# 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. It may be necessary to involve a USCG engineer or architect, preservation architect, or building conservator familiar with lighthouse preservation to assess the condition of the iron and prepare contract documents for its treatment.*

Cast-iron and steel features such as gallery deck brackets, handrails, skeletal structures, pilasters and door pediments, window architraves, as well as textured, finished surfaces such as raised diamond pattern non-skid surfaces, are important in defining the historic character of the lighthouse (see Figures 20 and 21). It is essential that the character-defining features are retained during any treatment. It should also be noted that while cast iron is among the most durable of historic building materials, it is also the most susceptible to damage by improper maintenance or repair techniques and by harsh or abrasive cleaning methods. Therefore, all treatment should be executed using the gentlest means possible. In Part V., **Beyond Basic Preservation**, examples of treatments that are considered rehabilitation and restoration are illustrated and discussed.

WPTC photo

**Figure 20.**

WPTC photo

**Figure 21.**

## Protection and Stabilization (Mothballing)

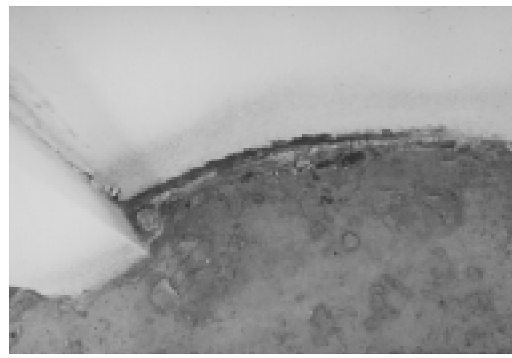
Despite their inherent durability, a historic iron lighthouse that receives only minimal or no routine maintenance is highly vulnerable to decay if it is not protected and stabilized properly. To properly protect and stabilize a historic iron lighthouse, a thorough inspection and diagnosis of all iron features: caisson structures, cast-iron plate walls, decorative features (cornices, door and window surrounds, decks, etc.) should be performed using the inspection chart in the preceding section as a guide. The results of the inspection are then used to develop a protection and stabilization plan. The following recommended protection and stabilization guidelines for vacant historic iron lighthouses are the minimum treatment requirements to prevent any further damage from occurring.

### Weatherization

It is essential that all iron components be completely weathertight. Water intrusion can be extremely detrimental to iron components. If water enters the interior cavity of an iron component it will cause corrosion to occur, or accumulated water can freeze and the resulting expansion can possibly crack the component.

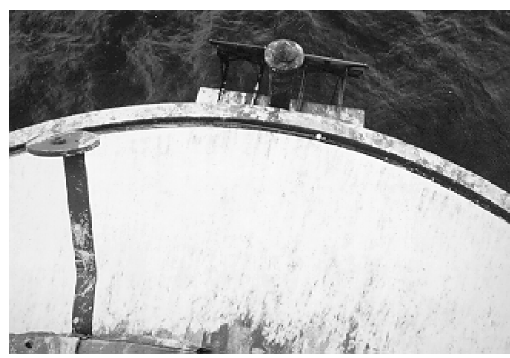
To prevent moisture penetration be sure the following infiltration points are weathertight or functioning properly:

- ***Lantern system:*** Cast-plate or sheet-iron lantern parapet walls, all lantern glass, cast-iron frames, and roofs must be weathertight. Caulk patches should be used only as a temporary fix and not relied on as a long-term treatment as they have a limited functional life span. Refer to the **Lantern** section of this handbook for more information concerning the weatherproofing of the lantern components.
- ***Built-in guttering systems:*** In order to prevent water from entering the interior cavity of double-wall iron or brick-lined iron wall systems, all rain water guttering systems (lantern roofs, or other tower roof forms) should be cleaned and checked for holes. It is imperative that all holes and non-functioning gutter system components are repaired. For more information refer to the discussion on roofing in the **Lantern** section of the handbook.
- ***Gallery decks:*** The seams between cast-iron gallery deck plates must be made weathertight. If rust is already present, this must be removed and the affected areas primed and painted. The joints should be sealed with a high quality



WPTC photo

**Figure 22.** Interior of a sheet-iron parapet wall that is rusting from the inside to out along the lantern room door. This is the result of water entering the interior cavity of the parapet wall.



WPTC photo

WPTC photo

**Figures 23 and 24.** Two types of gutters found on iron lighthouses; the gutters must be in proper working order and checked regularly during the mothballing period.

WPTC photo

**Figure 25.** The seams between the deck and wall plates of this lighthouse were not properly sealed; as a result the areas collected water and began to rust.

sealant. 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 cavity of the tower wall and cause damage that may go undetected until severe deterioration has occurred. See the **Windows** section of this handbook for the proper caulk for this application. Refer to the **Lantern** section of this handbook for more information concerning the weatherproofing of gallery decks.

- ***Wall plates:*** The joints between cast-iron wall plates must be kept weathertight. If rust is already present, this must be removed and the affected areas primed and painted. The joints should be sealed with a high-quality sealant. If the wall plates are not weathertight, moisture can enter the interior cavity of the tower wall and cause damage that may go undetected.

- ***Door and window frames and trim:*** The joints along the perimeter of iron door and window trim and frames where the trim or frame is attached to a masonry or iron tower must be made weathertight. Open joints should be cleaned of rust and loose paint. The affected areas must be primed and painted, then sealed with a high-quality caulking. This will prevent water from entering the interior cavity of either the iron trim or the wall itself. See the **Windows** section of this handbook for the proper caulk for this application.

- ***Protective coatings:*** As a protective measure and for recognition as a daymark, lighthouses were 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 spot-painted to match the existing color.

WPTC photo

**Figure 26.** This steel casement window frame was not sealed properly and as a result has begun rusting from the inside out.

Ultimately, as part of a mothballing treatment, the entire lighthouse should have all loose paint and corrosion removed and a new coating applied to the entire surface 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 paint and coating systems discussion under the repair treatment later in this section.

