Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

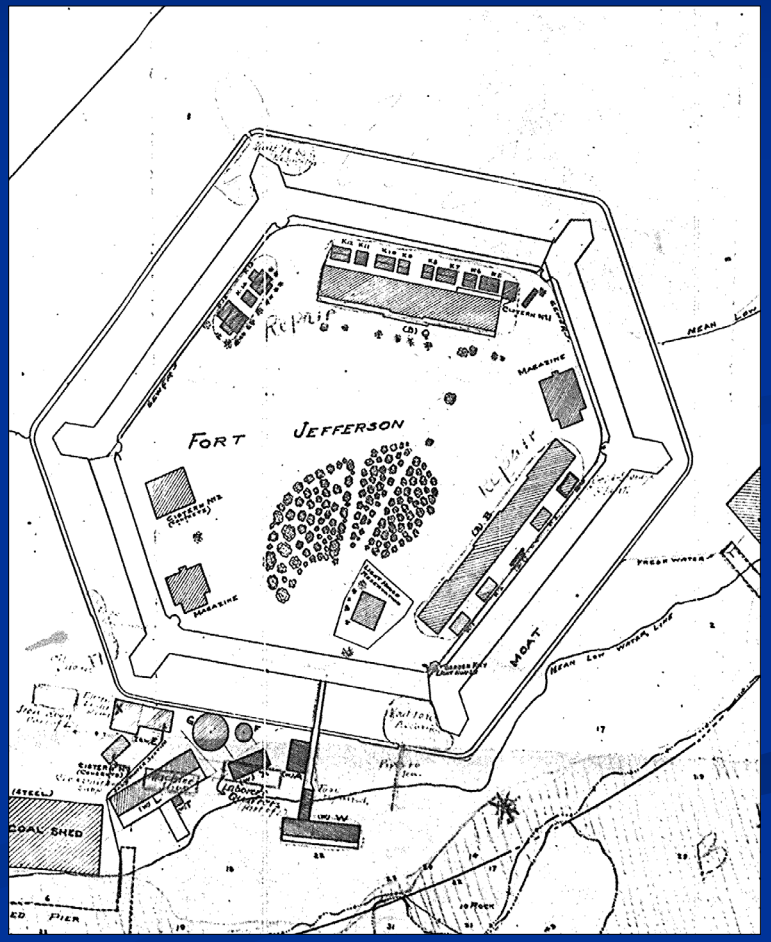
Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Project Goals:

- Disassemble furnace capturing as-built construction details before catastrophic failure
- Reassemble furnace using data collected during disassembly
- Replace all iron components with silicone bronze components
- Research and reconstruct missing elements such as chimney stones and slate roof
- Share project goals and methods with park visitors through interpretive displays and brochures

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

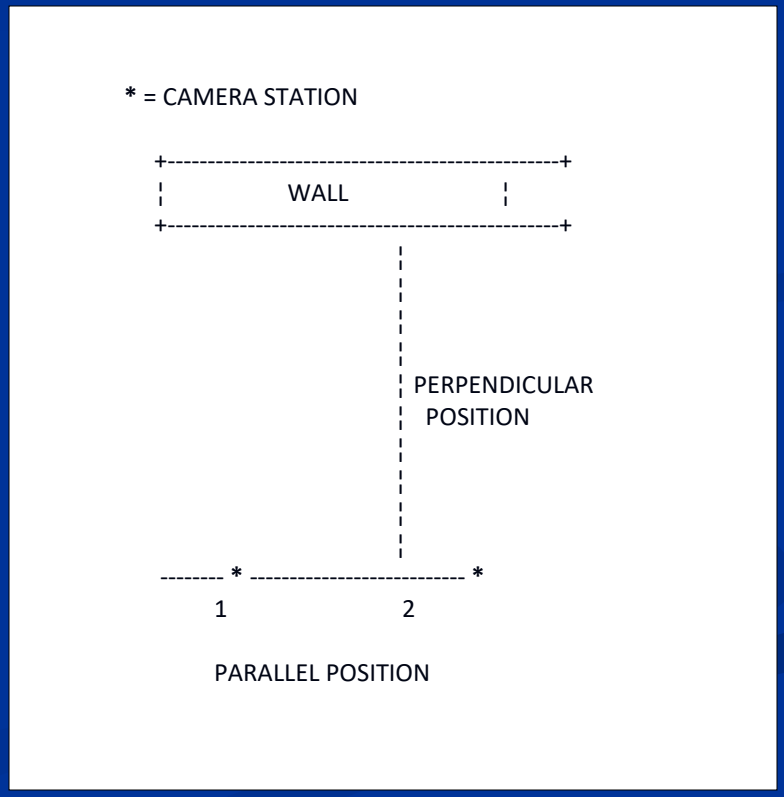
Step 1 - Locate, copy, and review all documents and images relating to the furnace's history; original plans to-date have not been located.



Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 2 - Physical documentation and disassembly of the furnace

The primary method used to create scaled photographs is known as “perspective controlled photography”. This method produces photographs that serve as templates for drawing scaled wall profile maps, and/or for measuring wall feature dimensions directly on the photographs.



Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 2 - Physical documentation and disassembly of the furnace

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

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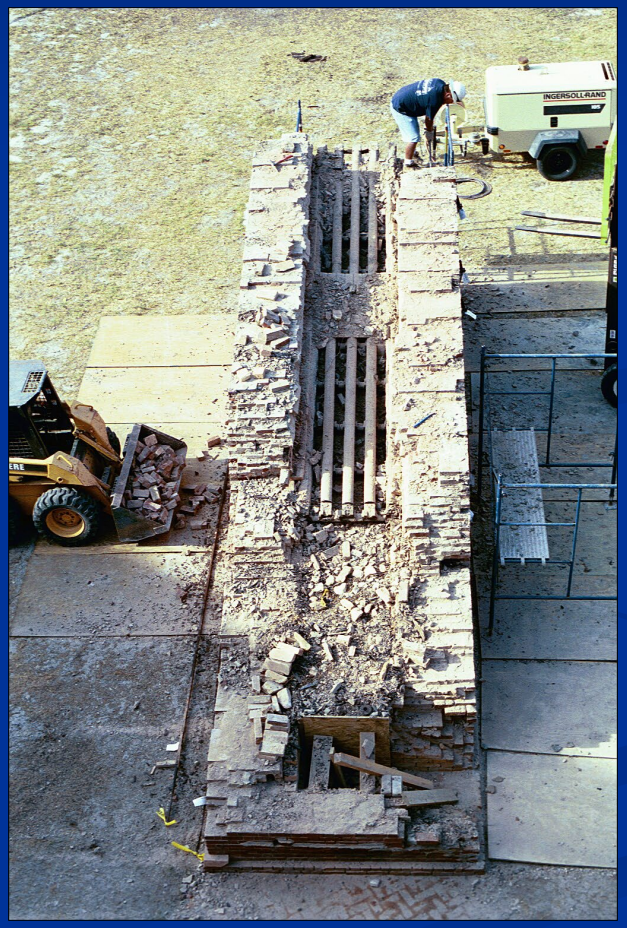
Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 2 - Physical documentation and disassembly of the furnace



Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

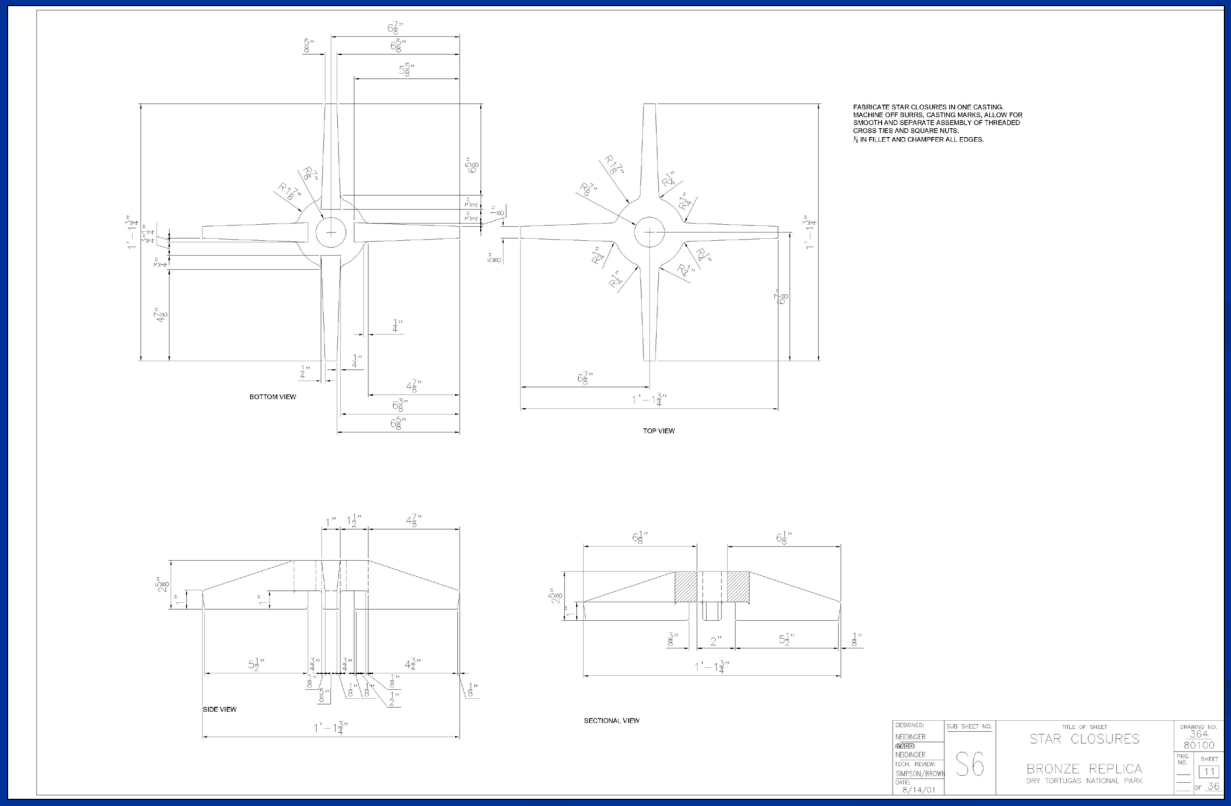
Step 2 - Physical documentation and disassembly of the furnace

