PRESERVATION TREATMENTS

WARNING: Many of the maintenance and repair techniques described in this text, particularly those relating to cleaning and painting, are potentially dangerous and should be carried out only by experienced and qualified workmen using protective equipment suitable to the task.

Lantern features such as gallery deck brackets, handrails, lantern frame structures, decorative panels cast into parapet walls, as well as textured finished surfaces such as raised-diamond-pattern non-skid surfaces, lantern glass, roof shape/material, etc., are important in defining the historic character of the lighthouse. Character-defining features should be retained during any treatment.

Protection and Stabilization (Mothballing)

Before mothballing, a thorough inspection and diagnosis should be performed, using the inspection chart in the preceding section as a guide. Keep in mind that a lighthouse lantern is designed to be an active part of the lighthouse. The light keeper gave the lantern daily maintenance attention. When mothballing a lighthouse lantern, this regimen of care and attention cannot be continued. As a substitute for daily attention and care, a comprehensive mothballing plan may be prepared using the following guidelines.

Weatherization

When a lighthouse lantern is mothballed, it is essential that the exterior envelope be completely weathertight. To prevent moisture penetration, be sure the following infiltration points are weathertight or functioning properly:

- ***Lantern roof***: The lantern roof must be made weather tight during the mothballing period. Any metal roofing patches should be made with like-kind materials soldered in place. In the case of excessive deterioration, a new roof which matches the original in material and configuration should be considered as a protective measure during the mothballed period. (For more information refer to the discussion on roofing later in this section.)
- ***Lantern glass***: Lantern glass and frames must be weathertight. Damaged glass can be temporarily repaired using sheet metal and caulking. Caulk patches should be used only as a temporary fix and not relied on during the mothballing period. To minimize water infiltration, damaged glass should be replaced as soon as possible, using glass because of its superior weathering qualities. (For more information on lantern glass replacement refer to the repair treatment later in this section.)

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Figure 17. Roof vents such as these should be inspected for leaks and maintained during the mothballing period. This shroud-style vent allows air to pass while preventing rain from entering.

- ***Built-in guttering systems***: All rain water guttering systems (lantern roofs, or other tower roof forms) should be cleaned and checked for holes. All holes and non-functioning gutter system components should be repaired. Holes in sheet-metal, built-in gutters, should be properly soldered to ensure the soundness of the repair (see Figure 18). Caulking should be used only for temporary repairs until a proper soldered repair can be made. (For more information refer to the lantern roof discussion later in this section.)

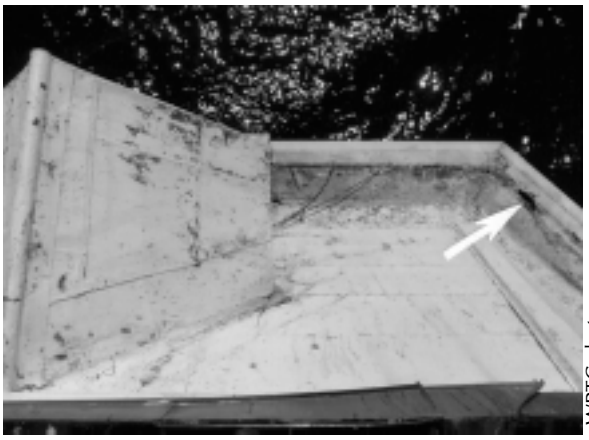

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Figure 18. View of built-in gutter on a caisson lighthouse; arrow indicates fist-size hole. This condition must be treated before mothballing.

- ***Gallery decks****:* In most lighthouses gallery decks are cast-iron, sheet-metal-covered wood, stone, or concrete. These decks are generally laid directly on top of the wall structure and act literally as the roof for portions of the lighthouse below. The decking should be sloped away from the lighthouse to shed the water away from the structure. If the decking material is not weathertight, moisture can enter the interior of the lighthouse or lantern. (Refer to the following repair treatment in this section for more information concerning the weatherproofing of gallery decks.)
- ***Parapet hatch, service room door:*** Regardless of the size of the lantern, it will have a hatch or door of some form in the lantern itself or in the service room that provides access to the exterior of the lantern. This opening must be made weathertight. To achieve this, the latch and hinges must be lubricated and in working order. The opening should be fitted with a gasket material such as neoprene that is both readily available and long lasting. The flashing that protects the door opening must also be in working order so that it diverts water away from the door or hatch opening.
- ***Service room windows:*** For more information on window treatment, refer to the **Windows** section.
- ***Protective coatings:*** As a protective measure and for daymark purposes, lanterns were

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Figure 19. The repair made to this stone gallery deck has begun to deteriorate; moisture penetration is occurring. This condition should be addressed before mothballing.