WPTC photo

**Figure 27.** Blistering paint, as pictured here, should be removed and the affected areas properly primed and painted.

## Stabilization

When mothballing an iron lighthouse or a lighthouse with iron components, all possible structural repairs should be made before the beginning of the "mothballed" period. If repairs cannot be made because of budget constraints, stabilization of the primary structural components should be first priority, followed by more general stabilization of the rest of the lighthouse. Temporary bracing and "splinting" may be possible techniques for non-structural components. More elaborate shoring may be required to support structural members that have failed or are in danger of failing. For situations where sophisticated structural bracing is required, a structural engineer or historical architect should be consulted for a proper stabilization treatment plan. The stabilization treatment utilized should not permanently damage historic character-defining features and should be easily reversible so that when the budget allows, the structure can be properly repaired. For more information refer to the discussion on structural stabilization under the repair treatment in this section.

## Ventilation

Iron lighthouse towers are typically one of four possible construction types: single-wall cast-iron plate, double-wall cast-iron plate, brick-lined cast-iron plate, cast-iron-and-steel skeletal. With any of these construction types, adequate ventilation in the unoccupied lighthouse is essential during the mothballing period. Adequate ventilation will achieve two goals: 1) minimize excessive heat buildup which can damage any sensitive electronic equipment operating inside the tower; 2) minimize condensation buildup inside the lighthouse (especially brick-lined towers) that can cause the iron to corrode on the interior of the tower. In some extreme cases minimal heating may be needed to minimize moisture buildup in the lighthouse. Ventilation of iron towers through passive and mechanical systems is covered in the **Windows** section.

## Fire Protection

Despite the fact that iron is noncombustible, fire is still a threat to combustible components of iron lighthouses and can possibly cause permanent deformation to the iron components exposed to intense heat. For guidance on these issues, refer to "Fire Prevention and Protection Objectives under **Related Activities** in Part VI.

## Repair

Before any preservation repair work is begun, all iron features that are important in defining the overall historical character of the lighthouse, such as walls, brackets, cornices, window architraves, door pediments, steps and pilasters, coatings and color should be identified. During all repair work it is imperative that measures are taken to ensure that these features are not damaged or that the action taken will not result in damage to the feature at a later date. The following are preservation repair treatments for iron lighthouses and lighthouses with iron components that can be undertaken after a thorough inspection.

### Cleaning

The simple act of cleaning painted iron surfaces can effectively enhance the appearance and extend the life of the coating. In a marine environment a buildup of potentially corrosive elements such as salts, bird guano, and, in more urban locations, industrial pollutants can cause premature deterioration of iron components. Simple but effective regular cleaning will greatly extend the life of the iron components found on historic lighthouses. The following are guidelines to follow when cleaning historic iron lighthouse components:

WPTC photo

**Figure 28.** Surfaces such as this sheet-steel-covered parapet door that are covered with seagull guano should be thoroughly cleaned before mothballing and should be checked and cleaned once a year during the mothballing period.

- Clean surfaces only when necessary to remove buildup of corrosive agents such as salts, guano, and industrial pollutants that are causing damage to iron on the iron coating.
- Clean surfaces with the gentlest method possible, such as using low pressure water and mild detergents and natural bristle brushes. High pressure water blasting may damage caulking between iron components and force water into openings, leading to accelerated corrosion and deterioration.
- Do not use a cleaning method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures within 48 hours of treatment.
- Do not clean with chemical products such as acids that will accelerate the corrosion of the iron components.

### Paint Removal

When there is extensive failure of the protective coating and/or when heavy corrosion exists, the rust and most or all of the paint must be removed to prepare the surfaces for new protective coatings. The techniques available range from physical processes, such as wire brushing and grit blasting, to flame cleaning and chemical methods. The selection of an appropriate technique depends upon how much paint failure and corrosion has occurred, the fineness of the surface detailing, and the type of new protective coating to be applied. Local environmental regulations may restrict the options for cleaning and paint removal methods, as well as the disposal of materials.

Many of these techniques are *potentially dangerous* and should be carried out only by experienced and qualified workers using proper protective equipment such as full face respirators, eye protection, protective clothing, and optimum workplace safety conditions. Before selecting a process, test panels should be prepared on the iron to be cleaned to determine the relative effectiveness of various techniques. The cleaning process will very likely expose additional coating defects, cracks, and corrosion that were not obvious before.

There are a number of techniques that can be used to remove paint and corrosion from cast iron:

- ***Hand scraping, chipping, and wire brushing*** are the most common and least expensive methods of removing paint and light rust from iron. They do not however, remove all corrosion or paint as effectively as other methods. Experienced craftsmen should carry out the work to reduce the likelihood that surfaces will be scored or fragile detail damaged.
- ***Low-pressure grit blasting*** (commonly called abrasive cleaning or sandblasting) is often the

International Chimney photo

**Figure 29.** Worker dressed in full personal protective gear. The full-face-shield self-contained respirator provides both respiratory and eye protection. The worker is wearing protective coveralls, gloves, and boot covers to prevent lead dust contact. The harness is part of a full protection system. He is holding a pneumatic needle gun that is hooked to a two-stage HEPA (High Efficiency Particulate Air) filtered vacuum system.

## SIDEBAR: Paint Removal Tools

A variety of hand tools are commercially available for the removal of paint from iron lighthouses. Typically, these tools are pneumatic or air powered and remove the paint from the iron substrate with rotating strippers and pulsating rods or needles. The rotating strippers consist of a shrouded, spindle-mounted head that has 3 or 4 "flaps" outfitted with metal studs that literally "knock" the paint off the iron surface. Commercially these tools are referred to as flush plates. This type of tool is best for the removal of paint from broad flat surfaces or curved surfaces with a radius of 5 inches or more. The tools with pulsating rods or needles typically consist of 12 to 15 hardened metal rods contained in a tube that strike the paint randomly as they pulsate. This action removes the paint by breaking or crushing it, thus breaking the bond with the iron substrate. Commercially these tools are referred to as needle guns or needle scalers. This type of tool is best for reaching tight-detailed locations such as around gallery deck brackets, etc.

