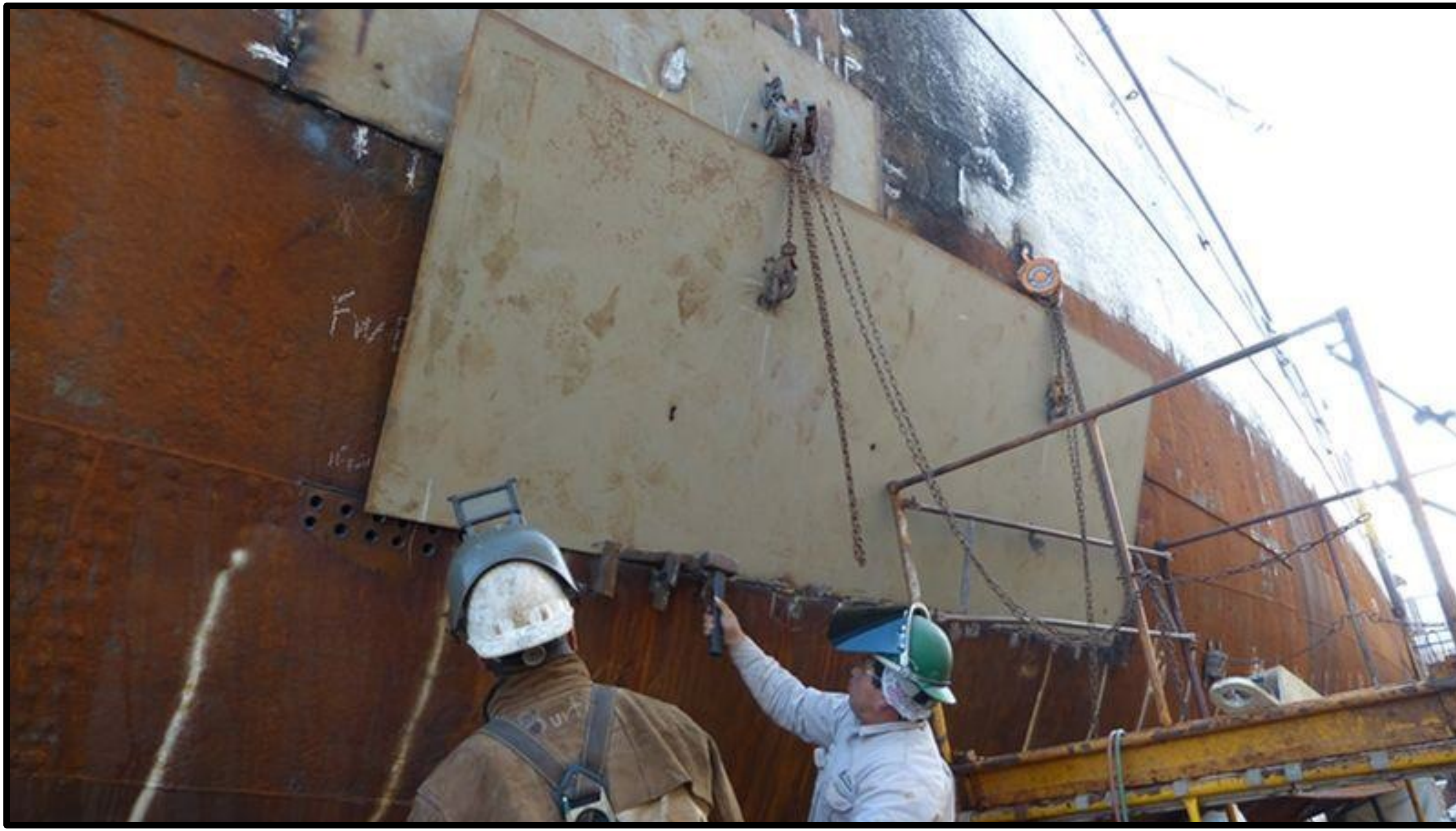
FRENCHING

Veeing and wedging the lip of point metal more firmly into the countersink with a special frenching tool and then filling in the “trench” with a fine weld bead. This actually draws a rivet tight without possibly distorting and weakening the metal around the rivet as ring welding may do.

Broken rivet between two finished
“Frenched” rivets

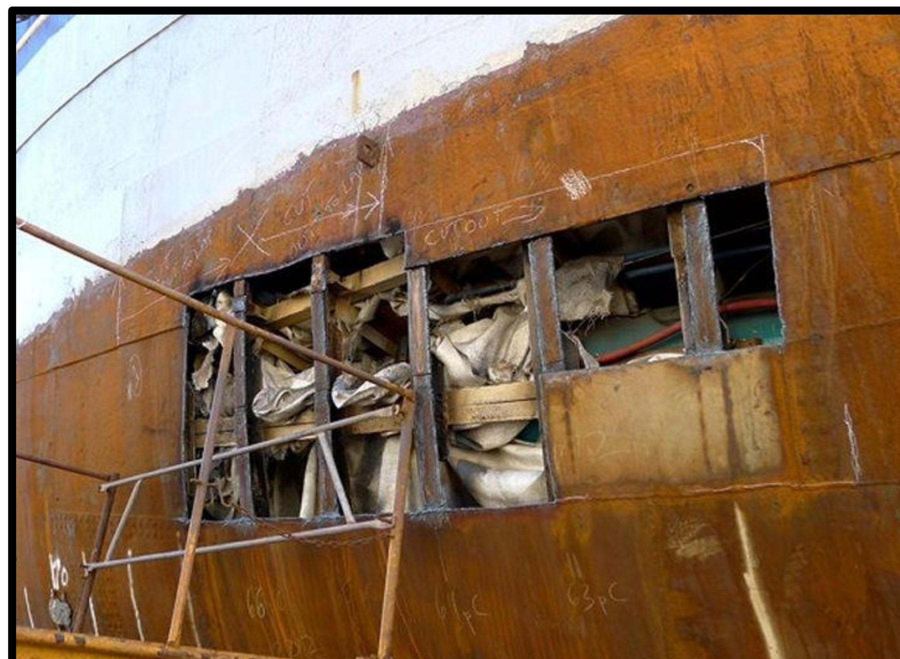
Frenched rivet points.

Fitting new steel plate in preparation for drilling, reaming out, and riveting.



