USCG photo

Figure 33. Point Bonita Lighthouse before rehabilitation; note missing gallery deck and holes below between the bottom of the lantern glass and top of the service room wall.

CASE STUDY: Rehabilitation of Point Bonita Light Station

by CWO3 Wayne Truax, USCG (formerly with CEU Oakland)

The original Point Bonita Lighthouse was built in 1855 on a cliff top in the Marin headlands 260 feet above the water. Within a few years of operation it became obvious that the light was too high and frequently blocked by the San Francisco fog. In 1877, a lower site on the point was chosen for a new lighthouse which reused the existing lantern and watch room.

Determining the Scope of Work

The poor condition of Point Bonita was first noted by the Officer in Charge of the San Francisco Aids to Navigation Team (ANT). His request prompted a site visit to Point Bonita in January 1993 to conduct a facility assessment and provide advice on how to repair the structure (see Figure 33). The original plan was to stop the water from entering the lighthouse and let Civil Engineering Unit (CEU) Oakland do the overall renovation in a couple years. But further investigation indicated the need for more immediate repairs, using self help-funding and the ANT personnel. The project soon grew into a full renovation that took six months and $75,000 to complete.

Researching Historic Details

In researching the history of Point Bonita, none of the books mentioned that the lantern on the current lighthouse was from the original lighthouse. Files at CEU Oakland had only site drawings describing the relocation of the lighthouse. Hundreds of copies of other 19th-century lighthouse drawings were available, but very little on Point Bonita. The Coast Guard Historian in Washington located two 1950s black-and-white photos that provided clear details of the awnings, storm doors, and gallery deck around the lantern that were removed in the early 1960s.

A lot of questions remained unanswered. The original 1855 Point Bonita watchroom, as in most lighthouses, was entered through the floor. The current watch room is entered through the side via a ladder from the first floor bunk room into the weather shelter on the southern roof. One door leads to the watch room and the other leads to the roof. Another problem was that the southern roof had at one time been completely covered by a large observation station. The lookout room had large, tinted green, plate-glass windows on three sides and electronic equipment installed. Was the ladder from the sitting room to the roof added; was the weather shelter even original? To compound problems, no original drawings of the current lighthouse were found.

In the process of moving files in the bottom floor at CEU, 12 file drawers and several boxes of microfilm were found. The drawers contained microfilm with drawings of almost every lighthouse on the west coast. The Point Bonita file, unfortunately, was missing. A check of all lighthouse files with a "B" in their name revealed the missing 1877 Point Bonita drawings, filed under Point Blunt. These drawings removed all doubt concerning the original historic features and made the restoration possible. During that same week, files of old black-and-white pictures were found in a cabinet. The Point Bonita file was full of pictures from the 1800s to modern day. There were pictures of the light after construction, as well as demolition photos of the exterior gallery deck and pictures of the now-removed observation room.

The old black-and-white pictures as well as the original drawings provided a strong base to work with, but not all the dimensions were clear or listed. Facilities assessments visits to several lighthouses built in the late 1800s helped. A visit to Cape Disappointment Lighthouse in Washington was most useful. Cape Disappointment and the original Point Bonita Lighthouses were both built in the mid 1850s and had the same style lantern, as well as the unique eagle-head downspouts for the roof gutters. Although Cape Disappointment was a larger first-order lantern and Point Bonita a second order, many of the details and dimensions were the same. The Cape Disappointment visit provided measurements, construction details, and close-up photos for later work at Point Bonita.

Gallery Deck Restoration

Investigative demolition followed. The original gallery deck had been removed in the 1960s, but no details were available on how it was performed. First removed was the fiberglass cloth that sealed the watchroom panels to the lantern room and covered the areas of the original gallery deck brackets. Fortunately, the old brackets had been cut off above the wide base flange with a torch, leaving the tenons from the original brackets intact inside the cast-iron lantern frame (see Figures 34 and 36). Removal of the remaining tenons from the frame and fabrication of new gallery deck brackets duplicating the originals proved impractical because the tenons were rusted tight and pinned in place. The tenon was therefore used as an anchor. The old base flange flush with the frame was cut using a portable metal-cutting bandsaw and the area ground flush. A special jig was designed for the magnetic drill press; two holes were then drilled and tapped directly between each set of tenons (see Figures 35, 36, and 37). A one-inch-thick mild steel mounting plate consisting of two recessed bolt holes and four tapped holes was then put in place. (304 S/S might have been an even better choice; the mild steel is holding up well, but may become a maintenance problem if the lighthouse isn't properly maintained.) The two recessed holes allowed the plate to be bolted to the lantern frame and the new bracket bolted directly over the two base bolts. The area beneath the plate was covered with a 1/8-inch layer of Belzona Metal filler to ensure there would be no voids and to act as a leveling compound (see Figure 38). The bolts as well as the plate were covered with a releasing compound (Vaseline)