The choice of one of these tools should depend on its impact on the historic iron substrate. Although iron is very hard, overly aggressive stripping methods can cause irreversible damage. Stripping tools should be tested in discrete locations to determine their effectiveness and potential impact on the historic iron substrate. In removing lead-based paint, these types of tools create both small chips and fine dust. To contain the dust and chips, the tools can be most effective approach to removing excessive paint buildup or substantial corrosion. Grit blasting is fast, thorough, and economical, and it allows the iron to be cleaned in place.

Grit blasting is performed by using compressed air to blow a grit at a high velocity through a hand held nozzle. The size and shape of the grit and the pressure of the compressed air determines the rate at which the paint and underlying substrate (iron or steel in this case) are removed.

Traditionally, the grit or abrasive used was sand. The use of sand for grit blasting has been discontinued because of the potential for the operator to develop silicosis. Today, a variety of grit mediums are available. These grits are typically derived from mineral slags and are available in a variety of grades engineered to produce the desired surface profile required by various iron and steel paint and coating systems. For more delicate applications a variety of alternative blast media are available. These include materials such as walnut shells,

outfitted with dust-collection hoods with vacuum hookup. As with any paint removal procedure, personal protective equipment required for health protection should be worn. Typical personal protective equipment includes eye/face protection, respiratory protection, gloves, coveralls, hard hat, and protection from falling if working 6 feet or higher above the ground (see Figure 29).

Figures 30 through 33 are paint removal tools used during the Sand Key Lighthouse rehabilitation. Sand Key Lighthouse is located in open water off the coast of Key West. The paint being removed contained lead; therefore it was essential that all debris be contained for proper disposal.


WPTC photo

**Figure 30.**

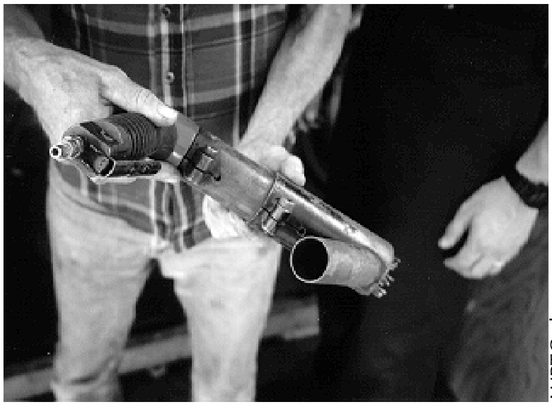

WPTC photo

**Figure 31.**


WPTC photo

**Figure 32.**

**Figure 30.** Close-up of a pneumatic needle gun. This tool works well for hard-to-reach and detail areas. The needle gun can be pressure-controlled to minimize impact on the iron substrate. This figure shows the vacuum-shroud connection on the right and air-hose connection on the base of the pistol-grip handle on the left.

**Figure 31.** The gun is activated by squeezing the lever on the rubber pistol grip. The amount of air pressure controls the speed and impact of the pulsating needles against the iron substrate. The needles can be seen protruding from the vacuum shroud.

**Figure 32.** Close-up view of a pneumatic flush-plate tool. During the Sand Key Lighthouse rehabilitation this tool was used for all flat surfaces and for removing paint from the light-tower columns. The rollers located at the top and bottom of the shroud guide the tool over the flat and curved surfaces. The amount of air pressure controls the speed and impact of the rotating head against the iron substrate. To contain the paint dust and chips, the shroud has been outfitted with a vacuum hookup.

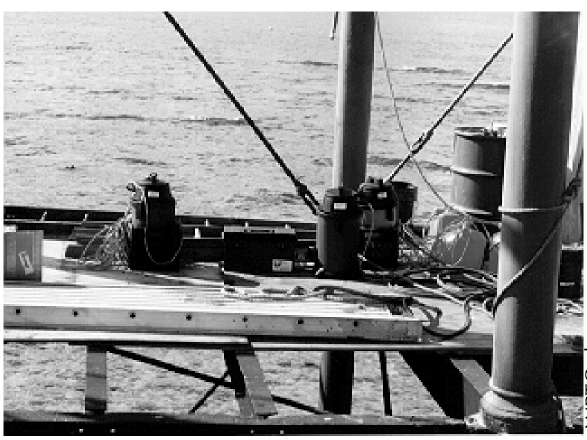
bicarbonate of soda, and frozen carbon dioxide (dry ice).

When selecting a grit media there are several factors to consider:

- A grit copper slag should be avoided because of the potential for electrolytic reactions that would corrode the iron surface.
- The grit medium should be chosen after testing has been performed to determine effectiveness of paint removal and potential impact or damage to the iron substrate, i.e., deep gouging or loss of detailed surfaces, and the surface profile produced.
- Do not use blast pressures above 100 pounds per square inch (psi). Keeping under 100 psi will still effectively remove the paint and help to minimize damage to the iron substrate.
- The environmental impact of the residue produced by the grit medium should be considered because many lighthouses are located in environmentally sensitive areas.

WPTC photo

**Figure 33.** Close-up of the studded flaps mounted on the rotating head. To use the tool, it is held against the face of the iron member and as the studded flaps spin they “slap” the surface and “knock” the paint off the iron.



WPTC photo

**Figure 34.** The small vacuums used at Sand Key Light are shown in this photo. Each vacuum has a HEPA filtration system to ensure that no lead dust escaped into the atmosphere. The conditions at Sand Key Lighthouse made the use of a large central vacuum system impractical. Using portable vacuums allowed for paint removal at numerous locations at any one time.


WPTC photo

**Figure 35.** This motorized chair was used to hoist workers as they removed paint from the cast-iron columns at the Sand Key Lighthouse. The chair’s motor is attached to a hoist, so the chair actually climbs a cable that has been strung alongside the column.

WPTC photo

WPTC photo

**Figures 36 and 37.** The left image shows the condition of the iron exterior service room wall before rehabilitation. The right image shows the same area after power hand tool cleaning and coating. The crescent shaped scars in the iron are from the arc of a grinding wheel.