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Figure 20. Close-up of a vented parapet hatch in a fourth-order lantern. The hatch should have a good seal and still remain operable. The built-in vent should also be kept open to maximize ventilation of the lantern and tower.

historically painted. As part of a mothballing treatment, the exterior coating should be checked for loose and flaking paint. Any deteriorating areas should be scraped and repainted to match the existing color. Ultimately, as part of a mothballing treatment, the entire lantern should have all loose and flaking paint removed and a new coating applied (if the lantern was historically painted) according to the manufacturer's specifications. This action will result in a coating system that will require minimal service during the mothballed period. (For more information refer to the discussion on paint and coating systems in the **Iron** section. For more information on lantern coatings refer to the Anacapa Island Lighthouse case study in Part V., **Beyond Basic Preservation**.)

Stabilization

Because the lighthouse lantern plays a role for protecting both the lighthouse and the illuminant, the structure should be sound during the mothballing period. Stabilization treatments should be reversible and fail-safe; effective methods include: installation of intermediary bracing and shoring that supports compromised members; 'sistering' of wood or steel members to compromised members to help carry the load. Treatments should not interfere with the daily operation of the light. With this in mind, it would be advantageous to repair any structural deficiency before mothballing the lighthouse. A structural engineer or historical architect should be consulted for a proper stabilization or repair treatment plan.

Ventilation

During any preservation treatment the vents should remain operable to allow the maximum amount of air flow through the lantern. To prevent pest infiltration, the exterior openings of the vents should be screened with fine brass or stainless steel screen. When vents are kept open, natural convection caused by sunlight heating the air within the lantern will create a chimney effect as the warm air rises that will help maintain an ambient temperature and humidity within the lantern. The chimney effect will also aid in the ventilation of the

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Figure 21. The diagonal tension rods in this empty lantern were installed to brace the lantern against lateral loading caused by high winds.

WPTC photo

Figure 22. Close-up of sill vents in a first-order lantern. The vents should be kept open during the mothballing period to maximize lantern and tower ventilation.

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Figure 23. As part of the lantern mothballing treatment the lantern glass sill vents should be kept open (except in extremely damp climates) to allow for the free flow of air through the lantern.

entire lighthouse. (For more information on lighthouse ventilation refer to the **Windows** and **Interiors** ventilation sections.)

Fire Protection

Despite the fact that lanterns are constructed of predominantly noncombustible materials, fire is still a threat to irreplaceable combustible components of the lantern. For guidance on these issues, refer to "Fire Prevention and Protection Objectives" under **Related Activities** in Part V.

Repair

WARNING: Many of the maintenance and repair techniques described in this text, particularly those relating to cleaning and painting, are potentially dangerous and should be carried out only by experienced and qualified workmen using protective equipment suitable to the task.

A thorough inspection and diagnoses should be performed using the earlier inspection chart as a guide, and a preservation treatment plan developed. If the lighthouse is still an active aid to navigation, the preservation plan should include repair treatments to ensure the effective operation of the lighthouse and lantern in the future. The following are general guidelines for repairing a lighthouse lantern.

Galvanic Corrosion

As mentioned previously, galvanic corrosion is an electrochemical action that results when two dissimilar metals react together in the presence of an electrolyte, such as water containing salts or hydrogen ions. This type of corrosion is normally only significant between groups separated by lines shown in the Galvanic Series in Water Table in the Special Conditions Associated with Historic Lantern Systems found earlier in this section. Galvanic corrosion is the result of a spontaneous flow of positive electric current from the more 'noble' metal to the more 'base' metal. The severity of the galvanic corrosion depends on the difference between the two metals, their relative surface areas, and time.