USCG photo

Figure 34. Close-up showing what remained after the gallery deck brackets were cut off with a torch. Note the heavy rust and paint failure caused by exposure.

and then slowly tightened until the plate was plumb. The Belzona was then allowed to dry before all excess Belzona was ground off (see Figure 39). This procedure worked very well and took no more than three days to accomplish. The base plates were then primed, painted, and caulked before being torqued in place.

The new gallery deck brackets were constructed of 3/4- and 3/8-inch steel plate welded and fabricated to match the original cast-iron brackets details. (This is another area where 304 S/S might have been better.) The stanchions were made of 1-inch 304 S/S round stock and 1-inch 316 S/S bolts. The bolts had a 1-inch diameter and 1/4-inch-deep recess machined in the head to ensure the bolts were properly aligned during welding. Custom 1-inch 316 S/S acorn nuts were then purchased to secure the stanchion to the brackets and the handrails. With the brackets and stanchions in place, the 3/8-inch flat bar handrails were then drilled, scribed, and fitted (see Figure 40).

Figure 35. Jig used to bore holes in the gallery bracket tenons.

Figure 36. View of the gallery bracket tenons after the holes have been drilled. The tenon on the right connected to the exterior gallery; the tenon on the left is part of the interior gallery deck bracket. The 'v' that has been stamped in the end of the left tenon is an assembly identification mark.

USCG photos

Figure 37. After drilling, threads were cut into each hole using a hand-operated tap.

USCG photo

Figure 38. To provide a plumb mounting surface for the gallery deck, each mounting surface was covered with Belzona (a two-part metal paste); then the mounting plates were installed and tightened until they were plumb. The excess Belzona can be seen oozing near the middle of the plate.

The hard part was laying out the new gallery deck. One 3-foot section of 1/4-inch-thick hard board was laid out at a time. Each section was different and had to be custom fitted. The completed templates were then taken to the Coast Guard Industrial Metal Fabrication Shop and used to lay out the new 3/8-inch 6061 aluminum diamond-plate gallery deck. Once completed, the new gallery deck sections were brought back to the lighthouse for final drilling, fitting, and painting. (The aluminum is working well here, with no signs of dissimilar metals reacting. S/S diamond plate, might however, avoid any future problems (see Figure 41).)

The final installation of the gallery deck required the use of an impregnated felt tape between the dissimilar metals to avoid galvanic reaction. All hardware was also coated with anti-seize compound before being installed. The choice of aluminum was based on cost and the knowledge that when properly installed, it will function very well with other materials. In an effort to ensure that the structure has a long life, however, dissimilar metals should be avoided. Not everyone who does maintenance

USCG photo

USCG photo

Figure 39 (left). View of the mounting surface after the Belzona had cured and the mounting plate had been removed. The 'knobs' or protrusions on the surface are where the Belzona was squeezed through the holes in the mounting plate. These were ground off along with the excess Belzona that squeezed out around the plate.

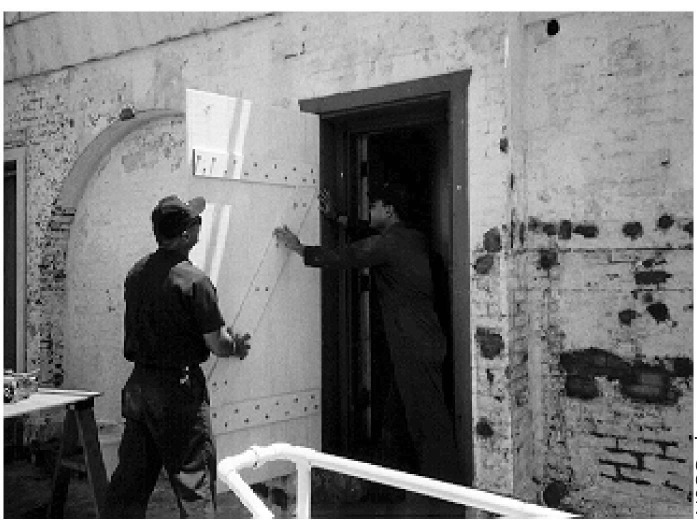
Figure 40 (above). The new gallery deck brackets after installation.