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 2 - Physical documentation and disassembly of the furnace

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 3 - Develop architectural drawings and specifications of all iron components recovered during disassembly and solicit proposals

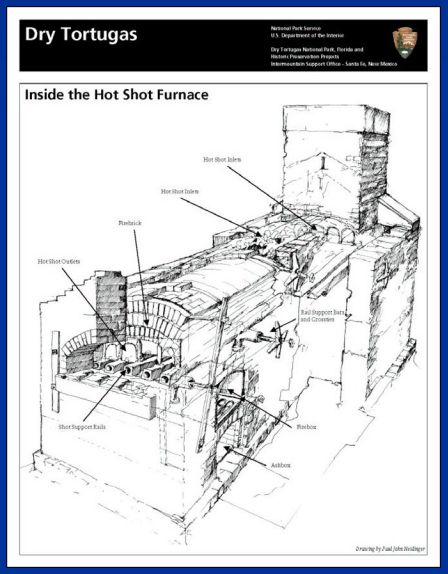


Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 4 – Fabrication of silicon bronze replica components by contractor

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components



Dry Tortugas

National Park Service
U.S. Department of the Interior

Dry Tortugas National Park, Florida and
Historic Preservation Projects
Intermountain Support Office – Santa Fe, New Mexico

Inside the Hot Shot Furnace

Drawing by Paul John Neidinger

Dry Tortugas

National Park Service
U.S. Department of the Interior

Dry Tortugas National Park, Florida and
Historic Preservation Projects
Intermountain Support Office – Santa Fe, New Mexico

Hot Shot Furnace Restoration

Project Overview

In 2001, preservation specialists from the Historic Preservation Projects program of the National Park Service's Intermountain Support Office in Santa Fe, New Mexico, began the complex task of stabilizing and restoring the Hot Shot Furnace at Fort Jefferson with the assistance of the staff at Dry Tortugas and Everglades National Park. When completed the project will have spanned three years, during which time the furnace will have been disassembled, the original internal iron components removed and painstakingly reproduced in corrosion-resistant bronze, and then reassembled. Though restored to nearly complete working order the furnace will no longer withstand the high temperatures for which it was designed. However, the restoration process will enable visitors who come to Fort Jefferson to continue to enjoy this intriguing aspect of the fort's design and history.

The History of Hot Shot and Hot Shot Furnaces

The use of hot shot represents one of the most unusual and effective defenses possessed by a fort such as Fort Jefferson in the eras predating modern armored warships. The idea of setting fire to enemy ships and equipment can actually be traced back to antiquity when flaming arrows and incendiary compositions such as "Greek Fire" were used in warfare hundreds of years before Christ. In 54 B.C., heated clay balls were used by the Britons to burn Roman tents and camps. In Classical and Medieval siege warfare, catapults and similar devices commonly hurled fireballs and incendiaries into besieged castles and towns. Then with the invention of gunpowder, cannons came into general use during the Hundred Years War (1337-1453). It was only a matter of time and logical thought that efforts would thus be made to modify cannon projectiles to cause fires. Perhaps the first successful use of hot shot was by King Stephen Bathory of Poland against the Russians in 1579 at Polotsk. Thereafter the use of heated projectiles became increasingly important over the next 200 years, especially against ships. During the Revolutionary War in this country, for instance, American and French artillerymen burned the 44-gun British warship *Charon* with hot shot during the battle of Yorktown in 1781. Perhaps the most famous use of hot shot took place in 1782 during the Second Siege of Gibraltar when French and Spanish forces attempted to use ten large floating batteries in a bombardment against British defenders. The floating batteries had been made of heavy construction and were thought to be invincible. However, British artillery in Gibraltar used hot shot to destroy nine of the ten batteries and inflict a loss of 1,500 crewmen.