Methods of Galvanic Corrosion Prevention:

- When repairing damage that has been caused by galvanic corrosion, first clean all surfaces of corrosion; second, identify the condition that caused the corrosion to form; third, address the problem with one of the prevention methods below.
- Ensure that the electrolyte, water, is not allowed to penetrate joints between dissimilar metals. The joints can be sealed using the existing detailing (i.e., flashing, profiles of members) combined with modern caulks and sealants.
- Use non-reacting stainless steel or brass fasteners when joining two dissimilar metals that have a potential for galvanic reaction. Brass screws are preferable to stainless steel. The hardness of the stainless steel screws may damage the receiving threads if not properly aligned. If the threads have been damaged, they will need to be tapped for a slightly larger screw.
- Always apply an anti-seize coating to fasteners before inserting them. This will prevent corrosion from forming in the hole which could cause the fastener to break off.
- Provide a barrier between the dissimilar metals. This barrier can be simply a coating of a corrosion-inhibiting paint that is rated as an electric insulator. If the original detailing provided for a gasket-type barrier, a chromate-impregnated wool, felt tape, or a commercially available neoprene gasket material may used.
- All welds should be made from a more noble material than the remainder of the structure.

Rust-Jacking

Rust-jacking is a deterioration condition associated with any iron or steel component. The 'jacking' is the result of the chemical change that takes place when iron corrodes or rusts. As the iron rusts, it changes from iron to iron oxide; this change is the result of the oxygen carried in water combining with the iron. The resulting iron oxide takes up more volume than the iron. The force of this expansion is strong enough to crack glass and force steel components apart. Lantern glass in this condition can cause severe damage. When moisture enters the channel that retains the glass, the iron frame may begin to rust. As the iron rusts, it expands and in turn cracks the glass. (For information concerning the repair of damaged or deteriorated iron, refer to the **Iron** section.)

Methods for Preventing Rust-Jacking

- Prohibit the infiltration of water into gaps between iron lantern frames and bronze window sub-frames, as well as other seams in iron or steel components.
- Maintain coatings and detailing that divert and shield water away from members that are prone to rust-jacking.
- When iron or steel components are repaired, be sure to coat any areas that have had their finish damaged with a corrosion prohibiting primer and top coat.
- Minimize condensation buildup in the lantern by providing adequate ventilation within the lantern at all times.

Ventilation

Nearly all, if not all, lanterns have a ventilation-ball-type vent and baffled secondary vents in various locations in the lantern and service room. These vents provided the fresh air for the illuminant and created a light draft that minimized condensation buildup inside the lantern. Air flow through the vents was also controlled by a variety of sliding registers and/or rotating dampers. To maintain an ambient humidity level in the lantern, the built-in ventilation system should be in working order, with all possible vents open to allow the maximum amount of air exchange to occur in the lantern. The exterior vent openings should be screened with brass or stainless steel screen to prevent bird and insect infiltration. Opening the lantern vents will aid in the overall ventilation of the lantern.

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Figure 24. The stainless steel through bolts used to join this bronze sash bar to the vertical lantern post is isolated from the bronze using a nylon washer as a barrier.

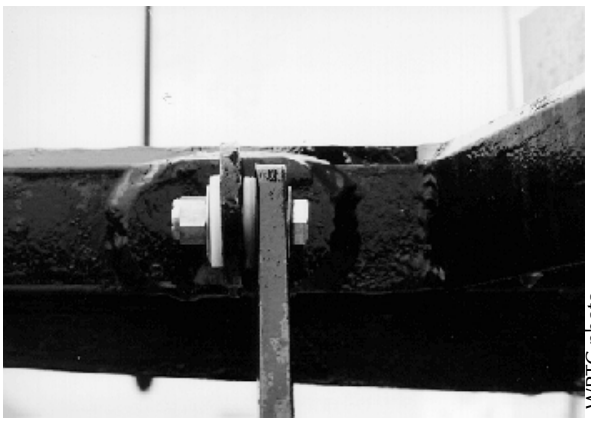

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Figure 25. This is a view of a typical dissimilar metal isolation solution; the steel ladder post (vertical member in the center of the image) is isolated from the aluminum lantern gallery deck with nylon washers. The bolt chosen for this application is made from Type 316 stainless steel.

WPTC photo

Figure 26. Detail of handrail that is being deformed by rust-jacking.

WPTC photo

Figure 27. This lantern vent opening has been covered with a fine stainless steel screen that prevents insect infiltration while maximizing air movement through the vent and into the lantern.

Lantern Glass

The lantern glass plays two important roles in the lantern system. First, the glass must be clean and clear to allow the greatest amount of light transmission. Second, the glass must be able to withstand high winds, driving rain, and airborne material (i.e., sand and other debris). It is absolutely essential that the glass meet these demands at all times. Proper installation care and replacement will ensure these demands are met.