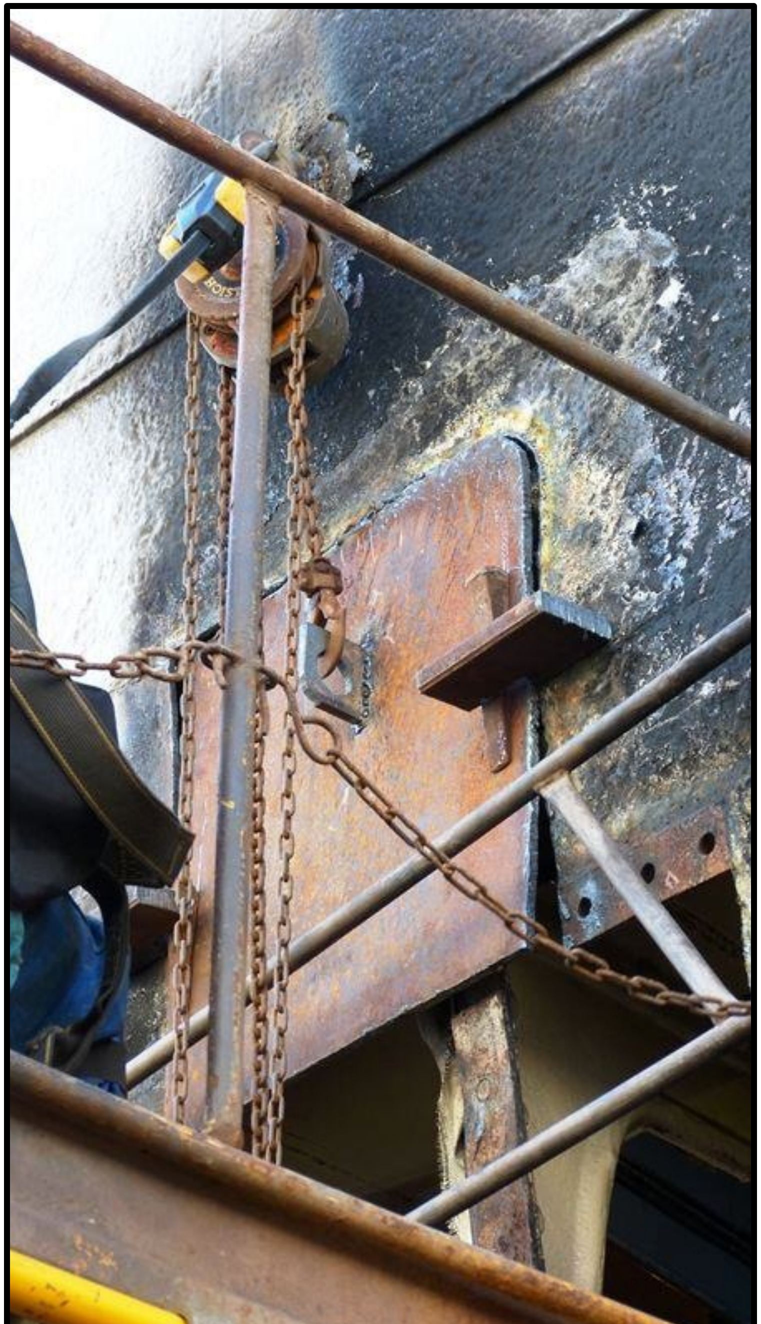
Dogging new steel plate.

A fracture in one of the plates was discovered and additional plate was cropped for “riveted renewal since it was at and above the waterline and visible.



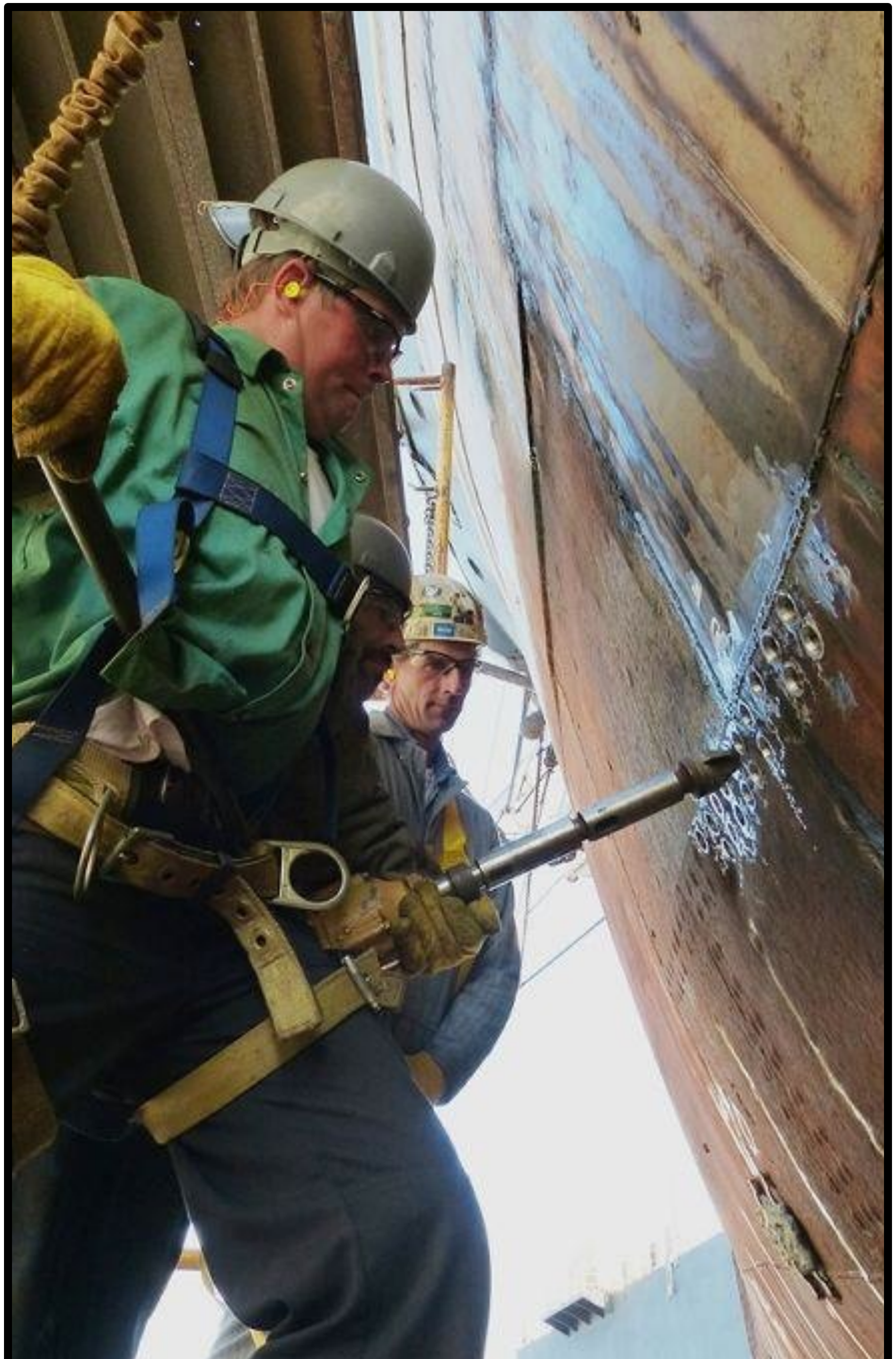
Section of fractured iron plate to be renewed by riveting new plate

There was a lot of interest in this repair work.
ELISSA seems to always attract a lot of attention.



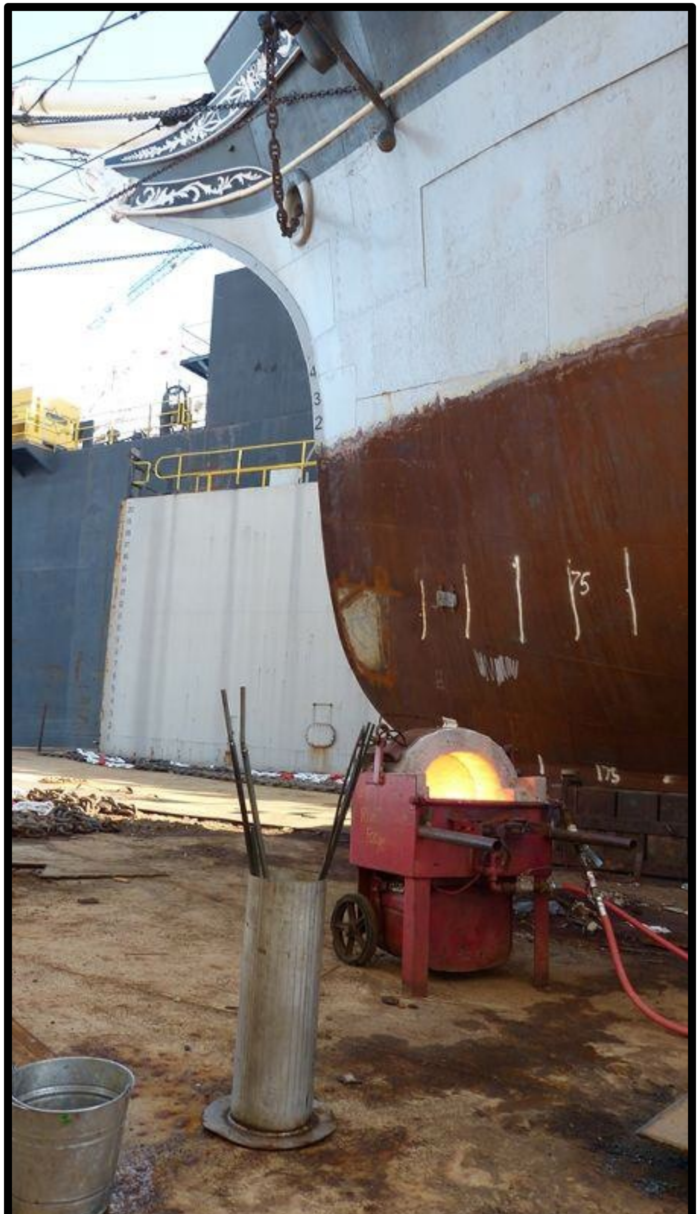
New steel plate in place and “dogged” - ready to be welded up before riveting new plate in space below.