Some local building codes and environmental authorities prohibit or limit dry grit blasting because of airborne dust. To conform with local codes, the lighthouse may have to be tented during the removal to contain airborne paint and aggregate dust.

- Adjacent materials, such as brick, stone, wood, and glass, must be protected to prevent damage.

- ***Wet sandblasting*** is more problematic than dry sandblasting for cleaning iron because the water will cause instantaneous surface rusting and will penetrate deep into open joints. Therefore, it is generally not considered an effective technique. Wet sandblasting reduces the amount of airborne dust when removing a heavy paint buildup, but disposal of effluent containing lead or other toxic substances is restricted by environmental regulations in most areas.

- ***Flame cleaning*** of rust from metal with a special multi-flame-head oxyacetylene torch requires specially skilled operators, and is expensive and potentially dangerous. It can be very effective, however, on lightly to moderately corroded iron. Wire brushing is usually necessary to finish the surface after flame cleaning.

- ***Chemical paint removal*** using alkaline compounds, such as methylene chloride or potassium hydroxide, can be an effective

Bender & Associates, Architects

**Figure 38.** Service room bracket after chemical cleaning.

alternative to abrasive blasting for removal of heavy paint buildup. These agents are often available as slow-acting gels or pastes. Because they can cause burns, protective clothing and eye protection must be worn. Chemicals applied to non-watertight, multi-piece features (such as deck plates or wall plates) can seep through crevices and holes, resulting in damage to the lighthouse's interior finishes and corrosion to the backside of the iron components. If not thoroughly neutralized, residual traces of cleaning compounds on the surface of the iron can cause paint failures in the future. For these reasons, field application of alkaline paint removers and acidic cleaners is not generally recommended.

Following any of these methods of cleaning and paint removal, the newly cleaned iron should be painted immediately with a corrosion-inhibiting primer to prevent 'flash rusting' from forming. This time period may vary from minutes to hours depending on environmental conditions. Before application, paint or coating systems may require the iron or steel surface to be wiped with a solvent that removes any microscopic rust that has formed on the surface.

The buildup of salt or chloride residue on bare metal surfaces will affect the paint or coating performance. The metal surface should be tested for chloride buildup from the salt-laden air found in a marine environment. If chloride levels are above levels recommended by the paint or coating manufacturer, the surface will need to be wiped with a solvent to remove the chloride buildup.

If priming is delayed, any surface rust that has developed should be removed with a clean wire brush just before priming. The rust prevents good bonding between the primer and the cast-iron surface and may also prevent the primer from completely filling the pores of the metal.

## External Coating Systems

The most common and effective way to preserve iron lighthouse components is to maintain a protective paint or coating on the metal.

The effective protective life span of an existing paint or coating can be greatly increased by routinely touching up areas of deterioration. A small break in the protective finish can lead to accelerated corrosion of the underlying iron (see Figure 39). Areas where the paint or coating has been damaged by mechanical impact or blistering has occurred should be addressed immediately. These areas should have all loose paint and rust scale removed using one of the recommended methods

WPTC photo

**Figure 39.** The finish on this tension rod failed and localized corrosion (rust) has formed. The rust is exfoliating in layers that are trapping moisture and causing corrosion to occur deeper and deeper into the tension rod. The result is pitting that will compromise the strength of the tension rod. If the area had been touched up in time, the corrosion might not have formed.

previously described. Hand tool cleaning and low pressure grit blasting are the most effective for this scale of paint removal. The bare metal should then be primed and painted with a primer/top coat system that will adhere to both the bare metal and the existing paint or coating system. The top coat should match the existing color to maintain the lighthouse daymark.

## Surface Preparation

Thorough surface preparation is necessary for the adhesion of new protective coatings. All loose, flaking, and deteriorated paint must be removed from the iron, as well as dirt and mud, water-soluble salts, oil, and grease. Old paint that is tightly adhered may be left on the surface of the iron if it is compatible with the proposed coatings. The retention of old paint also preserves the historic paint sequence of the building and avoids the hazards of removal and disposal of old lead paint.

It is advisable to consult manufacturer's specifications or technical representatives to ensure compatibility between the surface conditions, primer and finish coats, and application methods. If the composition of the existing paint or coating is not known, then a thorough analysis should be performed to determine composition of the existing coating to ensure compatibility with the future paint or coating. For more information refer to the Steel Structures Painting Council publication—*Steel Structures Painting Manual*.

When painting new stainless steel or other new steel or iron surfaces, special surface preparation steps must be taken. Typically these surfaces have a shop coating of light oil applied to prevent rusting. This oil must be removed with a solvent before painting. The surfaces of these materials may not have the right profile or roughness for the applied coating to adhere. To achieve the proper profile, the surfaces should be lightly grit blasted with glass beads to achieve the profile recommended by the manufacturer.


WPTC photo

**Figure 40.** The paint on this stainless steel replacement gallery deck has begun to peel less than three months after it was painted. This could have been prevented if the stainless steel parts were first cleaned and then lightly glass-bead blasted.

For the paint to adhere properly, the metal surfaces must be absolutely dry before painting. Unless the paint selected is specifically designed for exceptional conditions, painting should not take place when the temperature is expected to fall below 50 degrees Fahrenheit within 24 hours or when the relative humidity is above 80%; paint should not be applied when there is fog, mist, or rain in the air. Poorly prepared surfaces will cause the failure of even the best paints, while even moderately priced paints can be effective if applied over well-prepared surfaces.

## Selection of Paints and Coatings

The types of paints available for protecting iron have changed dramatically in recent years as the result of federal, state, and local regulations that prohibit or restrict the manufacture and use of products containing toxic substances such as lead and zinc chromate, as well as volatile organic compounds and substances (VOC or VOS). Availability of paint types varies from state to state, and manufacturers continue to change product formulations to comply with new regulations.