Lantern Glass Installation

- Use only tempered or laminated glass for replacement of clear panels. Do not use acrylic or polycarbonate for replacement glass; these materials are easily scratched by airborne sand and will fog with time. The glass panes must be sized for code-required wind loads and code requirements for glazing next to or above walking surfaces. In most cases only laminated glass will be acceptable. (Lexan may be more suitable for replacement of colored panels in that they allow more light to pass through than colored glass.)
- When removing the astragals and clamps that retain the glass, take care not to damage the screws that hold the members in place. These screws are typically made of brass which is relatively soft.
- The most effective way to remove the glass is to cut any paint or sealant away from the glass with a sharp knife. Next, using handled suction cups designed for handling glass, carefully remove the glass from the frame.
- Before the new glass is installed, the channel in the frame must be completely clear of all old putty or sealant and corrosion. Any 'hard spot' left in the channel could cause a point stress on the glass, which in turn could cause the glass to crack or break.
- While the glass is out of the iron lantern frame, the iron should be inspected for corrosion. All corrosion that is present must be removed. Any bare iron surfaces should be painted with a corrosion-resistant coating system.
- When cutting glass to fit, it is imperative that the glass does not touch the frame in any location. This will prevent the glass from breaking when the lantern frame racks under windy conditions.
- The glass must rest on either soft wood (pine or cedar) spacers, commercially available Teflon gasket material (that is approximately 3/16 inch thick), or neoprene setting blocks. The rest of the glass should be bedded in pressure-sensitive neoprene or butyl-rubber-gasket material designed for architectural glass installation.
- Install the new glass using handled suction cups.
- Apply the neoprene or butyl-rubber gasket to the outside of the glass and install the astragals and clamps; only snug tighten the screws at first, then tighten again a few days later to allow the gasket to set.
- This system should prevent water from entering the window channel and in turn prevent future damage to the glass from rust-jacking. As an

WPTC photo

Figure 28.

WPTC photo

Figure 29.

SIDEBAR: Use of Lexan in Lantern Glass Replacement

In 1986 the wire-glass in the lantern of the Sombrero Key Lighthouse was replaced with Lexan (plastic) panels. A 1996 site visit found the Lexan panels hazed by sunlight and salt air exposure. This condition greatly reduces the transmission of light and therefore reduces the effective range of the aid to navigation. The inability of the Lexan panels to withstand the conditions of the marine environment gives the panels a short life expectancy when compared to glass. With these inherent limitations, Lexan or other plastic panels should only be used as a temporary repair and not be relied upon as a long-term lantern glass material.

Sombrero Key Lighthouse is located in open water in the Gulf of Mexico. In similar locations that experience hurricane force winds, laminated glass has proven successful for the lantern glass replacement. Laminated glass is made by sandwiching a piece of plastic film between two sheets of tempered glass. This technology produces a very durable panel with long lasting clarity that does not compromise the effectiveness of the aid to navigation or impact the historic character of the lighthouse.

Figure 28 (top left). Close-up view of severely hazed Lexan replacement panel. Note the limited visibility caused by only ten years of sunlight and salt air exposure.

Figure 29 (bottom left). Looking out through severely hazed Lexan panels, note the limited amount of light transmission; this greatly hinders the effectiveness of the aid to navigation. If the panels are not replaced, the degradation may continue and diminish the light transmission, ultimately rendering the aid to navigation ineffective.

WPTC photo

Figure 30. Close-up of a first-order lantern that retains its lantern glass; note the clarity.

added measure, a bead of clear silicone caulk may be applied to the exterior side of the window/frame joint to shed water away from the joint.

- When curved glass is to replaced, professional assistance is recommended.

Lantern Roof

The lantern roof typically serves as the roof for the entire lighthouse; therefore it is essential that it and any guttering systems be weathertight. Traditionally, the lantern and lighthouse roof (as in the case of the caisson lighthouse) were either terne-coated metal or copper. The roofing was commonly laid in a standing-seam or flat-seam style. Any metal roofing patches should be made with like-kind materials soldered in place. If deterioration is excessive, a new roof which matches the original in material and configuration should be considered.