Reaming out old rivet hole for new rivet.



New rivet hole drilled and reamed in renewed steel plate before riveting.

Cutting new rivets to proper length ~ each one is slightly different in length.



Rivets being brought to an orange heat – too hot and they burn; too cold and they do not peen over properly.

"Hot Rivet" is the cry as it is passed through a hole cut into the hull. This hole will be welded closed later.

Later a spigot patch is used to closed the round hole.

During ELISSA's original construction the rivet forge would be inside the hull, allowing the hot rivet to be passed from inboard through the reamed rivet hole.

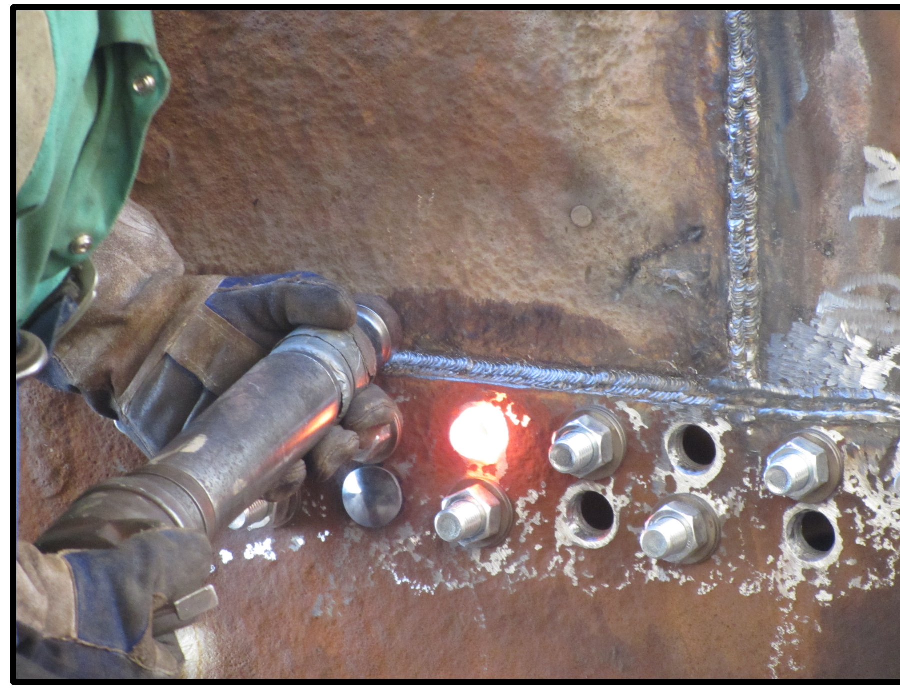


Plate bolted up ~ rivets are placed in empty holes and then the bolts are removed and the remaining rivets passed.

Inside the hull, a “bucking” hydraulic jack is used to hold the rivet head while the rivet point is worked outside.

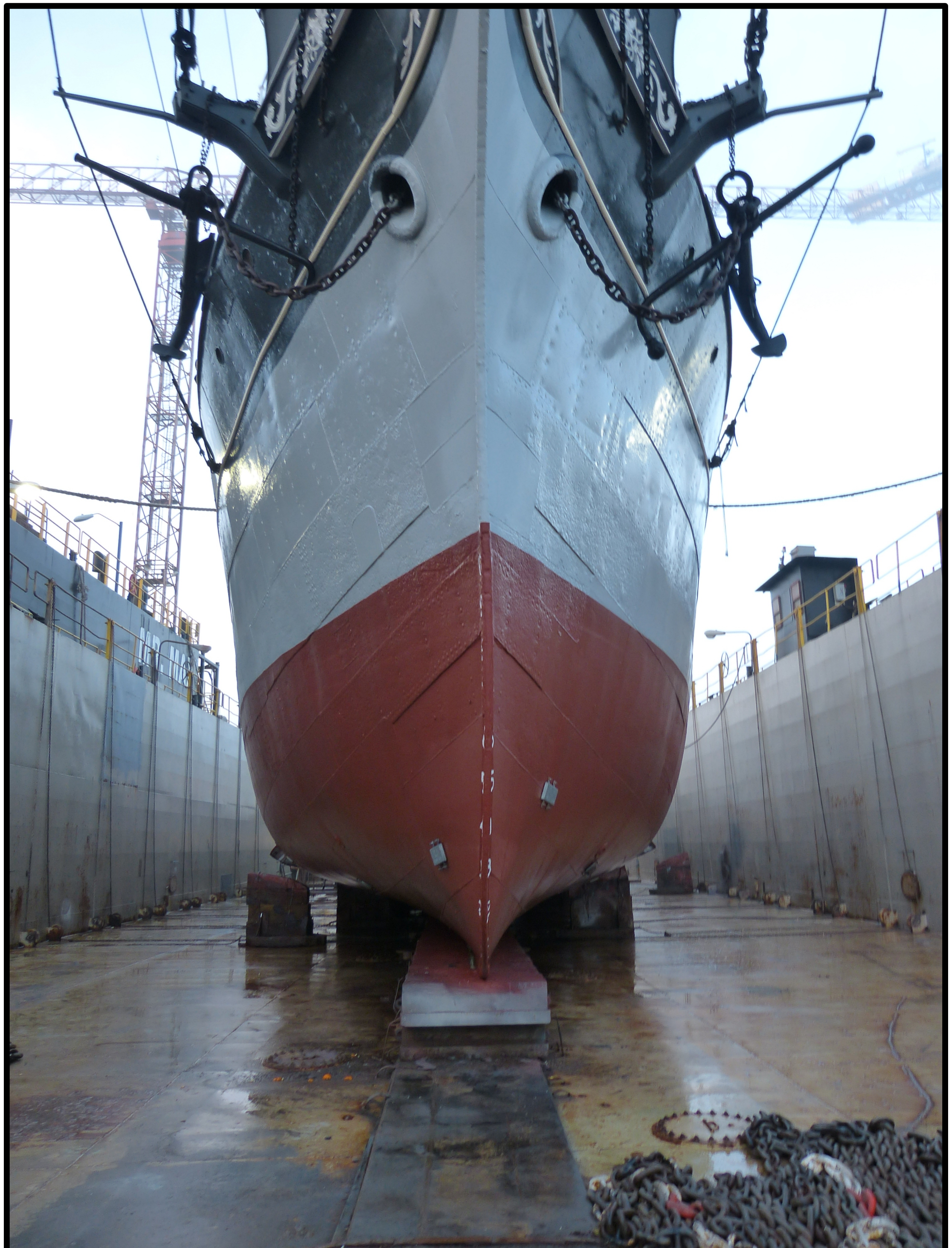
A shinny new rivet~ the rivet gun polishes the rivet point as it works the rivet in the chamfered hole. This is an example of a welded to rivet transition.

After drenching or re-riveting the plate, it is then “caulked” using a chisel point to peel over a sliver of metal to form a watertight joint.

Sandblasting the hull before applying ceramic coating and bottom paint.

Ceramic coating applied at 150 degrees fahrenheit and 40 mils thick.