Traditionally, red lead has been used as an anti-corrosive pigment for priming iron. Red lead based paint forms a tough and elastic film impervious to water that is highly effective as a protective coating for iron. At least two slow-drying linseed-oil-based finish coats have traditionally been used over a red lead primer; this combination is effective on old or partially-deteriorated surfaces.

Today, alkyd paints are very widely used and have largely replaced lead-containing linseed-oil paints. They dry faster than oil paint, with a thinner film, but they do not protect the metal as long. Alkyd rust-inhibitive primers contain pigments such as iron oxide, zinc oxide, and zinc phosphate. These primers are suitable for previously painted surfaces cleaned by hand tools. At least two coats of primer should be applied, followed by alkyd enamel finish coats.

Latex and other water-based paints are *not* for use as primers on cast iron or steel because they cause immediate oxidation if applied on bare metal. Vinyl acrylic latex or acrylic latex paints may be used as finish coats over alkyd rust-inhibitive primers, but if the primer coats are imperfectly applied or are damaged, the latex paint will cause oxidation of the iron. Therefore, alkyd finish coats are recommended over alkyd primer.

High-performance coatings, such as zinc-rich primers containing zinc dust, urethane based coatings and modern epoxy coatings, can be used on cast iron to provide longer-lasting protection. These coatings typically require highly clean surfaces and special application conditions.

One particularly effective system has been developed to coat commercially blast-cleaned iron with a zinc-rich primer, followed by an epoxy base coat, and two urethane finish coats. Some epoxy coatings can be used as primers on clean metal or applied to previously painted surfaces in sound condition. Epoxies are particularly susceptible to degradation under ultraviolet radiation and must be protected by finish coats which are more resistant. There have been problems with epoxy paints which have been shop-applied to iron where the coatings have been nicked before installation. Field touch-up of epoxy paints is very difficult, if not impossible. This is a concern since iron exposed by imperfections in the base coat will be more likely to rust and more frequent maintenance will be required.

In recent years, moisture-cured urethane coating systems have begun to take the place of epoxy-based coating systems. Moisture-cured urethane coatings are more surface tolerant, can be used in lower temperatures, and can be applied and work better at higher humidities than epoxy-based coatings. Moisture-cured urethane coatings, however, have a tendency to thicken quickly under humid conditions and have the potential of being applied too thickly, resulting in a loss of the character-defining features of the substrate.

A key factor to take into account in selection of coatings is the variety of conditions affecting existing and new materials on a particular lighthouse. One primer may be needed for surfaces with existing paint; another for newly cast, chemically stripped, or blast-cleaned cast iron; and a third for flashing or substitute materials—all three followed by compatible finish coats.

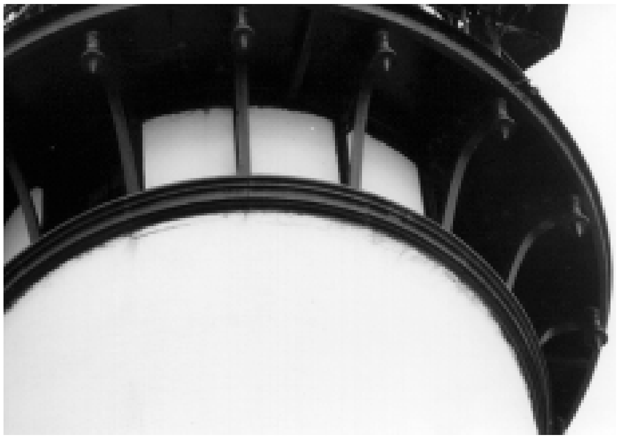
Another factor to consider when choosing a high performance coating is that these coatings tend to have a high gloss finish that is slippery when wet. When painting gallery decks and other iron or steel walkways, anti-skid strips may need to be installed for personnel or visitor safety.

## SIDEBAR: Masonry and Iron Interaction

A common practice in masonry lighthouse construction is to use iron door and window hoods, gallery deck brackets, belt courses, and water table caps. These details are both decorative and structural components of the lighthouse; however, they pose special preservation issues. The iron that is in contact with the masonry tends to corrode more readily than the rest of the iron component. This condition is typically evidenced by rust streaks on the masonry surface (see Figures 41 and 42). This rusting is caused by moisture either from condensation or precipitation combined with chloride or salt buildup that collects in the joint. If the joint is not sealed and the coating on the iron is failing, rust will readily form.

This condition can easily be remedied if the following issues are addressed during the preservation treatment of the lighthouse. During any repairs or repainting, all masonry and iron surfaces must be cleaned of all loose paint and rust scale. All mortar that has been placed between the masonry and the iron should also be removed. The mortar helps trap moisture against the iron. Once the joint is clean, all exposed iron must be coated with a rust-inhibiting primer and top coat to provide a barrier between the iron and the mortar. The void created by the missing mortar should be filled with a new mortar mixture that matches the strength of the historic mortar (for more information on the matching of mortar strength refer to the **Masonry** section). When filling the open joint with the mortar, hold the mortar back about 1 inch. The joint should then be filled with a ½-inch-diameter polyethylene foam backer rod. To seal the joint, use a high quality silicone or urethane caulking. (Some caulks may require a painted surface to adhere to brick; therefore, the surface of the brick that will come in contact with the caulk may have to be painted before the caulk is applied). Ideally, the caulking depth should equal the joint depth up to a ½ inch. The profile on the caulking should be slightly concave to shed water. Refer to Figures 43 and 44 for more details.

WPTC photo



WPTC photo

**Figure 41 (left).** This masonry lighthouse has been detailed with a two-tier cast-iron water table (the iron portions are painted black). Rust-bleed is occurring along lower edge of the upper tier.

**Figure 42 (above).** The lower gallery deck of the same masonry lighthouse has rust-bleed occurring along the lower edge of the iron belt course that supports the gallery deck brackets.