All rainwater guttering systems (lantern roofs or other tower roof forms) should be cleaned and checked for holes. All holes and non-functioning gutter system components should be repaired. Holes in sheet-metal built-in gutters must be repaired with a properly soldered repair to ensure the durability of the repair. Caulking should be considered only for temporary repairs until a proper soldered repair can be made. Guttering systems must discharge rainwater safely to parts of the site which are designed and maintained to receive concentrations of water flow.

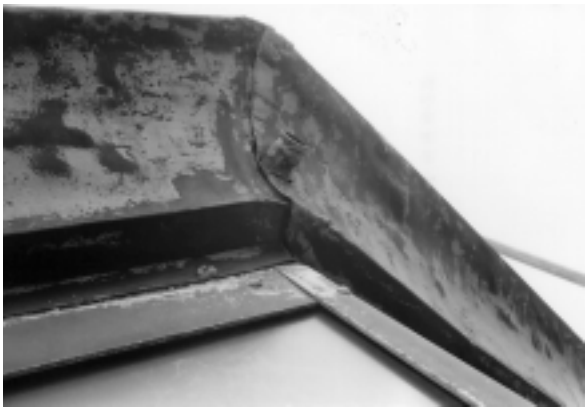

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Figure 31. View of built-in gutter spout on a copper roof.

Gallery Decks

In most lighthouses gallery decks are cast-iron, sheet-metal-covered wood, stone, or concrete. These decks are generally laid directly on top of the wall structure and act literally as the roof for some portions of the lighthouse below. If the decking material is not weathertight, moisture can enter the interior of the lighthouse or lantern.

- When repairing gallery decking, use only like-kind materials.
- The decking should be sloped away from the lighthouse to shed the water away from the structure.
- Inspect all seams for water infiltration: in cast-iron decking there will be raised corrosion along the length of the seam; with flat-seam sheet metal there may be a leak present on the interior of the lighthouse; in stone decking there may be open gaps between the pointing and the stones.
- Flat-seam sheet-metal decking should be repaired with soldered patches or with selective removal and replacement with like-kind material; all new seams should be double locked and soldered.
- Cast-iron decking should first have all corrosion removed and the affected surfaces painted with

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Figure 32. This sheet-copper-covered lantern gallery deck has been repaired several times by soldering sheet copper patches over the holes. This method of repair, if performed properly, greatly increases the life span of the roof covering.

a corrosion-inhibiting coating. The seams should then be caulked with either butyl-rubber or polysulfide caulking.

- Some coating systems are very slick when cured; therefore it is essential that non-skid materials are used on gallery decks that do not already have a non-skid surface texture.
- Deteriorated portions of iron or steel can be repaired using metal polymers that can be molded and shaped to match existing textures and contours.
- Gaps in the joints between stone decking should be raked out and repointed with a mortar that matches the original in color and strength. Damaged stones should be carefully removed and replaced with like-kind stones.

Removal and Application of Protective Coatings

WARNING: When performing any of the following treatments it is essential that the classical lens and clockworks (if extant) be protected.

As a protective measure and for daymark purposes, lanterns were historically painted. As part of a repair treatment, the exterior coating should be checked for loose and flaking paint. Any deteriorating areas should be scraped and repainted to match the existing color. Ultimately, as part of any preservation treatment, the entire lantern should have all loose and flaking paint removed and a new coating applied according to the manufacturer's specifications.

Several factors should be considered when removing paint from lantern components. The combination of ferrous (iron and steel) and nonferrous (bronze, brass, copper) metals present different challenges when performing paint removal. As mentioned in the **Iron** section, paint can be removed from iron using low-pressure-aggregate blast methods and chemical strippers. These methods can be used on bronze and brass as well; however the choice of blast media and chemicals is different.

Because of the relative softness of bronze, brass, and copper when compared to iron, a less aggressive blast media is desirable. Walnut shells and bicarbonate of soda are acceptable blast media for bronze, brass, and copper. Before use, the media should be tested in an inconspicuous location at various pressures to determine if the treatment will damage the substrate.

Chemical strippers used on bronze, brass, or copper should be designed for use on these metals. Tests should be performed with the chemical stripper before use on the

entire lantern. The stripper used should not cause etching or corrosion of the bronze or brass substrate.