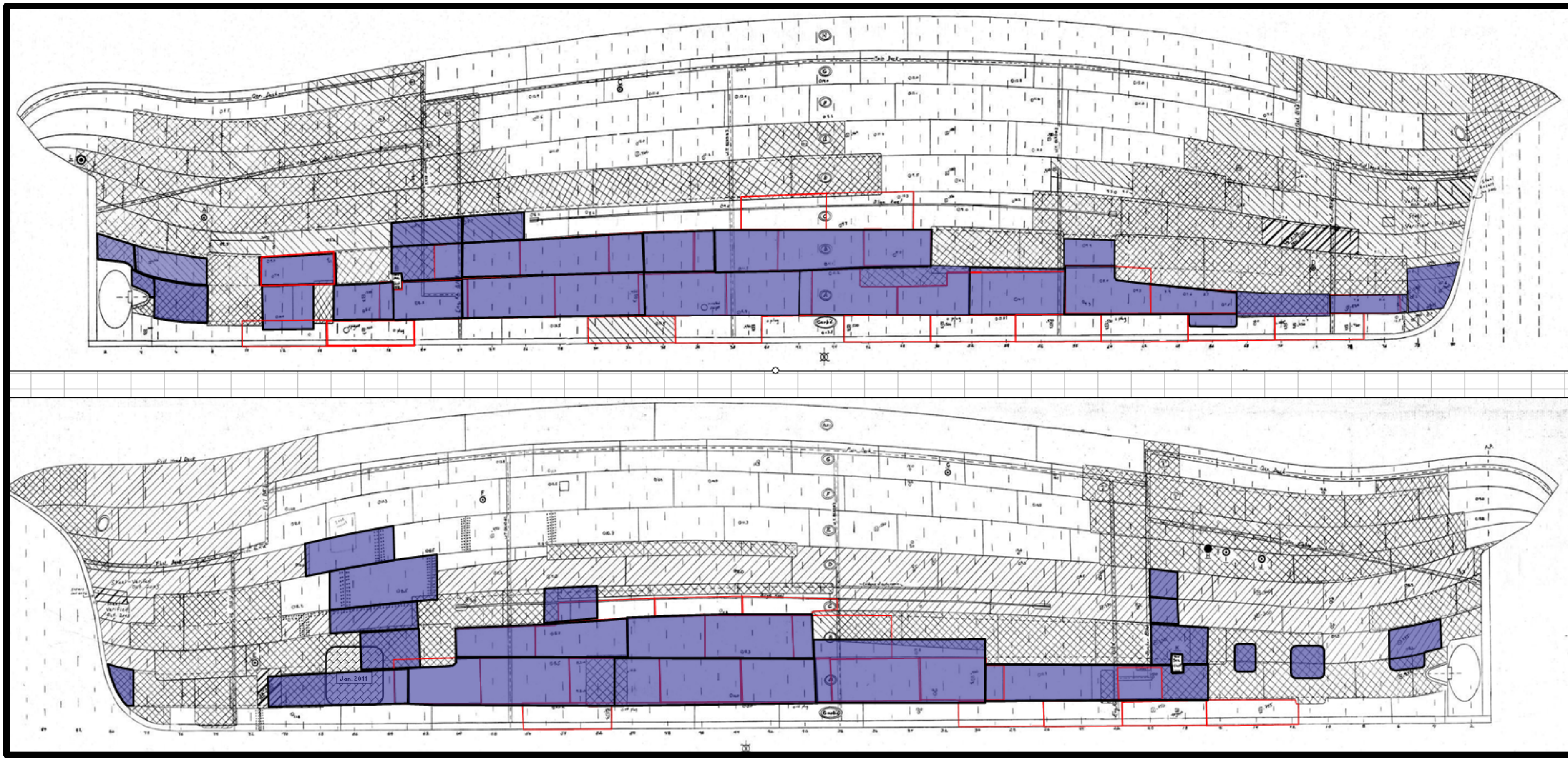
Applying the ceramic coating. It was below 50° outside, but the hull heated up to 60° with the 150° coating.




ELISSA

Returning to her element after 5 months in dry dock.

A beautiful and fine fore foot
and entry.



1,800 square feet of ½" mild steel hull plate renewals.

Purple area is actual plate renewal; red outline area is original USCG anticipated renewals.

Back home.
~ now to renew the deck….

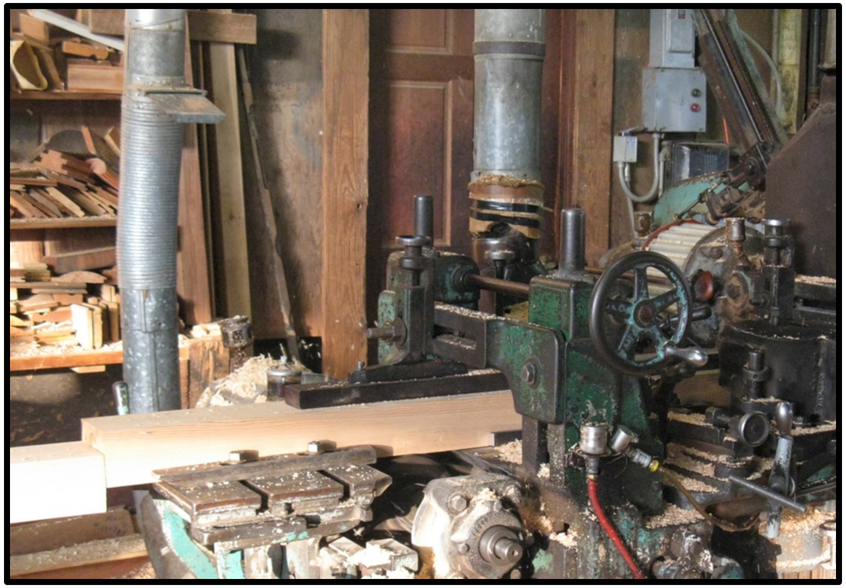
ELISSA's New Decks

Ship decking 4" X 6" rough sawn, kiln dried and run to pattern finished size 3-1/2" X 5"

- Clear vertical grain Douglas Fir, West Coast Lumber Inspection Bureau, Rule book 17, Paragraph 175a with the extra provision: *"free of sapwood"*

- A total of 8,895 to 9,000 lineal feet of decking or over 18,000 Board Feet on a 4" X 6" count. With allowance for rejects, over 21,000 Board Feet was ordered.

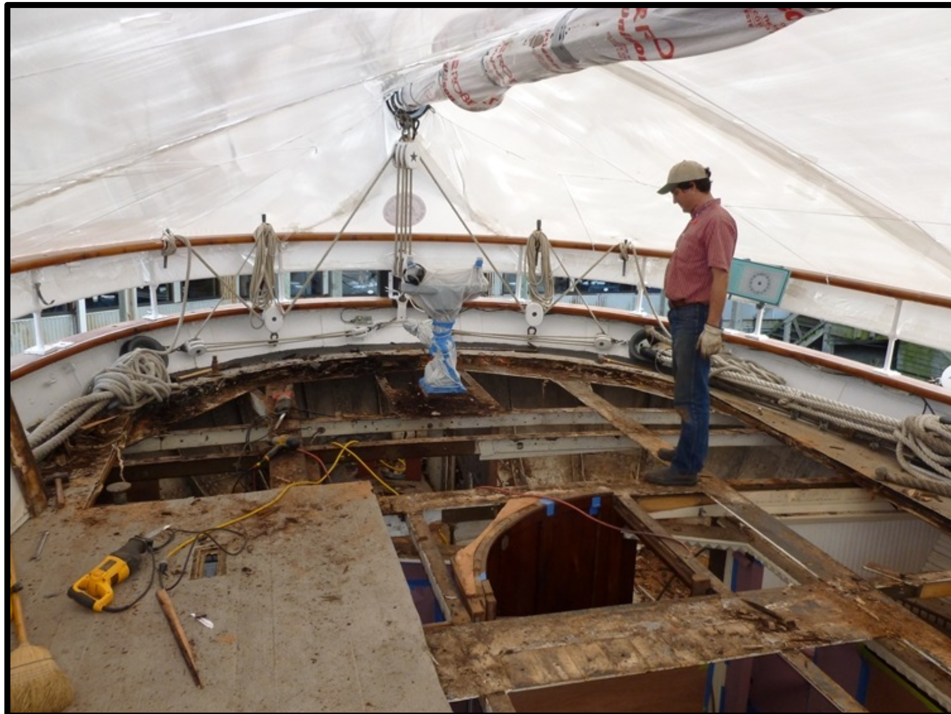
From this tree… 21,000 board feet of lumber for the decks.