During all these instances the usual method of heating cannon balls was by covering them in the coals of a large wood fire, or heating them on metal grates placed over a fire pit dug into the earth. A significant improvement over this time-consuming method was soon developed by the French, who employed the use of air furnaces to heat shot in their batteries on the Mediterranean at the mouth of the Rhône River in 1704. Little wonder that when master French engineer General Simon Bernard came to the United States in 1816 to head the Board of Fortifications for the construction of permanent forts to defend the U.S. coast, the idea of Hot Shot Furnaces based on the French pattern came with him. The chain of U. S. seacoast forts built between 1817 and the Civil War, of which Fort Jefferson was a part, thus had one or more Hot Shot Furnaces built as part of their standard defenses.

The Hot Shot Furnace at Fort Jefferson

Construction of the Hot Shot Furnace at Fort Jefferson began early in 1862 and was completed by September 1863. Once finished, the Hot Shot Furnace became one of the last and largest furnaces ever built. As no shots of anger were ever fired from Fort Jefferson, the Hot Shot Furnace was never extensively used. Evidence gathered during the restoration shows that the furnace was fired at least once, but it is still uncertain when that event took place. Other evidence gathered during the restoration process suggests that the Hot Shot Furnace may have been used as a background for occasional riflery. Impact points were identified on the sides of the furnace as well as on the granite threshhold of the south opening, through wich shot was placed into the furnace.

The Restoration Process

The internal and external iron pieces that are integral to the design of the Hot Shot Furnace, have endured the constant corrosive forces of the surrounding marine environment. Over the years the iron pieces of the furnace continually expanded as they oxidized and became infiltrated with salts. As the iron pieces expanded, they began to displace the brickwork around and above. In order to preserve the furnace, all of the internal iron had to be removed and replaced with a non-reactive material. To accomplish the replacement, the furnace required careful disassembly, removal and replication of the ironwork, and then reassembly. This process is not as easy as one would think. It requires precise photographic and written documentation prior to disassembly, careful oversight of the ironwork replication, and then the meticulous reassembly by specially-trained historic preservation specialists.

Disassembly

Disassembly of the Hot Shot Furnace began in May 2001, and took approximately one month. During that time two preservation masons, a historical architect, and a photograher, all under the direction of the exhibit specialist, worked side by side to gather as much information as possible from the furnace as it was slowly dismantled. The masons removed brickwork to expose new features, the architect rendered them on paper, and the photographer captured them on film. Each brick removed was inspected and set aside for possible use during the reassembly. The remnants of each piece of ironwork was measured and drawn by the architect to serve as a guide during replication. When all of the ironwork and loose brick had been removed, the furnace was cordoned off, reusable materials were stored in the adjacent bastion, and the process of replicating the ironwork began.

From Iron to Bronze

The most suitable non-reactive metal that could take the place of the ironwork in the Hot Shot Furnace is an alloy called silicon-bronze. This alloy, which is a combination of copper, manganese, and silicon, will withstand the marine environment for many years.

Replication of the ironwork in silicon-bronze was accomplished under contract with Pyrotech Services of Townville, Pennsylvania, who won the contract through sealed bidding. Pyrotech Services utilized drawings prepared by the National Park Service architect to produce wooden patterns and recast each piece exactly as was in iron. After each new piece was cast it took on the slightly greenish color, characteristic of cast bronze. Though attractive in appearance, the color of the new bronzework did not match the blackish color of the original ironwork; therefore each new piece was placed in an acidic bath for 60 seconds thus producing a blackish patina resembling the iron.

Reassembly

The reassembly of the Hot Shot Furnace began in June and is expected to be completed by mid-August of 2003. Currently, three to four preservation masons are working under the direction of the exhibit specialist. The exhibit specialist will use the photos, drawings, and notes collected during the disassembly to guide the masons in placement of the bricks, stones, and bronze back in their original places. New bricks will be used to replace those that were fractured as the original iron corroded and expanded, and the stones that were damaged will be carefully repaired using epoxy adhesives and stainless-steel pins. When all is completed the Hot Shot Furnace at Fort Jefferson will appear as it once did, just one of the many tools designed to be used in to protect the coasts of the United States from hostile ships.

The Historic Preservation Projects Program

The Historic Preservation Projects program is located in Santa Fe, New Mexico, and is part of the Division of Facilities Management of the National Park Service's Intermountain Support Office. Historic Preservation Projects has on staff architects, carpenters, exhibit specialists, and masons who work in partnership with parks, other agencies, partners, and contractors, to help preserve the important buildings and structures located throughout the United States. Questions regarding this project or other projects may be directed to:

Historic Preservation Projects
P.O. Box 728
Santa Fe, NM 87504
(505) 988-6728

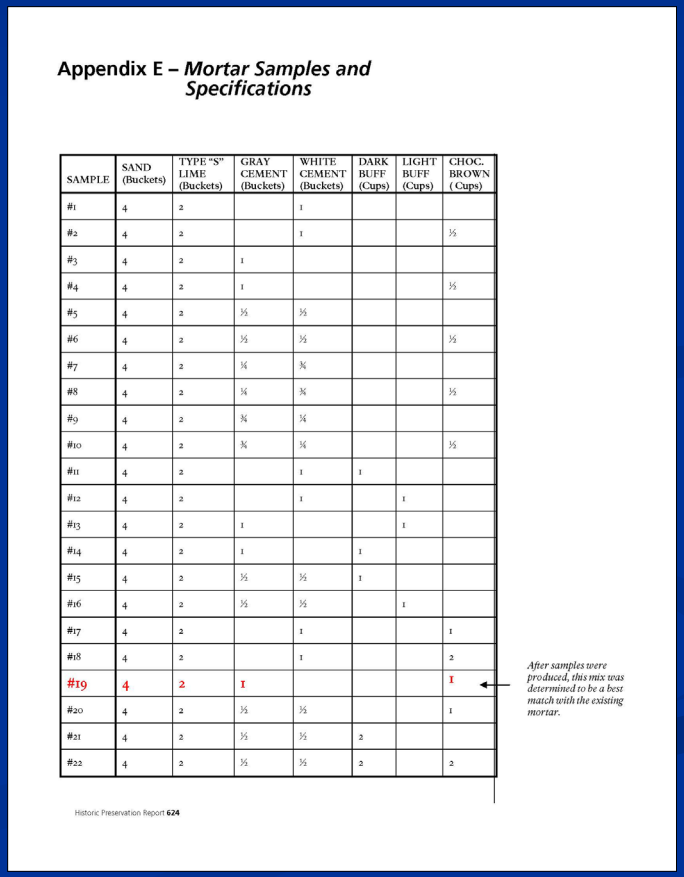
EXPERIENCE YOUR AMERICA

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components

22 Samples were made

Final Mix – 4 local sand
2 type “S” lime
1 white Portland
1 tbs. Chocolate Brown dye



Appendix E – *Mortar Samples and Specifications*

SAMPLE	SAND (Buckets)	TYPE "S" LIME (Buckets)	GRAY CEMENT (Buckets)	WHITE CEMENT (Buckets)	DARK BUFF (Cups)	LIGHT BUFF (Cups)	CHOC. BROWN (Cups)
#1	4	2		1			
#2	4	2		1			½
#3	4	2	1				
#4	4	2	1				½
#5	4	2	½	½			
#6	4	2	½	½			½
#7	4	2	¼	¾			
#8	4	2	¼	¾			½
#9	4	2	¾	¼			
#10	4	2	¾	¼			½
#11	4	2		1	1		
#12	4	2		1		1	
#13	4	2	1			1	
#14	4	2	1		1		
#15	4	2	½	½	1		
#16	4	2	½	½		1	
#17	4	2		1			1
#18	4	2		1			2
#19	4	2	1				1
#20	4	2	½	½			1
#21	4	2	½	½	2		
#22	4	2	½	½	2		2

After samples were produced, this mix was determined to be a best match with the existing mortar.