Bronze, brass, and copper lantern components historically may or may not have been painted. These metals will form a protective oxidized surface coating or *patina* if not painted. This is the greenish brown tint that is commonly seen on outdoor bronze sculpture. Brass typically found on the interior of the lantern, however, is traditionally kept bright and shined through regular cleaning and buffing by the lighthouse keeper. To maintain a bright shiny finish, the brass may be coated with a finish such as clear lacquer that can be applied to maintain this bright appearance (see following sidebar on maintenance of classical lenses). When painting bronze or brass components on the exterior of the lantern, all surfaces should be wiped clean with a metal preparation solvent to remove any chloride residue or other contaminants. If chemical strippers were used, any remaining stripper residue must be neutralized prior to painting.

For more information on paint application methods refer to the discussion on paint and coating systems in the **Iron** section.

Limited Replacement In Kind

When replacing all extensively missing or deteriorating lantern components, such as a ventilation ball or decorative gutter spout, the replacement materials need to match the old materials both physically and visually, i.e., the metals should not have a galvanic response.

When replacing deteriorated bolts or other hardware, use matching materials of the highest quality and resistance to the marine environment. When replacing bronze bolts or other elements use Silicon Bronze alloy 655 or Naval Bronze; both alloys have a high corrosion resistance and can be left unpainted to naturally oxidize or *patina*. When iron or steel components are to be replaced because of severe deterioration, stainless steel should be considered as a substitute. Given the complexity of the issues and the potential application, however, the selection of the proper grade for use in a marine environment requires careful evaluation by an engineer.

Installation of Modern Utilities and Equipment

Many historic lighthouses have been upgraded to either alternating current (AC) or solar power during the conversion to automatic operation. During this conversion various pieces of equipment

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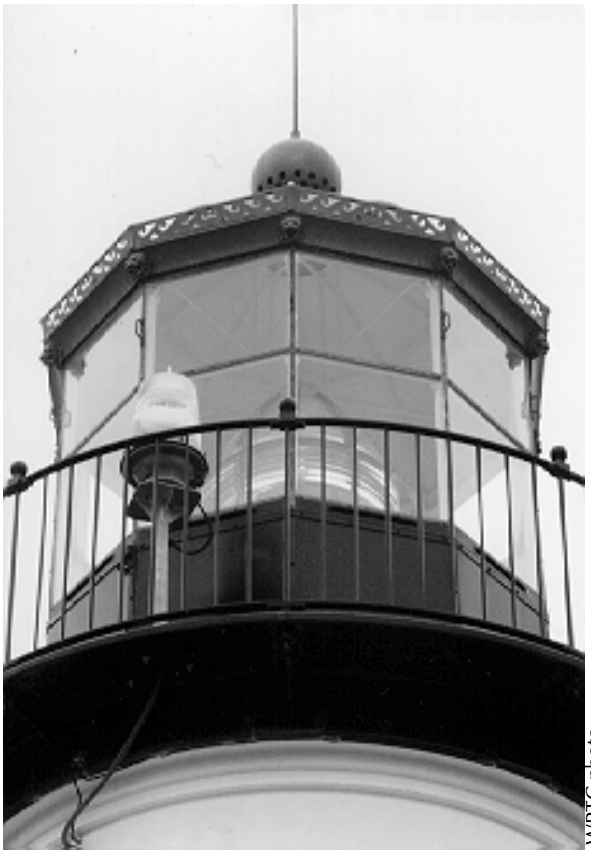
Figure 33. To minimize damage to historic wood beadboard panelling, these new panels should have been installed on a sheet of plywood attached to the historic wood beadboard panelling in four locations. These batteries stored on the floor should be in containment boxes in case the batteries leak.

such as electrical panel boxes, conduit, battery racks, and batteries have been installed. As this equipment ages or becomes obsolete, new fixtures may need to be installed. When installing new utilities and equipment the following factors should be considered:

- Use existing openings to run conduit through. Avoid boring or cutting holes in interior floors and exterior gallery decks and walls.
- Install electrical panel boxes on plywood panels that are mounted to the historic walls. This will minimize the impact on interior masonry, iron, or wood walls. Do not mount panels on built-in cabinets.
- Attach conduit with clamp or strap-type fasteners that do not impact the historic fabric by use of screws or nails.
- Store batteries in spill-proof boxes that will contain the liquid battery contents in case of an accident.
- Avoid mounting heavy solar panels and auxiliary lights on the outside of historic gallery deck rails; this will create eccentric loading that will ultimately damage the railing.
- When a classical lens has been converted to AC or solar power, retain the extant accessories such as lens jacks, clockwork cranks, wrenches designed for use with the lens, etc., that were used for the care and maintenance of the lens.