From tree to planking stock at the mill in Pt. Townsend, Washington.

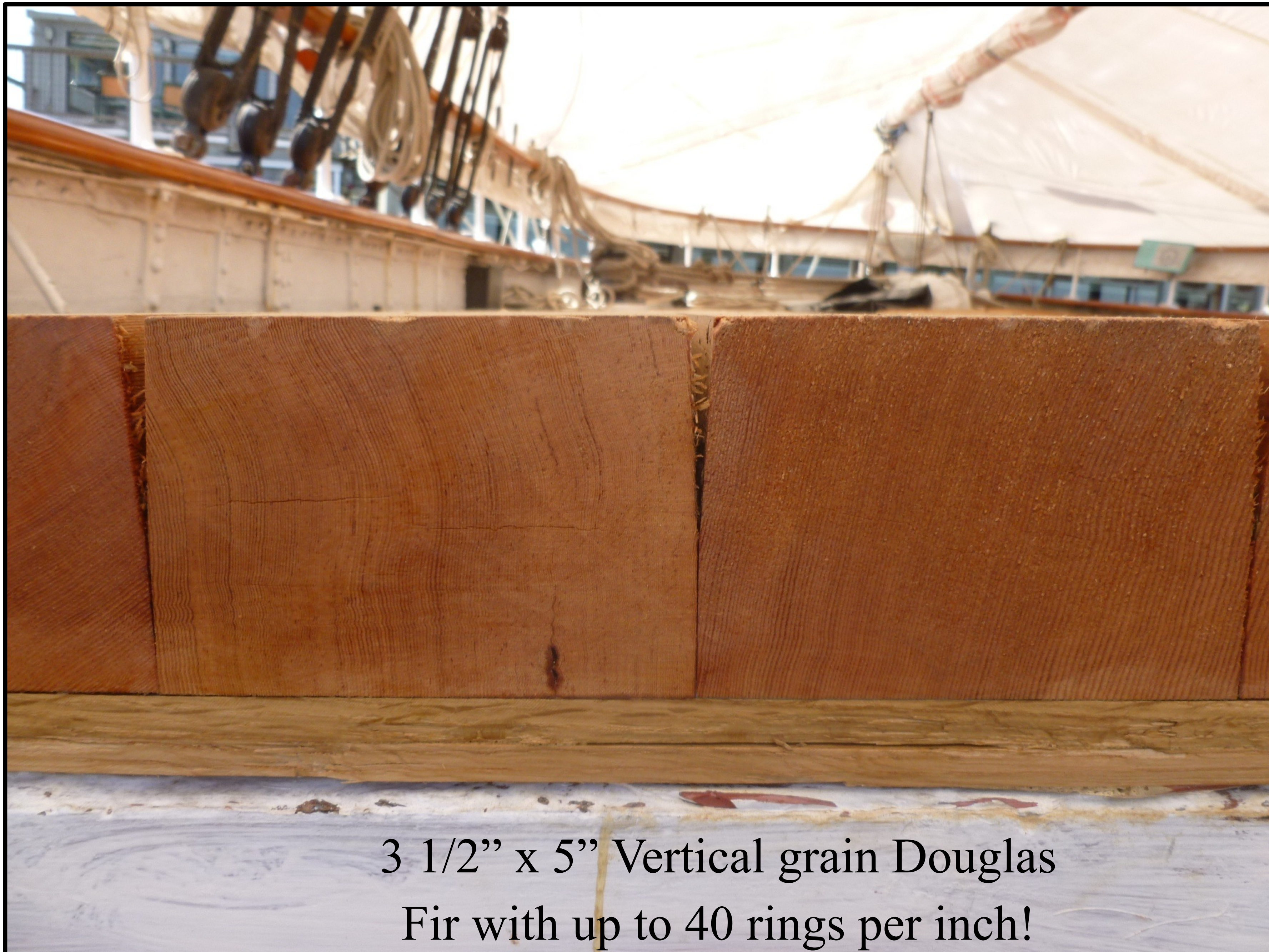
21,277 board feet of beautiful vertical grain old growth Douglas fir.

One of the first jobs was the demolition of the deckhouse.



Quarterdeck demolition begins.

It was a challenge keeping the ship open to the public during this job.

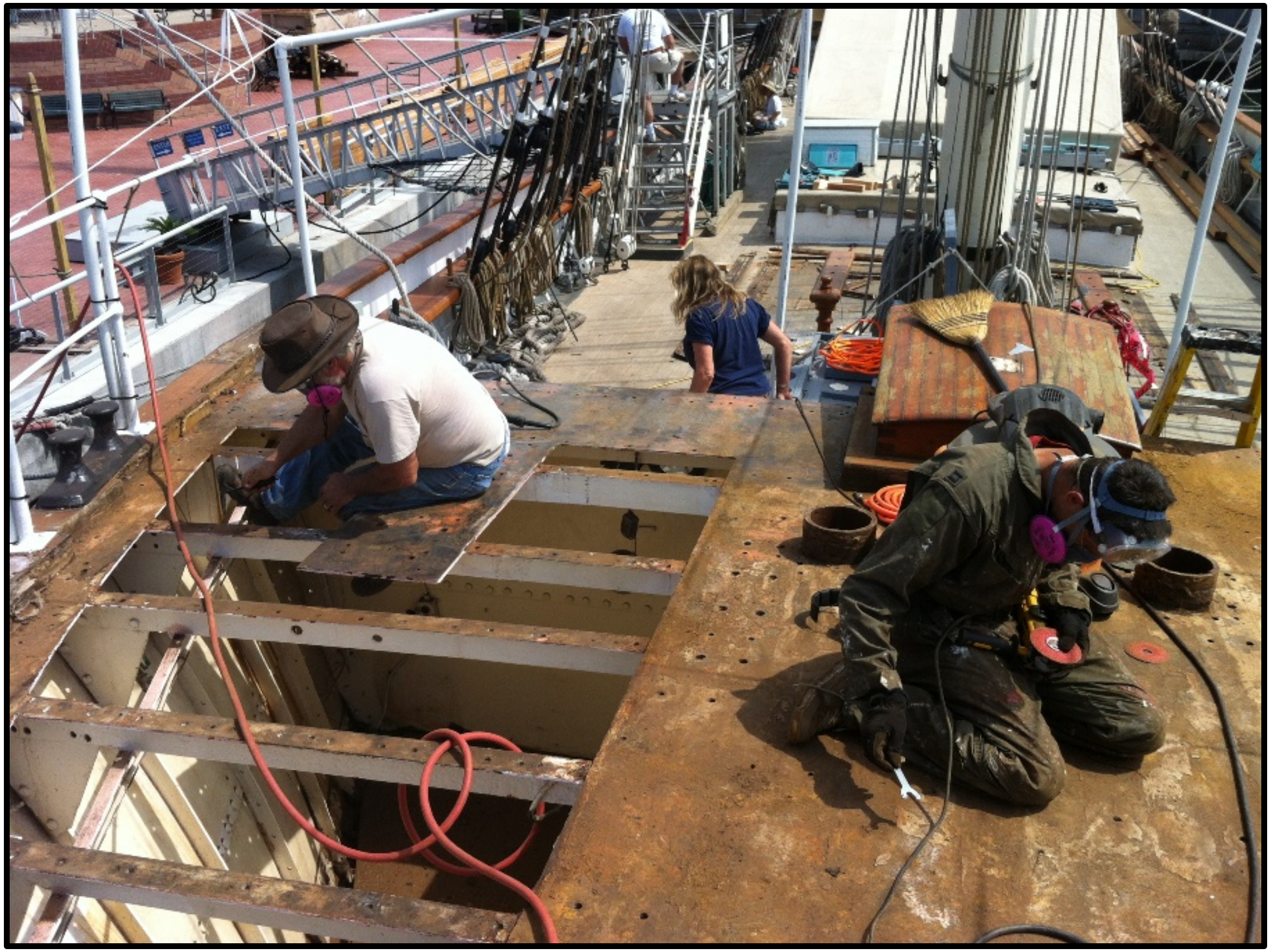


3 1/2” x 5” Vertical grain Douglas
Fir with up to 40 rings per inch!