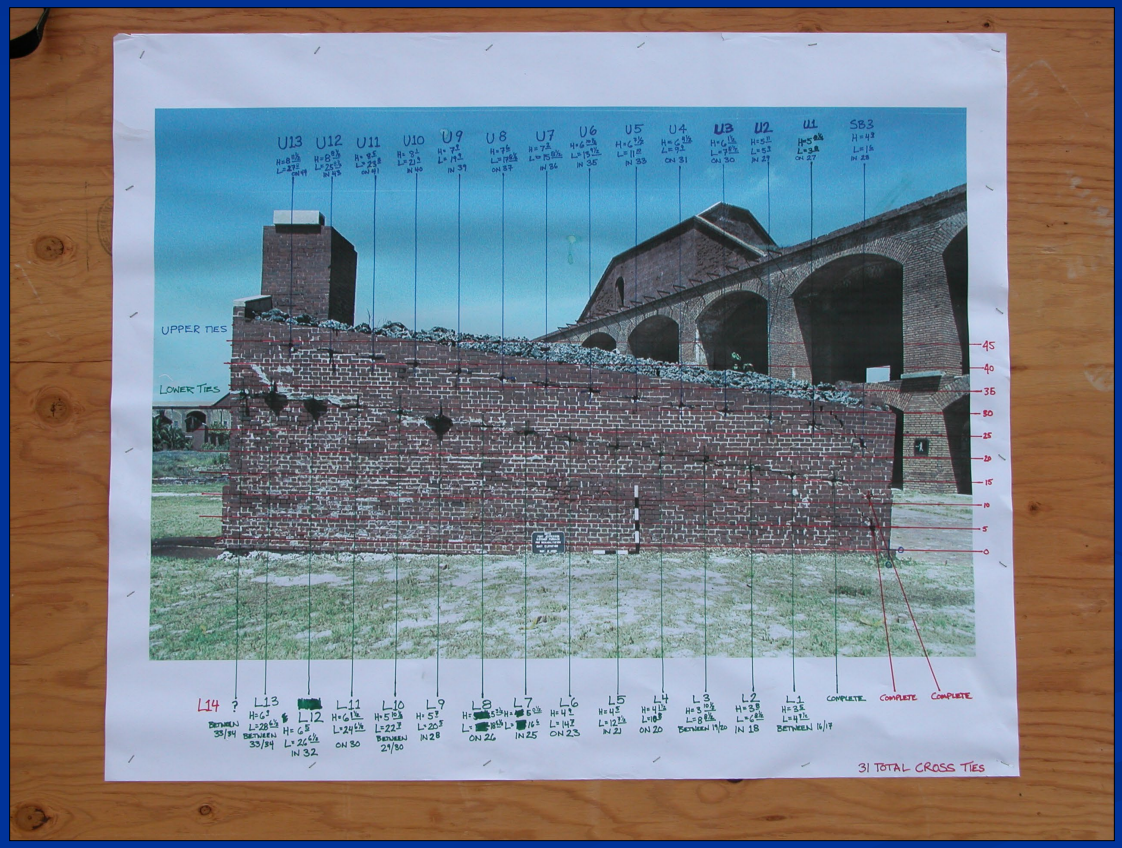
Historic Preservation Report 624

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components

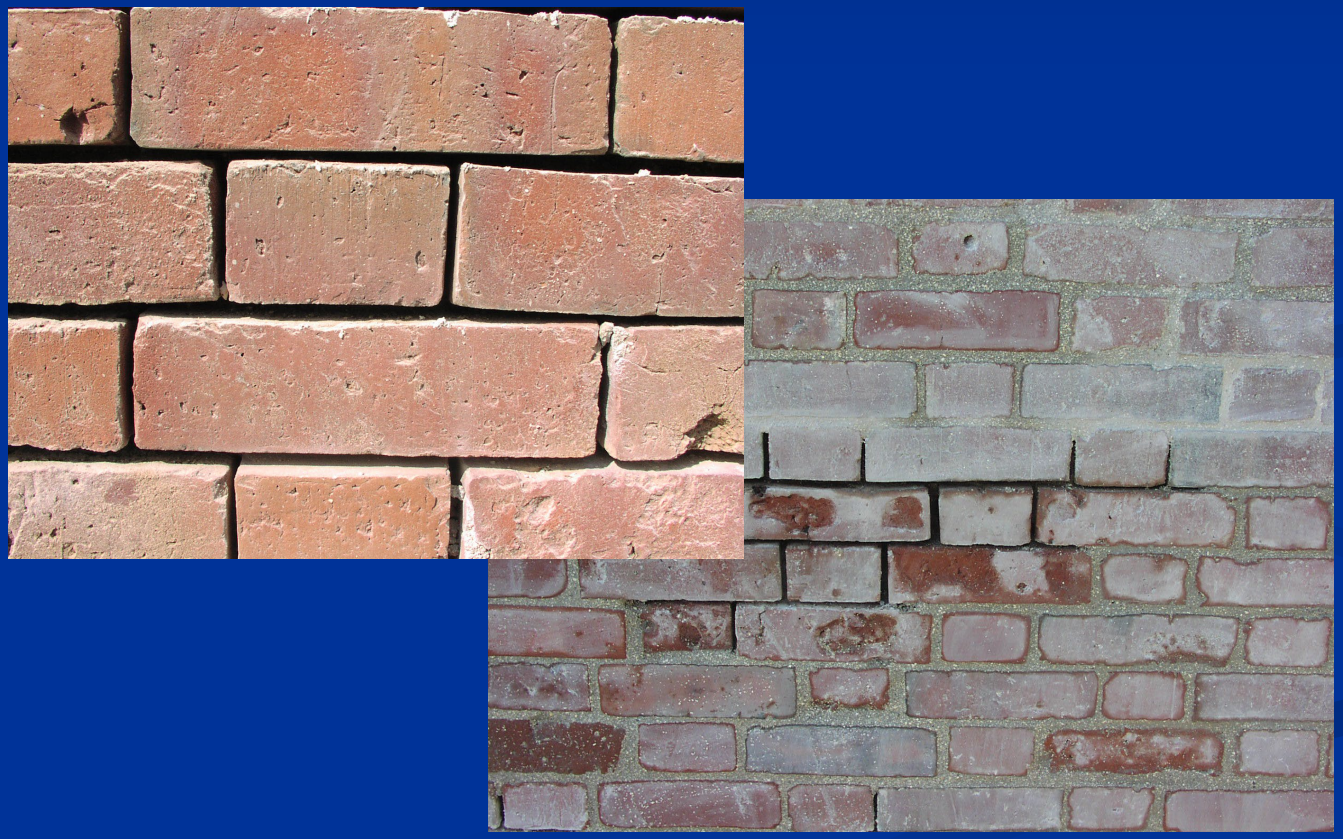


Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components and some new brick