WPTC photo

Figure 35. This is an acceptable auxiliary light installation. The light is mounted on an aluminum pedestal that has been bolted to the replacement aluminum deck.

WPTC photo

Figure 36. This c. 1926 lens was designed to be AC powered; the original lens jacks are still in place. The three jacks (the third is obscured by the brass bearing cover) were used to lift the lens assembly so that bearings could be serviced.

WPTC photo

Figure 34. When this first-order classical lens was converted to AC power, the original drive gear (pictured here) was the crank used to wind the clockworks.

SIDEBAR: Maintenance of Classical Lenses

As noted in Part III., historic lighthouse lenses are considered character-defining features of a lighthouse. Briefly, a classical Fresnel lens (also called the beacon or optic) is a large composite illumination device which can include hundreds of separate pieces of glass all organized to capture radiant light and create a directed beam. Glass segments are either secured to each other or to the brass superstructure. Segments are secured to each other by means of a beveled cut (along the edge) of a prism and a little litharge (white lead) glazing putty to hold them in place. Prisms are also secured directly into the brass framework with glazing putty and wood shims placed in between the glass and brass to position the prism. In addition, some lenses also have a series of brass or bronze retaining bars to help secure the sections.

The glass used in Fresnel lenses was manufactured in France and is quite hard and scratch resistant. It is also quite brittle, which lends itself to chipping and fracture. By comparison, more modern flint (which contains lead) glass is softer, quite clear, and comparatively easy to scratch. Litharge glazing putty was the standard glazing material of its time. It is composed of linseed oil, whiting (calcium carbonate), and either a lead oxide (yellow to reddish) or a lead carbonate (white) filler and dryer. The use of litharge is the source of many of our current preservation problems.

During the historic period of operation, maintenance practices were prevention oriented. Every effort was made to prevent inadvertent damage or scratches to the glass, corrosion of the brass, or loss of a prism through disintegration of the glazing putty. In addition, the turning mechanism, clockwork, and lantern room were kept meticulously clean. Condition assessments of numerous classical lenses reveal that most damage and deterioration encountered today occurred recently.

Recommendations for Maintenance

Historically Fresnel lenses were 1) dusted daily, 2) cleaned with "spirits of wine" or vinegar, and 3) polished with rouge once a year.

The goal of preventive care is to substantially reduce loss of original historic material to deterioration and inappropriate maintenance procedures. Preventive care aptly describes those activities which minimally trained personnel can utilize to keep a lens in a stable state. The introduction of new materials, preservatives, and/or coatings, as well as the removal of established corrosion layers, all constitute a degree of intervention which, in the absence of appropriate training and experience, are beyond the scope of preventive care.

Inspection

- Examine and document the condition of the classical lens before preventive care procedures are carried out. (If deteriorated glazing has resulted in prisms not being firmly seated, then the optic cannot be safely cleaned.)

Handling

- Pad the work area with sheets of expanded polyethylene foam.
- Remove jewelry such as rings, bracelets, and long necklaces, and belts that might scratch or chip the objects. Preferably, wear an apron to ensure the prisms will not be scratched.

- Moisture, oils, and acids left from fingerprints will disrupt and eventually etch these delicate surfaces. Use snug fitting latex gloves when handling these objects. (Handle classical lenses as little as possible.)
- Do not apply pressure to annular rings which are not supported in the brass, or bronze superstructure. Be especially careful not to apply pressure from the interior of the lens. This is a major cause of damage because unsupported annular rings and bullseye lenses can easily fall out.