Caulking ~ 1 pass of cotton and 2 of oakum.

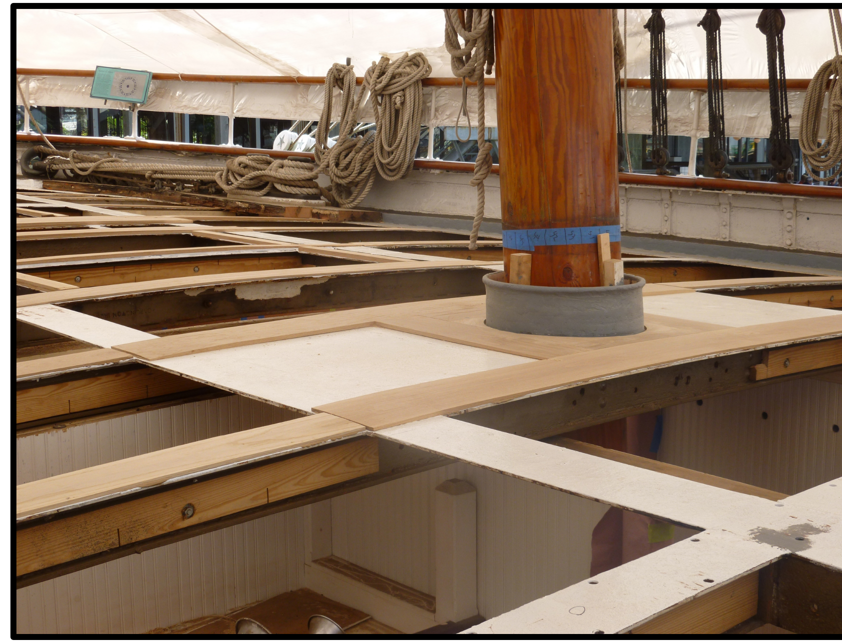
After caulking, the seams are “horsed” home with a large mallet called a Beetle.

Seams paid with pitch and
scraped smooth.



Dressing the steel plate on foc’s’le head deck.

Dressing the steel plate on main deck, before
painting steel and laying new decking.

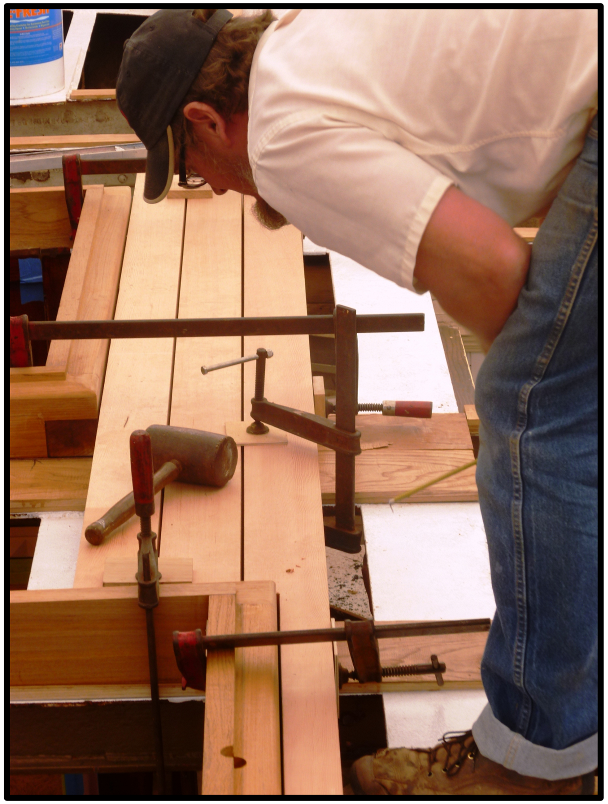


To avoid letting in the decking to lay flat against proud deck beams, all the low beams were shimed up with white oak shims. This eliminated the many cuts and exposed end grain of letting in the planks.

Teak skylight grub to serve as a base for new skylight.

Checking the fit of the shims and decking.

First planks being fit..



The beautiful vertical and tight grain of the Douglas fir decking.

Caulking the deck with one pass of cotton and two of oakum.

Fancy electric pitch pot and payed seams.

Rolling oakum next to the pitch pot.

Paying decks with traditional Jefferies #2 marine glue (pitch)

Fo'c'sle head deck.

Decking shims as on the main and quarterdecks.

All decks nearing completion.

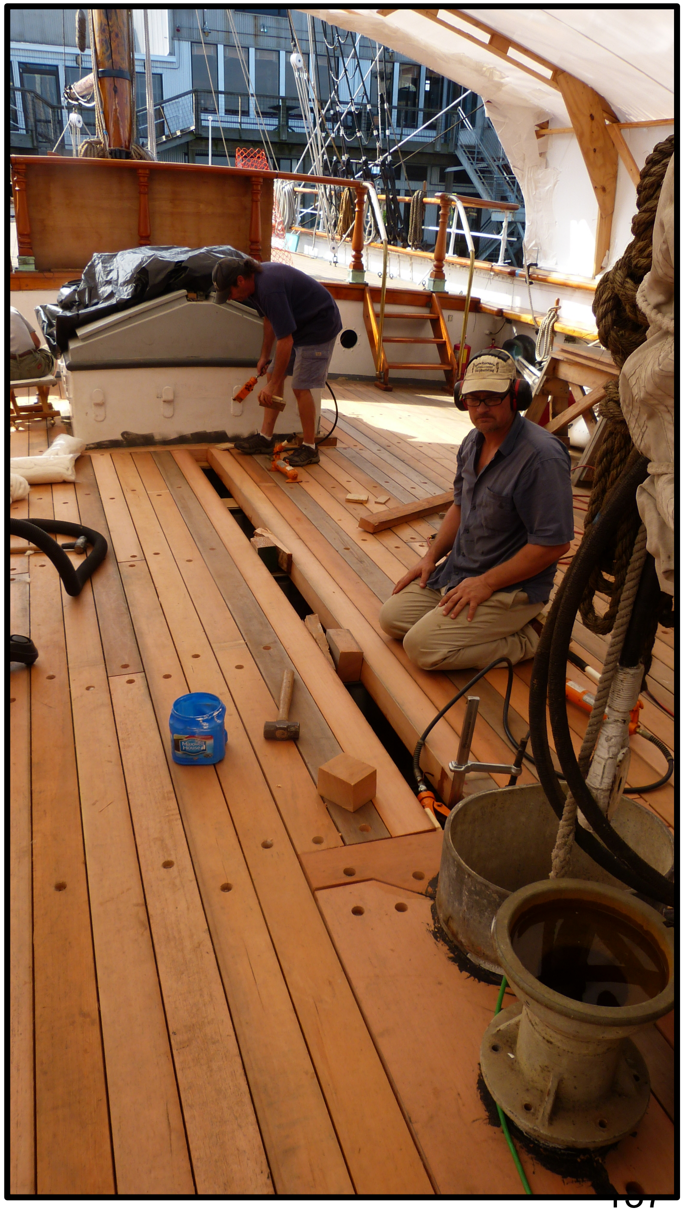
Signing the whisky plank.