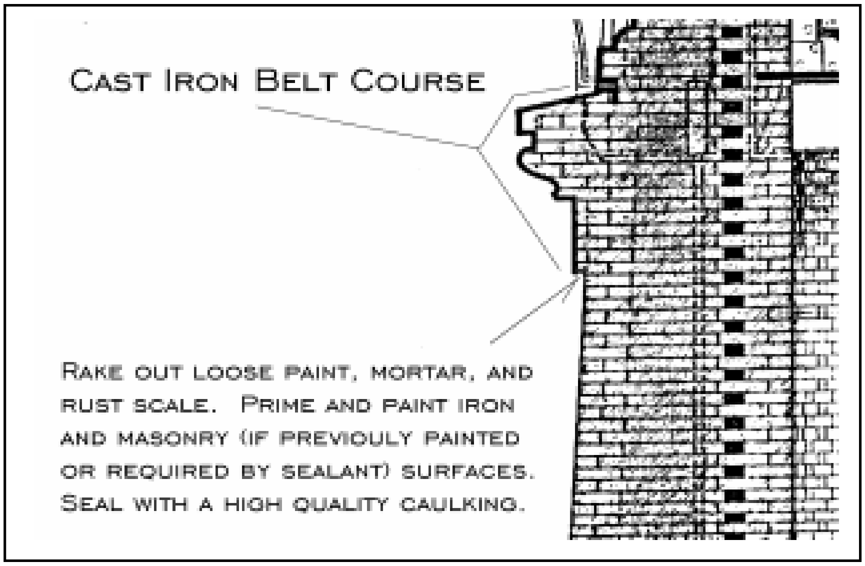



**Figure 43.**

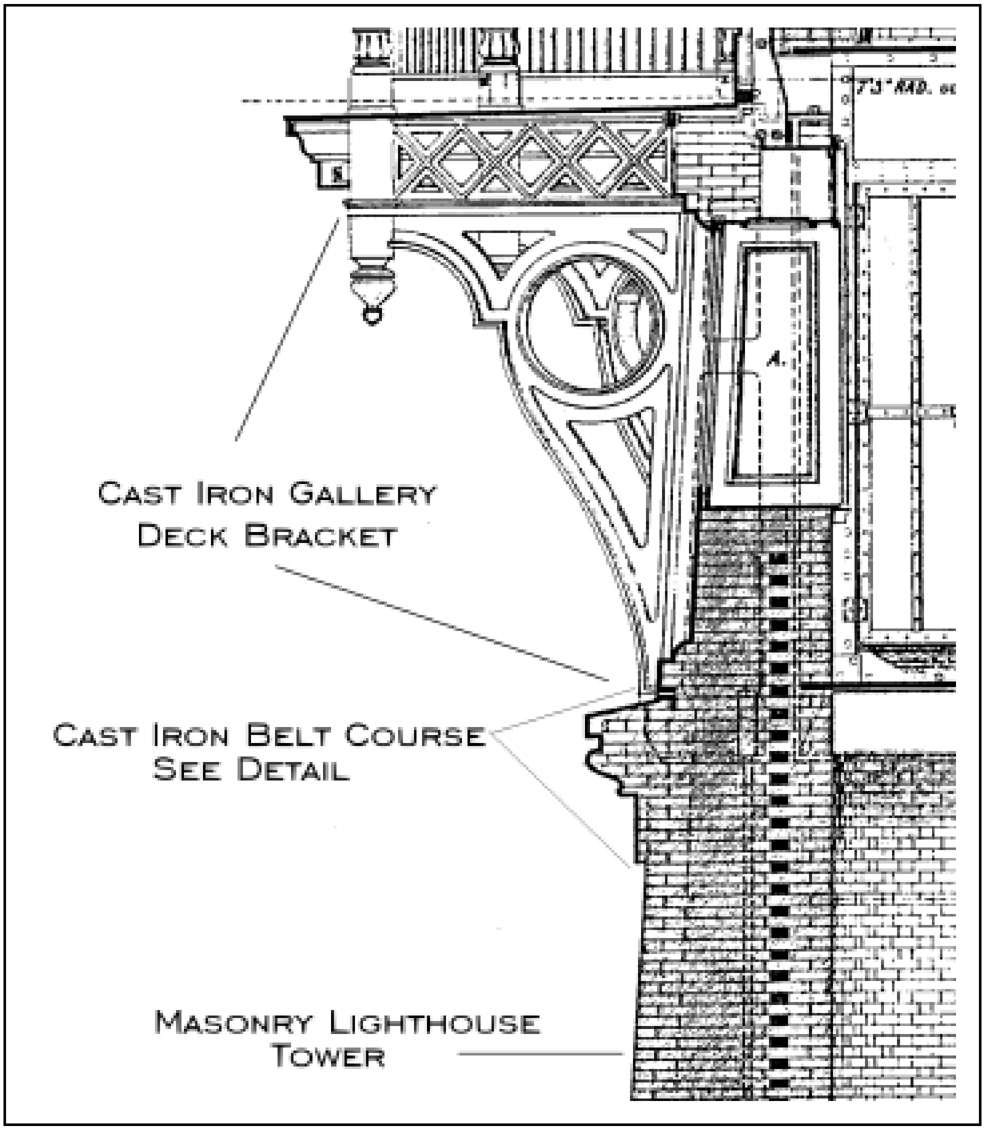



**Figure 44.**

## Application Methods

Brushing is the traditional and most effective technique for applying paint to iron. It provides good contact between the paint and the iron, as well as the effective filling of small pits, cracks, and other blemishes in the metal. The use of spray guns to apply paint is economical, but does not always produce adequate and uniform coverage. For best results, airless sprayers should be used by skilled operators. To fully cover fine detailing and reach recesses, spraying of the primer coat, used in conjunction with brushing, may be the most effective application method. During application, all overspray must be contained; this may be achieved by tenting the lighthouse. Because of the potential for overspray drift and its environmental impact, the industry standard for lighthouse painting is to use brushes.

Rollers should never be used for primer coat applications on metal and are effective for subsequent coats only on large, flat areas. The appearance of spray-applied and roller-applied finish coats is not historically appropriate and should be avoided on land-based lighthouses which are viewed up close by the public.