Cleaning the brass

Historically, a form of calcium carbonate called whiting was used as a mild cleaning agent on the brass, and jeweller's rouge was used as a polishing compound. These materials maintained a clean and polished appearance on the copper; however, the practice needed to be repeated regularly to keep corrosion in check. Preventive care should shy away from a regime of repolishing because the brass is continually being sacrificed and lost to achieve a shiny appearance. If a polished appearance is desired, a more conservative approach would have the polished lens coated to isolate the copper alloy from the environmental agents which cause corrosion. Clear coatings are often used today, but their use can bring about a new set of associated problems. Their success is dependent upon surface preparation, the means of application, and the degree of exposure to ultraviolet light. A poorly applied protective coating may cause differential corrosion, and a mottled appearance will develop. If surface preparation has not been adequate, the coating is likely to peel, and the useful lifetime of clear coatings exposed to elevated levels of ultraviolet (especially when within a tower) is controversial. These problems are difficult to deal with because they require the complete removal of the coating in order to effect a remedy. What emerges here is the realization that although all classical lenses were historically treated in about the same way, today's decision to polish brass should be based on what technical expertise is available and at least some consideration of the following factors: 1) What kind and how much corrosion is present upon the brass? 2) Will the lens be in an urban environment? 3) Will the lens remain in the tower, or has it been relocated? 4) Is staffing sufficient to carry out scheduled maintenance?

Brass which has a well-established reddish brown cuprite corrosion layer is not considered to be actively corroding. The decision to polish brass in this condition is an aesthetic one. Once polished, the metal then needs to either be repolished periodically or it needs to be coated to preserve a polished appearance.

Cleaning the glass

The historic record indicates that the prisms were routinely washed with mild soap or "spirits of wine." Periodically, the prisms were also rubbed down with whiting, or a combination of whiting followed by rouge to polish the glass. Keepers were instructed to first brush the glass with a feather brush to remove surface dust. Before removing airborne particulates which have settled in, try to determine if in fact the deposit contains abrasive particulate. If the 'dust' is particularly abrasive, or if a large quantity of deposits is to be removed, then a vacuum aided by a soft mop-type artist's brush will be effective. Be sure that sufficient hose is available to avoid the vacuum endangering the lens, and that the hose attachments are nonmetallic to avoid scratching. If the deposits are light and nonabrasive, then it is suggested that the glass be wiped down with lint free cotton toweling moistened with distilled water. Small amounts of denatured alcohol can safely be added to form an alcohol and water solution, especially if the deposits are a combination of dust and oils. It is usually recommended that alcohol be added until the solution is an effective cleaning solution. The exact proportions will vary for each site because of such environmental factors

as proximity to industrial sites, freeways, or visitor contact. Be alert to the presence of a clouded glass surface. If noted, a conservator should be contacted. A clouded surface indicates that the glass is deteriorating.

Care for deteriorated putty

If human error in cleaning, handling, and/or moving is overall the most serious threat to classical lenses, then deteriorated glazing putty is the second most serious threat. The consolidation of

NMI photo

NMI photo

Figures 37 and 38. Joe Cocking (above) and Nick Johnston (below) restore a classical lens at the U.S. Coast Guard Exhibit Center.

porous putty conforms to *The Secretary of Interior's Standards for Rehabilitation* by preserving as much original historic material as possible; the National Park Service, Division of Conservation, is currently evaluating a variety of synthetic resins to establish which is best suited as a consolidant for the preservation of historic glazing putty. Our approach had been to try and reconstitute the original putty. In addition, substantial cost savings are realized by consolidating the original putty both because it is a less expensive treatment option than reglazing, and because replacing a hazardous material requires proper abatement, control, and disposal procedures. Unfortunately, consolidation is only feasible if the original putty is porous and adsorbent enough to accept the introduction of a solvented resin. Preventive care as it applies to litharge glazing putty begins with establishing a monitoring program to determine if the putty has deteriorated. This is accomplished by the use of lead indicator test patches or strips. Indicators do not establish levels of lead containing compounds, only their presence. The relative rate of deterioration is established by a combination of condition assessment and monitoring. To monitor, wet clean the area and monitor periodically for additional lead particulate deposition. Working in the presence of lead oxide or lead carbonate particles requires that the worker wear appropriate protective clothing and a respirator rated for the removal of lead bearing particulate. Additional state or local regulations may also apply. If a lens is in your custodial care by means of a loan agreement, then only the owner is authorized to make decisions about the care and treatment of a lens. Because of the inherent health hazards, it is strongly advised here that only trained personnel attempt to address litharge glazing putty preservation issues. At present, and until a more satisfactory solution is found, both the National Park Service and the U.S. Coast Guard often stabilize loose lenses or prisms by the localized addition of a vinyl glazing compound.

A classical Fresnel lens with significant deterioration requires stabilization and perhaps restorative treatment and may require a professional conservator.

For more information on the maintenance of classical lenses, refer to the forthcoming NPS *TECH NOTE: Preventive Care for Classical Lighthouse Lenses.*