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components and some new brick

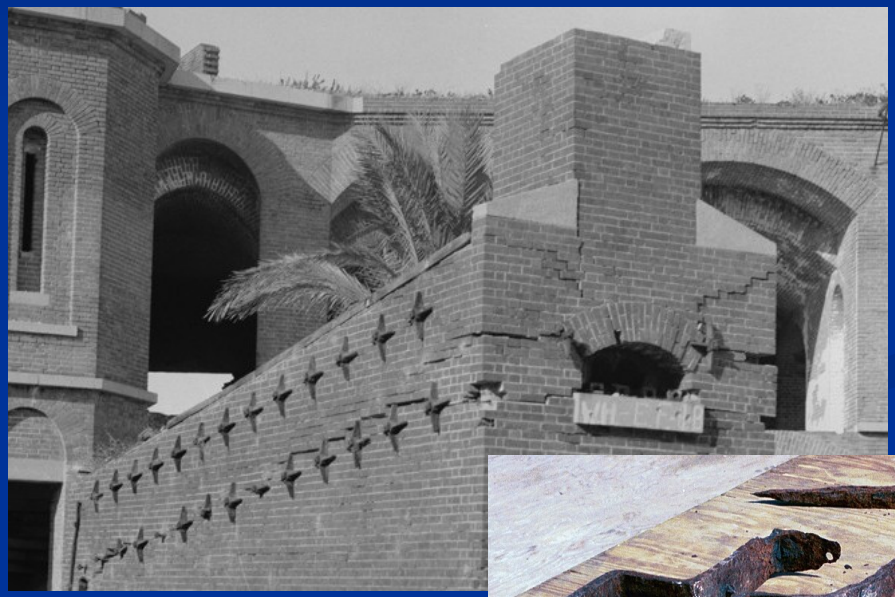


Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 5 – Reassemble the furnace brickwork incorporating the replica components and some new brick