## Caulking, Patching, and Mechanical Repairs

Most iron components on historic lighthouses were made of many small castings assembled by bolts or screws. Joints between pieces were caulked to prevent water from seeping in and causing rusting from the inside out. Historically, the seams were often caulked with white lead paste and sometimes backed with cotton or hemp rope; even the bolt and screw heads were caulked to protect them from the elements and to hide them from view. Although old caulking is sometimes found in good condition, it is typically crumbled from weathering, cracked from structural settlement, or destroyed by mechanical cleaning. It is essential to replace deteriorated caulking to prevent water penetration. For good adhesion and performance, an architectural-grade polyurethane sealant is preferred. For a more in-depth discussion of various types of caulking compounds refer to the **Windows** section.

Water that penetrates the hollow parts of iron components causes rust that may streak down over other elements of the lighthouse. The water may freeze and the expanding ice may crack the cast iron. Cracks reduce the strength of the total cast-iron assembly and provide another point of


WPTC photo

**Figure 45.** Within three months after painting, the rust began to bleed through this weep hole on the bottom of this pediment bracket. Two lessons are to be learned from this condition: 1) keep weep holes open to allow any water that may have entered the casting to escape, and 2) keep joints around applied castings sealed; apparently this was not done and water has entered the hollow cavity of the pediment, causing rust to form inside.

entry for water. Water entering seams may also cause rust to form within the joint and damage the surrounding iron through a process known as 'rust-jacking'. Thus, it is important that cracks be made weathertight by using caulks or fillers, depending on the width of the crack.

Filler compounds containing iron particles in an epoxy resin binder can be used to patch superficial, non-structural cracks and small defects such as rust pits in cast iron. The thermal expansion rate of epoxy resin alone is different from that of iron, requiring the addition of iron particles to ensure compatibility and to control shrinkage. Although the repaired piece of metal does not have the same strength as a homogeneous piece of iron, epoxy-repaired members do have some strength. Polyester-based putties, such as those used on auto bodies, are also acceptable fillers for small holes. For more information on metal paste use in lighthouse restoration, refer to the Point Bonita Lighthouse rehabilitation case study in the Part V., **Beyond Basic Preservation**.

In rare instances, major cracks can be repaired by brazing or welding with special nickel-alloy welding rods. Brazing or welding of cast iron is very difficult to carry out in the field and should be undertaken only by very experienced welders.

In some cases, mechanical repairs can be made to cast iron using iron bars and screws or bolts. In extreme cases, deteriorated cast iron can be cut out and new cast iron spliced in place by welding or brazing. It is frequently less expensive, however, to replace a deteriorated cast-iron section with a new casting rather than to splice or reinforce it. Cast-iron structural elements that have failed must either be reinforced with iron and steel or replaced entirely.

Screws with stripped threads and seriously rusted bolts must be replaced. To compensate for corroded metal around the bolt or screw holes, new stainless steel bolts or screws with a larger diameter need to be used. In extreme cases, new holes may need to be tapped.

The internal voids of hollow iron lighthouse components should not be filled with concrete; it is an inappropriate treatment that causes further problems. As the concrete cures, it shrinks, leaving a space between the concrete and cast iron. Water penetrating this space does not evaporate quickly, thus promoting further rusting. The corrosion of the iron is further accelerated by the alkaline nature of concrete. Where iron components have been previously filled with concrete, they need to be taken apart, the concrete and rust removed, and the interior surfaces primed and painted before the components are reassembled.

## Flashing

In some instances, it may be necessary to design and install flashing to protect areas vulnerable to water penetration. Flashings should be designed and fabricated carefully so that they are effective, as well as unobtrusive in appearance. The most durable material for flashing iron is terne-coated stainless steel. Other compatible materials are terne-coated steel and galvanized steel; however, these require more frequent maintenance and are less durable. Copper and lead-coated copper are not recommended for use as flashing in contact with cast iron because of galvanic corrosion problems. Galvanic problems can also occur with the use of aluminum if certain types of electrolytes are present.

## Dismantling and Assembly of Iron Components

If repairs cannot be successfully carried out in place, it is sometimes necessary to dismantle all or part of a cast iron lighthouse structure during restoration. Dismantling should be done only under the direction of a preservation architect or architectural conservator who is experienced with historic cast iron. Extreme care must be taken since cast iron can be brittle, especially in cold weather.

Dismantling should follow the reverse order of construction and re-erection should occur, as much as possible, in the exact order of original assembly. Each piece should be numbered and keyed to record drawings. When work must be carried out in cold weather, care needs to be taken to avoid fracturing the iron elements by uneven heating of the members. Both new castings and reused pieces should be painted with a shop-applied prime coat on all surfaces. All of the components should be laid out and preassembled to make sure that the alignment and fit are proper. Many of the original bolts, nuts, and screws may have to be replaced with similar fasteners of stainless steel.

After assembly at the site, joints that were historically caulked should be filled with an architectural-grade polyurethane sealant or the traditional white lead paste. White lead has the advantage of longevity, although its use is restricted in many areas.

## Limited Replacement In Kind

The replacement of cast-iron components is often the only practical solution when such features are missing, severely corroded, or damaged beyond repair, or where repairs would be only marginally useful in extending the functional life of an iron element. For more information on replacement iron or steel lighthouse components refer to the case studies in Part V., **Beyond Basic Preservation**.

### SIDEBAR: Lighthouse Designer/Builder George Meade

General George Gordon Meade is famous to most people as the commander of the Army of the Potomac which defeated General Robert E. Lee at the Battle of Gettysburg in 1863. But to lighthouse enthusiasts, Meade is famous for his lighthouse work, specifically Florida Reef screwpile lighthouses. A screwpile is a screw-like flange located on the end of a lighthouse foundation pile, which when wound into the substrate, provided greater holding power than a straight-pile. The first screwpile lighthouse in the United States was at Brandywine Shoal, Delaware Bay, built by Major Hartman Bache, a distinguished engineer of the Army Corps of Topographical Engineers. Work began in 1848 and was completed in 1850, with construction cost at $53,317. Alexander Mitchell, an Englishman who invented the screwpile principle, served as consultant. The screwpiles were turned by a four-foot capstan worked by 30 men. Major Bache also built the second screwpile lighthouse in the United States with construction of the Pungoteague River Lighthouse, Chesapeake Bay, built in 1854.