USCG photo

Figure 41. Final fitting and installation of the new aluminum deck plate.

USCG photo

Figure 42. View of the Point Bonita Lighthouse after the gallery deck replacement.



USCG photo

Figure 43. Installation of the new exterior wood storm door.

on lighthouses understands dissimilar metals or even how to ensure that materials are properly reinstalled (see Figure 42).

Awnings and Exterior Doors

The exterior copper awnings were easy to duplicate and relocate. The historic black-and-white photos provided close-up views, and the outlines of the original awnings were still visible. A sheet-metal shop reproduced the awnings based on dimensions and the old photo. The wall anchors should have had S/S hardware. This is minor item and can be easily corrected with new anchors.

The exterior storm doors were also easy to duplicate. The pictures were clear and showed one door open and one closed. Both exterior doors were made of 1- by 6-inch tongue-and-groove redwood and fastened together using S/S carriage bolts, nuts, and washers. After the doors were test fitted, they were disassembled, primed, painted, and reassembled. These doors have held up extremely well and have given no trouble (see Figure 43).

Figure 44. *Before the rehabilitation*. Note the doors at the watch room. A new louvered panel will be installed for added ventilation.

CASE STUDY: Rehabilitation of Point Conception Light Station

by Judd Janes, USCG Architect, formerly with CEU Oakland

In 1995 the U.S. Coast Guard completed a major six-month rehabilitation of Point Conception Light Station located near Lompoc, California. The historic lighthouse was built in 1882 and contains its original first-order Fresnel lens. Other than being automated in 1973, the only major structural rehabilitation to the light station was in 1947. The goals of the project were to stop the water infiltration and condensation that was accelerating the deterioration of the lighthouse; repair all damaged structural members; and install new work that would require minimal maintenance by Coast Guard personnel. The major structural work on the lantern involved complete reconstruction of the lantern gallery deck, the lantern ladder, ladder rails, cornice, and sill castings as well as installation of a natural ventilation system to reduce condensation. The extremely remote location (approximately 30 miles off the highway and down 198 steep wooden stairs) as well as constant exposure to heavy rains and over 100-m.p.h. winds made the project extremely challenging.

Determining the Scope of Work

The main factors in determining the scope of work were overall project cost and preservation of the integrity of the structure. The original budget was set at $250,000. Given the severity of the deterioration, the primary focus was to complete all major structural repairs to the lantern, as well as minor painting and repairs to the masonry tower and fog signal building.

Selection of the Contractor

A contractor was chosen under the 8A Small Business Administration Program who was experienced in previous Coast Guard light station rehabilitation projects.

This particular method of government contracting involves negotiating the final cost of the job with one known contractor, rather than a low bid situation with many unknown contractors. In California, the Coast Guard has been able to use the 8A program effectively to achieve a more consistent quality of workmanship. Light station projects require very specialized skills, so selecting a qualified contractor is crucial. Prequalification criteria should require knowledge of the *Secretary of the Interior's Standards for Rehabilitation*, and include the minimum following experience:

- Logistic planning and mobilization for remote sites.
- Rigging and scaffolding around towers and historic structures.
- Asbestos and lead paint removal on historic structures.
- Masonry and concrete repair on historic structures.
- Fabrication and repair of historic metalwork.
- Applying industrial paint systems in marine environments.

Logistical Planning

Because of difficult site accessibility, all materials were airlifted to and from the light station via helicopter. Since helicopter services are very costly, staging had to be planned very carefully. A complete inventory of materials and equipment was required in advance to determine size and weight of the lifts. The proximity of the staging area to the lighthouse was also critical given the radius of the blades and the local wind conditions. No electrical, telephone, water, or sanitary facilities were available for use onsite. Basically, everything had to be brought in and out by the contractor. The lighthouse is 198 wooden steps down from the parking lot; the nearest town is located over 40 miles away, down one-lane roads following hairpin turns and steep ravines. The contractor's mobilization costs, as well as personal travel and per diem costs, significantly increased normal project costs.

Figure 45. *Staging the work.* Note the temporary location of the auxiliary light on the fog signal building chimney.

The weather was also a major factor on this project. Heavy fog, rain and plus-100-m.p.h. winds, common at Point Conception, caused many delays in the construction schedule and created extremely difficult working conditions. At one point during the project,


USCG photo

Figure 46. *Lighthouse lantern before rehabilitation.* Note the missing ladder rails and the severe rust on the lantern cornice and lower watch room panels. The badly spalled concrete gallery deck was installed in 1947 and is not original.