Fitting the “Whisky Plank”


PRINTER

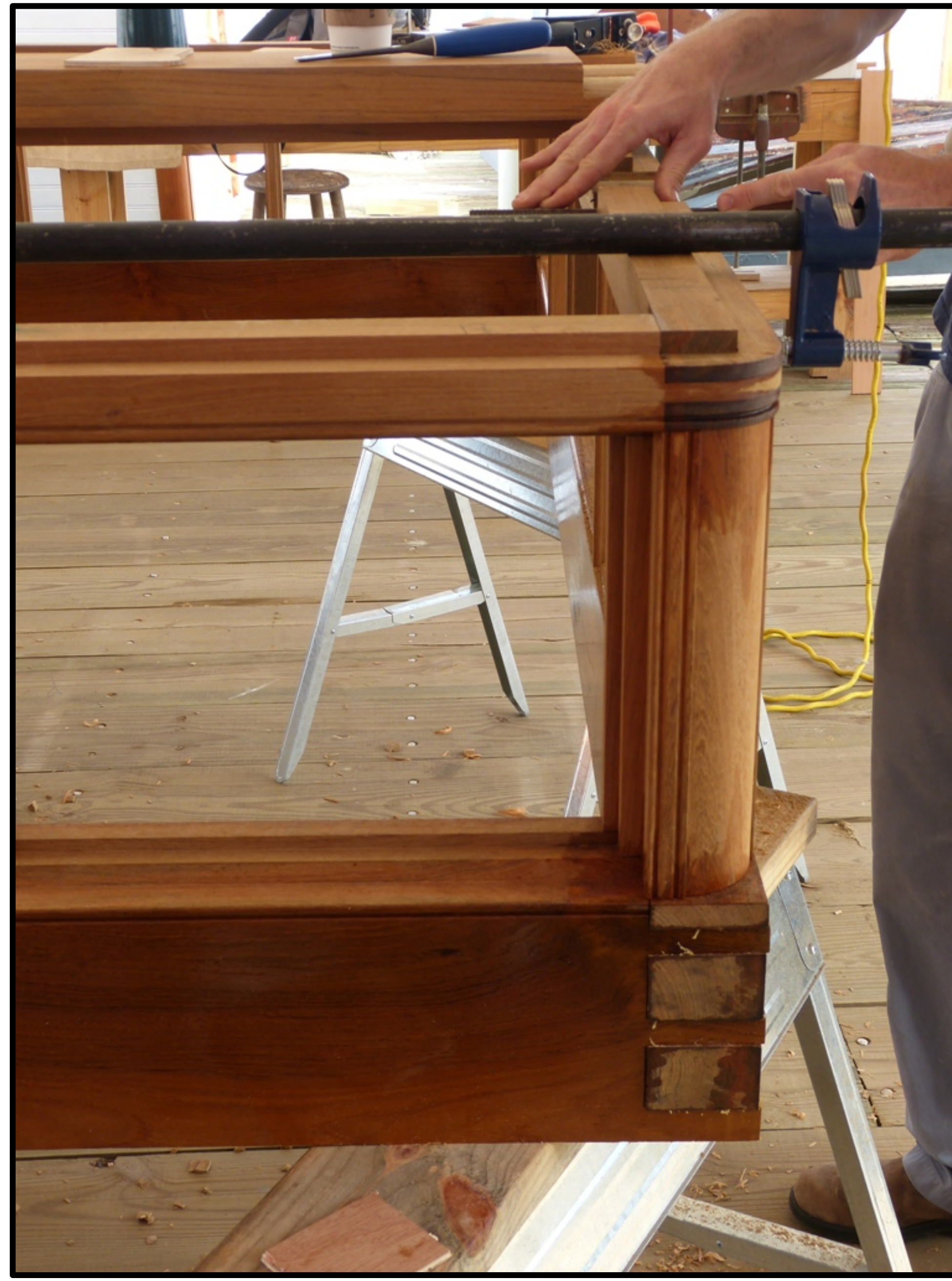
Rebuilt windlass and capstan coming aboard.

$12,000 of new teak margining planking.



A new teak skylight replicated from the 1877 teak skylight.

The new skylight being glued up and awaiting the new glass panels with an exact replication of original etched design.



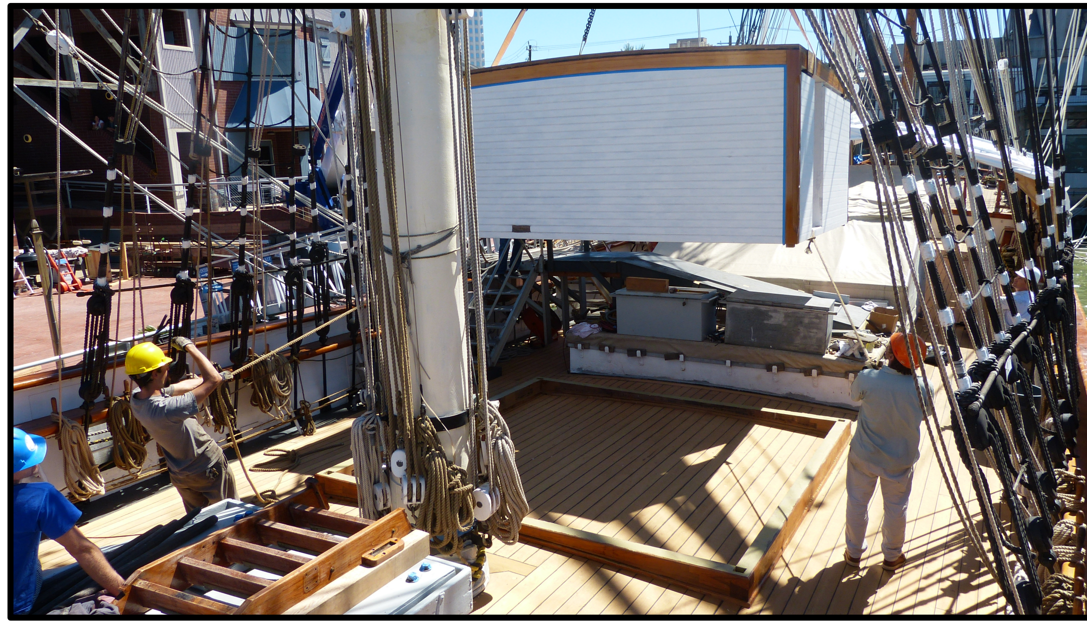
Hand-cut dovetails in 3” thick teak with exquisite detailing.

1877 aft companionway scuttle showing rot in base and joints. A new one was built to the exact dimensions with identical etched glass panels.

A new aft companionway teak
scuttle was built.