George Meade was also an engineer in the Army Corps of Topographical Engineers. He worked with Bache designing and constructing screwpile foundation lighthouses in Delaware Bay. Meade was also asked to survey and chart the Florida Reefs. The first screwpile skeletal lighthouse to be built on this dangerous stretch of reefs between Cape Florida and Key West was the Carysfort Reef Lighthouse, located off Miami and designed by I. W. P. Lewis. The entire structure was first erected in Philadelphia "so as to obviate the necessity of fitting parts at its isolated site." It cost $105,069 to complete. When the engineer in charge of the Carysfort Reef Lighthouse project died, Meade, now a lieutenant, was assigned the task of completing the job. This was the first of what was to become many lighthouse jobs for which Meade had total responsibility. Carysfort Reef Lighthouse was successfully completed in 1852. The offshore Carysfort Reef Lighthouse is believed to be the first screwpile skeletal tower in the U.S. to use foot plates or disks to help disperse the weight of the tower over a broader foundation base.

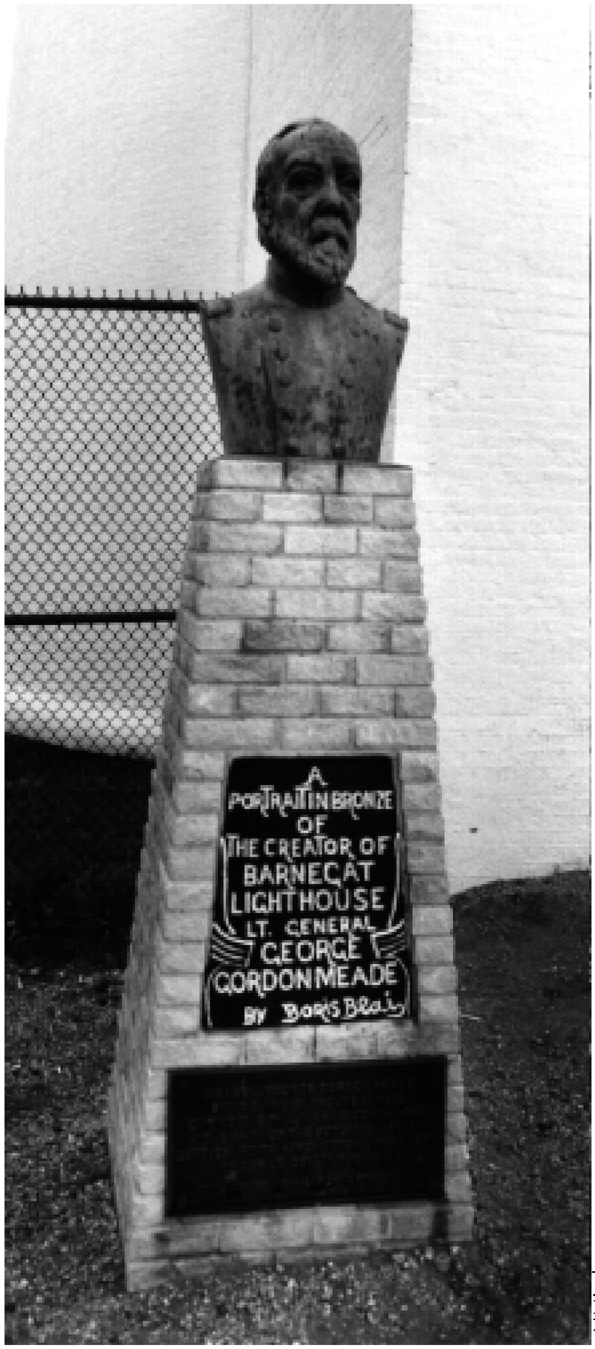



Figure 46. Bust of George Meade at Barnegat Lighthouse, Long Beach, New Jersey.

Two months after completing Carysfort Reef Lighthouse, Meade was asked to inspect the site selected for the Rebecca Shoal screwpile lighthouse, also in the Florida Keys. Meade commented that "no beacon of any kind had been erected, either in the United States or in Europe, in a position that is more exposed or offered greater obstacles." His wrought-iron skeleton light tower was nearly completed when a three-day storm completely carried away the structure. A second attempt was so severely racked by the pounding seas that the piles worked out of the sand and it collapsed. The Lighthouse Board abandoned the lighthouse project and marked the shoal with buoys.

Meanwhile Meade went on to complete the 132-foot-tall screwpile Sand Key Lighthouse in 1853 and the 142-foot-tall screwpile Sombrero Key Lighthouse in 1858, also in the Florida Keys. One historian stated that Sombrero Key was the most important lighthouse built by Meade. Meade also designed a five-wick, first-order, hydraulic lamp which was adopted by the Lighthouse Board in about 1853. Meade was placed in charge of both the Fourth and Seventh Lighthouse Districts. In 1855 Meade surveyed the Barnegat Lighthouse, New Jersey, which had received many complaints by mariners. His suggestion that the tower needed to be replaced with a first-order coastal tower was approved; the present Barnegat Lighthouse was completed in 1859. Meade also supervised construction of the 167-foot-tall brick Absecon Lighthouse, Atlantic City, New Jersey, completed in 1857. In 1860 Meade was transferred from Florida to direct the surveys of the Northern Lakes, but with the advent of the Civil War, Meade requested and received active military service. He was promoted to brigadier general of the Pennsylvanian Volunteers and in June 1863 became commander of the Army of the Potomac.

While there are many monuments to George Meade because of his military achievements, few people are aware of a monument commemorating his lighthouse work. At the base of the Barnegat Lighthouse is a bronze bust of Meade and a dedication plaque. Ironically, even fewer people are aware of Meade's most important lighthouse contribution; his work with Florida Reef screwpile lighthouses.