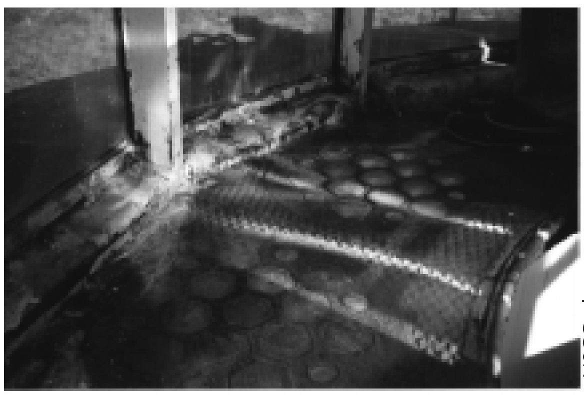

USCG photo

Figure 47. *Lantern room before rehabilitation.* Note the lower sill channels filled with concrete. This shortsighted 'repair' method blocked the ventilators and caused condensation to spill out on the deck, effecting rust and further damages below.


USCG photo

Figure 48. *Reconstructing the cornice.* The cornice plates were removed to expose the corroded cast-iron brackets and top channels. New brackets were cast in bronze, and the top sill channels were fabricated in stainless steel. Note the plywood 'curtain' erected for weather protection and shoring the lantern roof during reconstruction.

heavy rain washed out portions of the road, which cut off access for over a week. A special plywood 'curtain' was erected in the lantern room with clamps to protect the classical lens from the weather and shore up the lantern structure during reconstruction.

Dissimilar Metals

Although surface rusting was the main problem at the lantern, some of the deterioration was caused by galvanic reaction between dissimilar metals. Dissimilar metal problems were eliminated by replacing the original deteriorated cast-iron cornice plates and brackets with copper and bronze. The original copper roof dome was then stripped of its paint and allowed to naturally patina. Besides low maintenance, the other advantages of copper are its flexibility to withstand strong winds, building movement, and wide temperature changes. In other areas, neoprene gaskets, felt or teflon tape, thick epoxy primers, and bituminous paints were used between dissimilar metals to prevent future corrosion.

Preparation Methods and Painting Systems

The Secretary of the Interior's guidelines mandate using the "gentlest method possible" in preparing surfaces on historic buildings. This generally means hand tool preparation, non-caustic strippers, and low pressure blasting. Given the lead paint and heavy rust on the lantern, a variety of methods were used including chemical stripping, hand tool preparation, power tool preparation, and grit blasting. The existing exterior paint on the masonry tower and fog signal building was in

Figure 49. *Reconstructing the gallery deck.* After removing the existing concrete, remnants of the original cast-iron deck were found.

Figure 50. *Lantern cornice after rehabilitation.* Replacing the original steel cornice plates with copper eliminated the dissimilar metals problem.

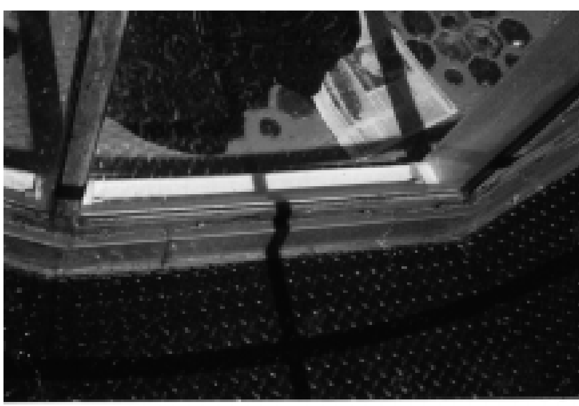


Figure 51. *Lantern galley deck after rehabilitation.* The new gallery deck was fabricated with stainless steel diamond plate and carefully flashed with copper at the lantern room. The interior lower sill channels were rebuilt to catch condensation from the glass.

good condition and required only hand scraping and washing to remove the loose paint, dirt, salt, and contaminants. The interior masonry walls of the tower were stripped of loose paint and repainted with a 'breathable' acrylic paint to alleviate hydrostatic pressure. Paint removal on lighthouses can be a costly operation because it often involves lead or asbestos abatement. This can necessitate using specialized safety equipment and tools, as well as hiring certified abatement contractors and installing very expensive containment systems.