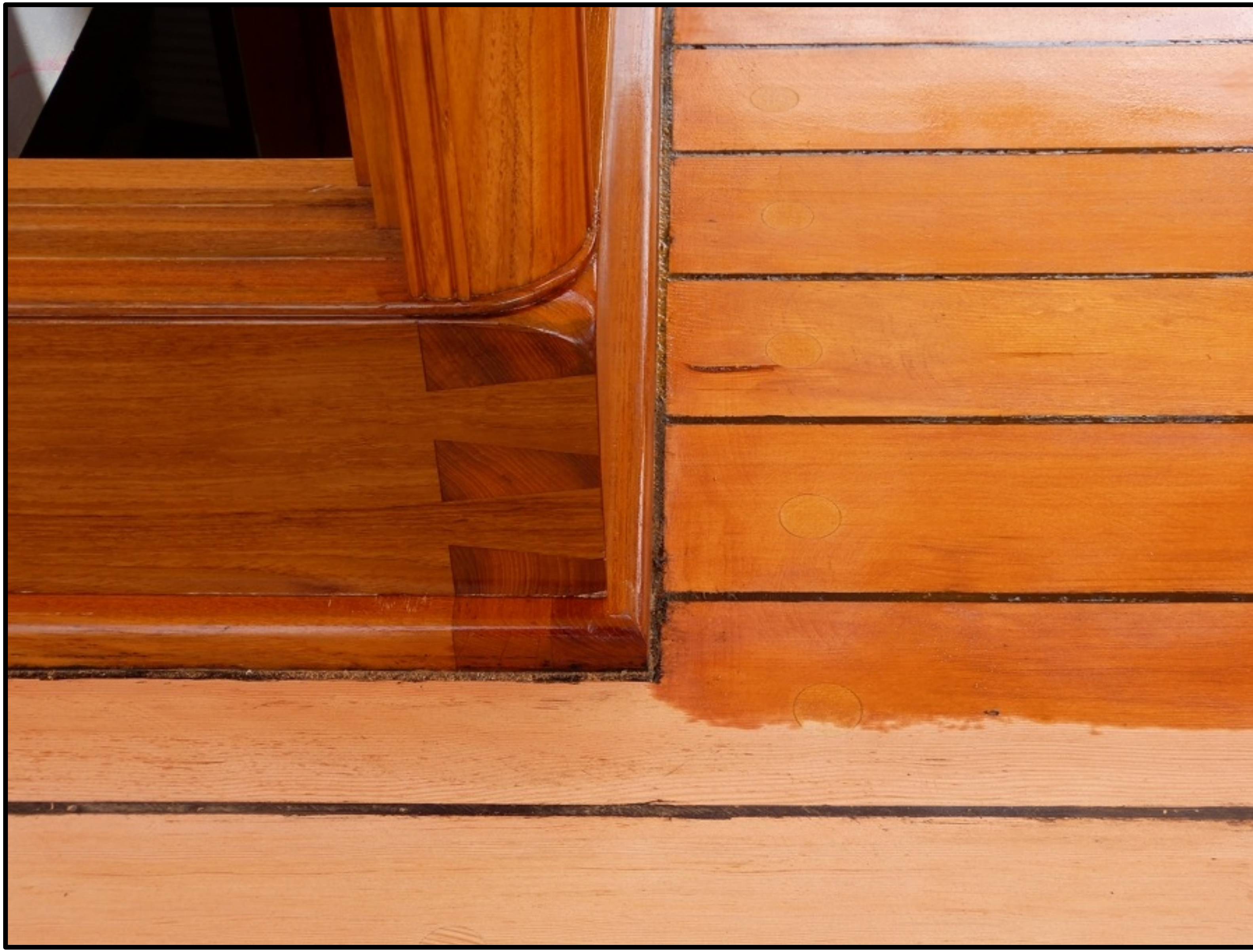
After scrapping the pitch, the newly rebuilt deckhouse came aboard..


GROVE



Bill Hynek applying finish to decking. Bill worked on ELISSA in Greece during the original restoration in the late 1970’s.

The bosun installs first of many eye bolts for the ELISSA's rigging.



Craftsmanship

Building out after side of deckhouse abaft the galley.

New tile laid on the galley deck and soapstone counter tops.

Quarterdeck finished with new
skylight and scuttle/companionway.

Glazing the new etched glass panels in the renewed aft companionway scuttle. We used Burma teak from the 1980 restoration of ELISSA to rebuild the skylight and scuttle.

Burma teak has a glow new plantation teak lacks.

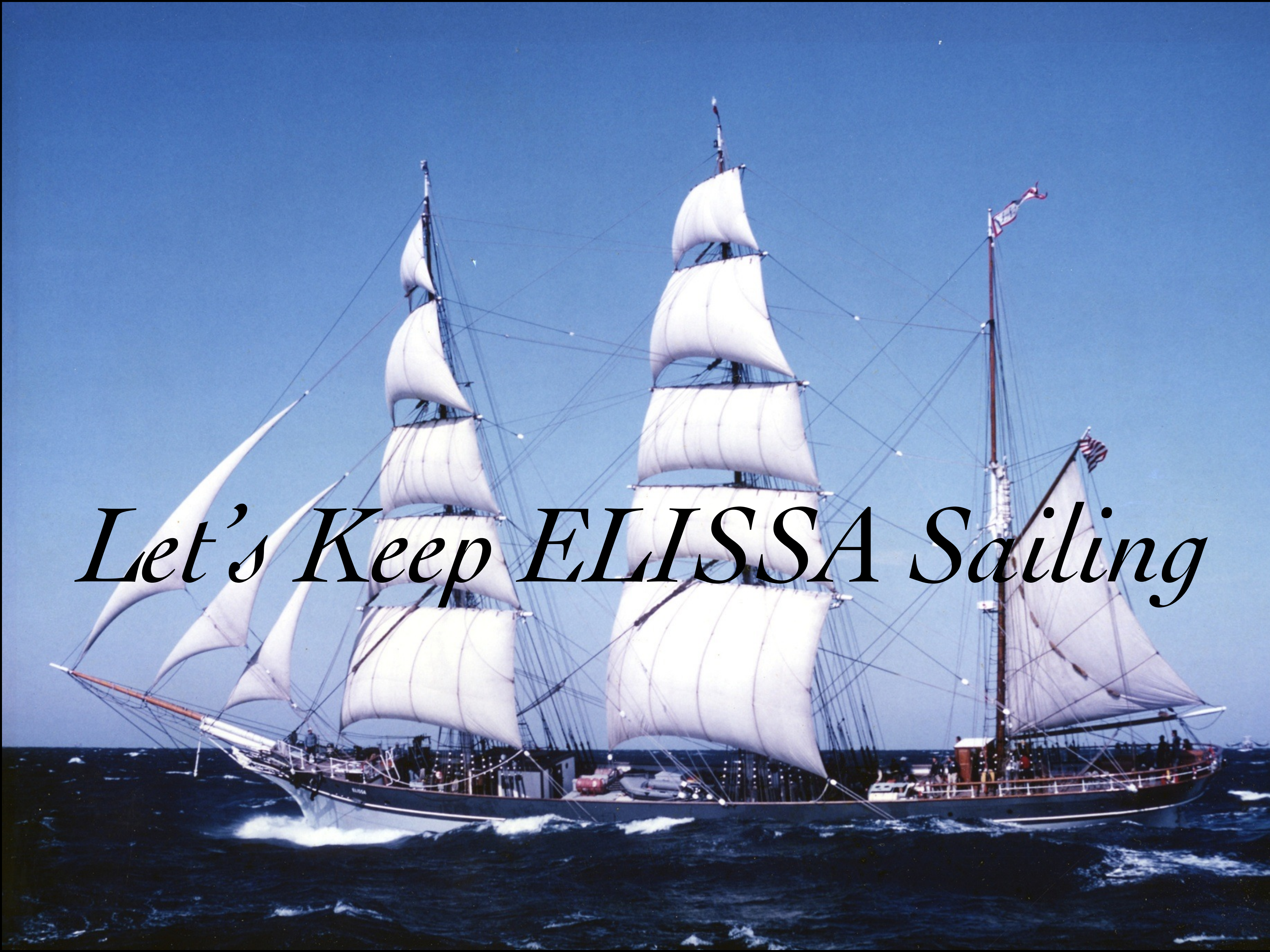
Before and after.


GHF

Ships have never been built for posterity, and to find ELISSA still sailing is beyond remarkable and a signal of her significance as a survivor from the Great Age of Sail. That is only half of the story, for the balance of ELISSA's tale is found in each of you…her crew and admirers.

Without volunteers, ELISSA would not be able to sail and cast her magic into this and future generations of her admirers, sailors and suitors. The critical and manifest importance of volunteers is a characteristic of ELISSA and the larger historic ships' community as a whole. Since restoration to full working order and sailing trim over 30 years ago, ELISSA has provided the public and her crew with unparalleled heritage maritime experiences through sea-going daysails off the waters of Galveston and along the Gulf Coast.

ELISSA has left a long wake since her restoration and it is her crew, her volunteers and supporters who have breathed life into her sails and rigging and brought her decks alive with the mate's cry of "mainsail haul".


Let’s Keep ELISSA Sailing