Painting in this harsh marine environment was a difficult challenge. To avoid flash rusting, a rust inhibitor was applied immediately after preparing the surfaces. Even with this painstaking effort, bleeding rust was a constant problem that often led to rework. Under these conditions, it is unrealistic to expect any paint system to last beyond five years without some maintenance. The following generic paint systems were selected based on durability, performance over minimally prepared surfaces, non-toxicity, and permeability:

- Exterior ferrous metalwork: synthetic rust inhibitor, inorganic zinc primer (new metal only), high-solids self-priming epoxy, aliphatic polyurethane topcoat.
- Interior ferrous metalwork: waterborne epoxy primer, epoxy acrylic topcoat.
- Exterior masonry and concrete: elastomeric acrylic, coarse texture.
- Interior masonry: 'breathable' acrylic, minimum 55% permeability.

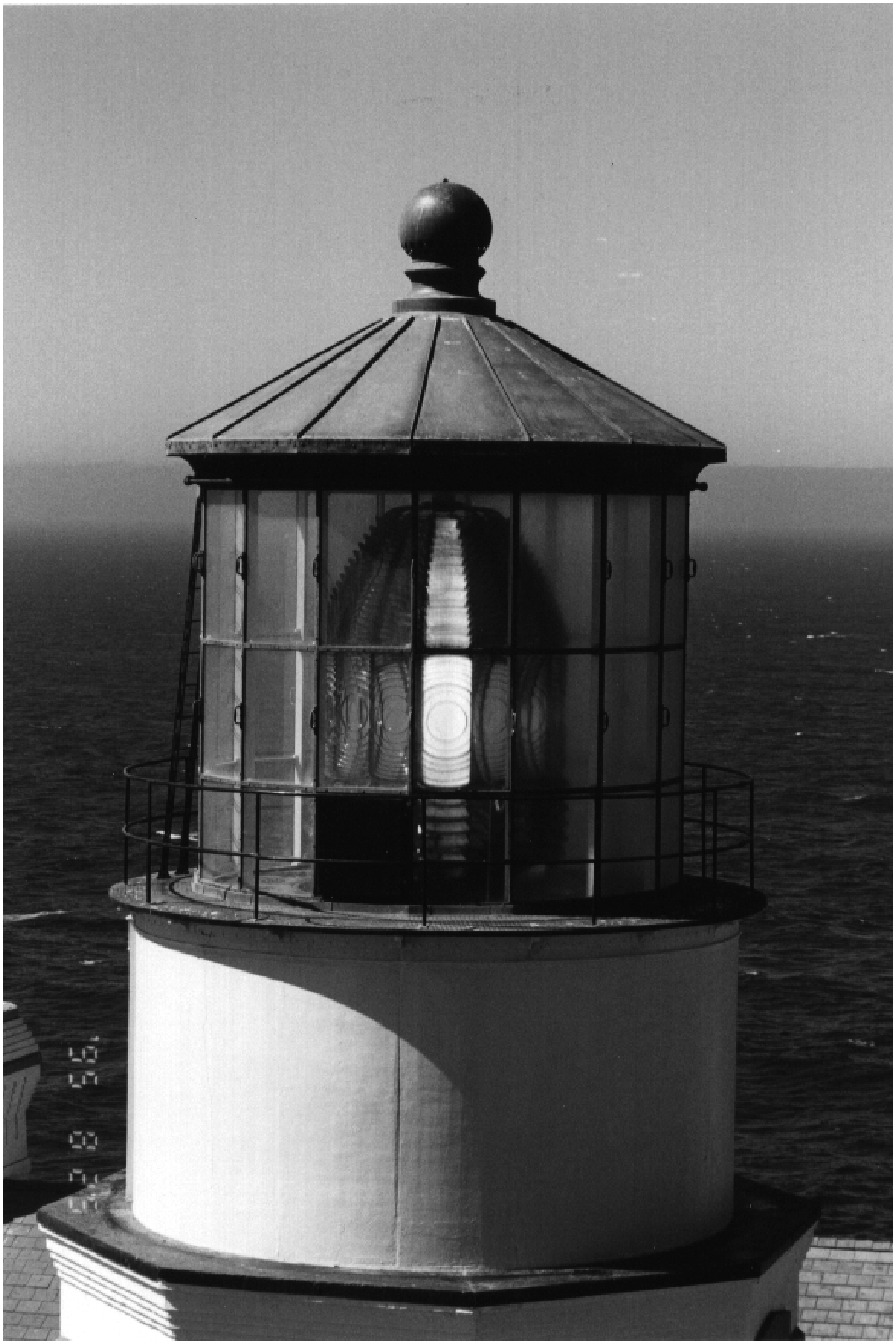


Figure 52. *Light tower lantern after rehabilitation.* The nonferrous metalwork at the lantern room is left unpainted and allowed to naturally patina, thus saving maintenance costs.