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly

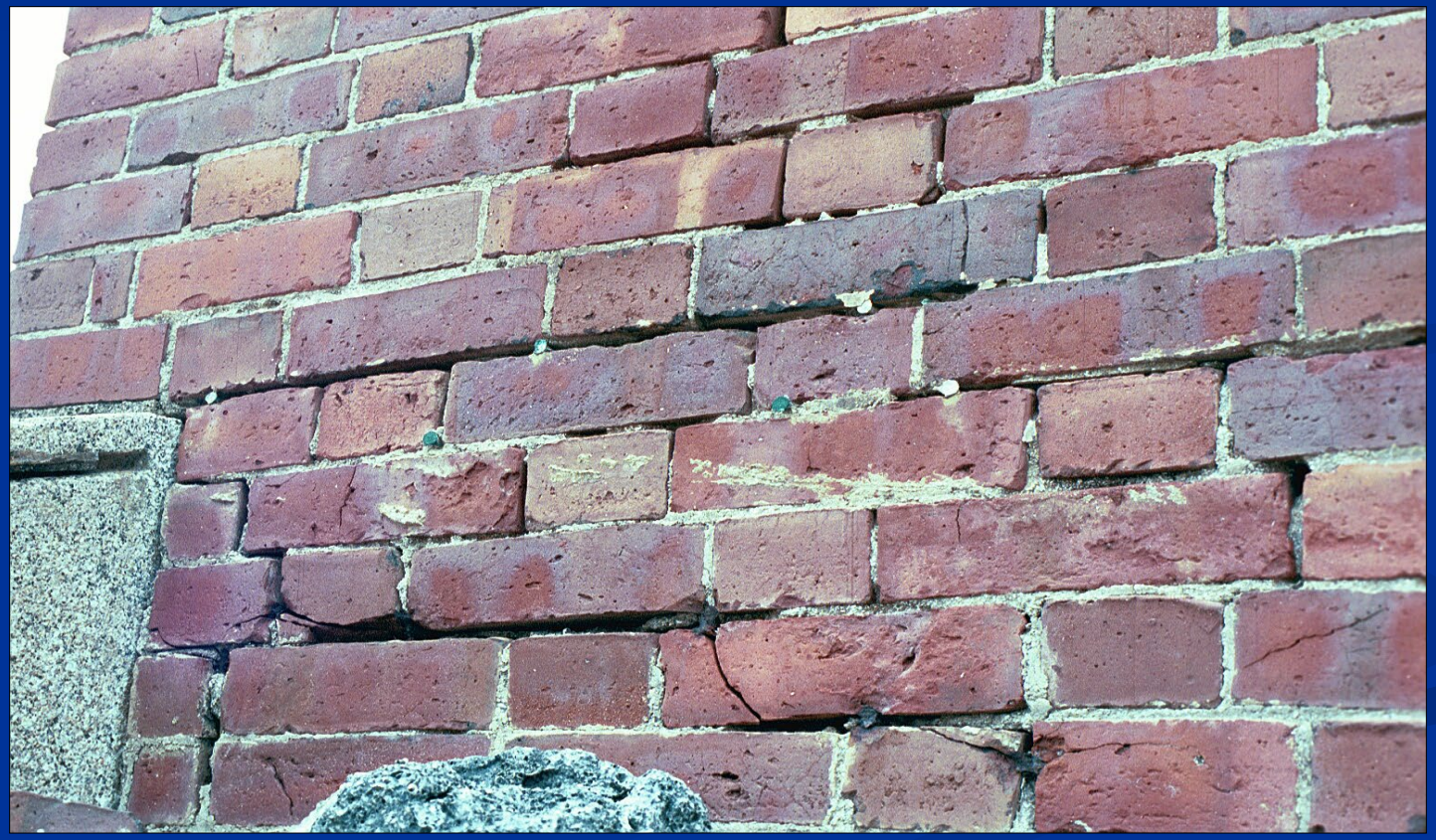


Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly and other sources

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly and other sources



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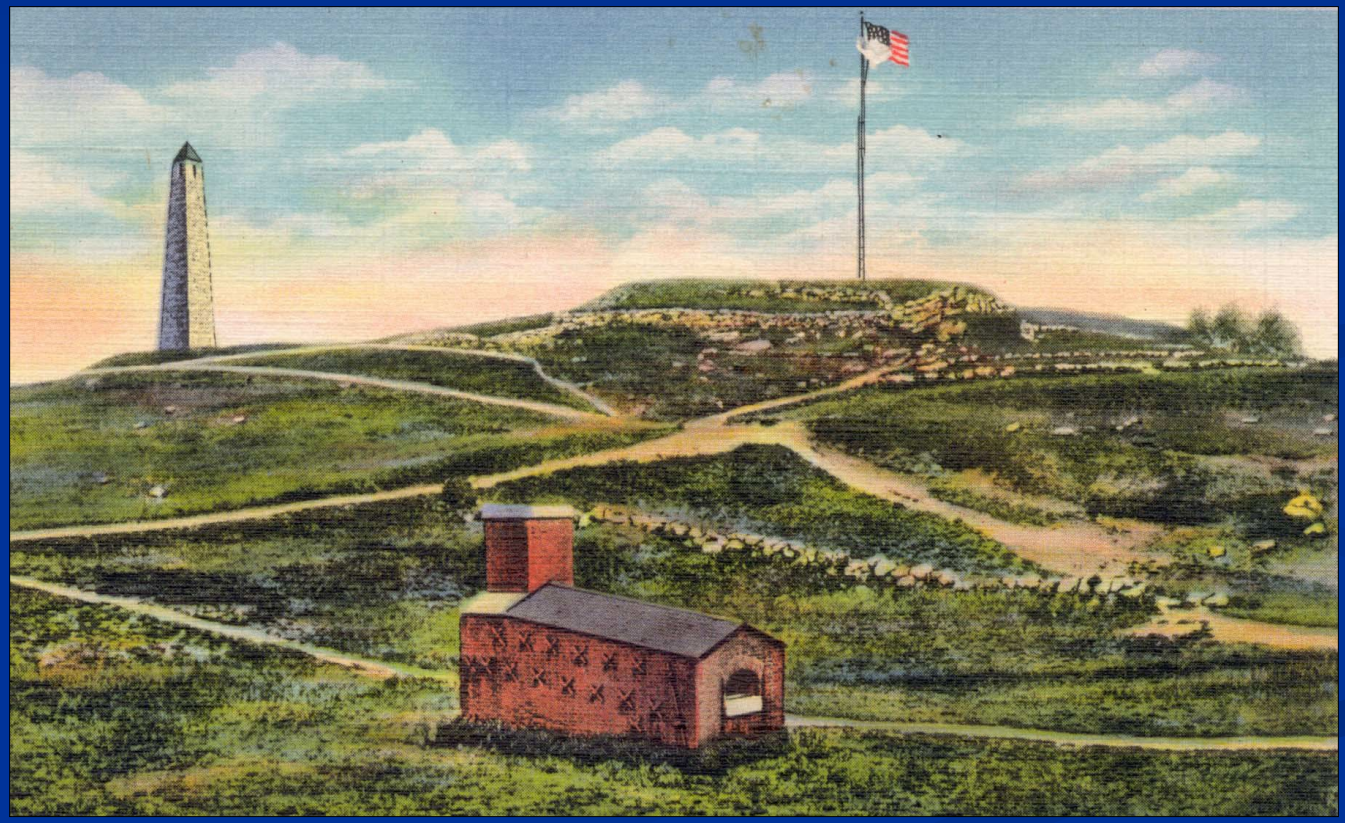


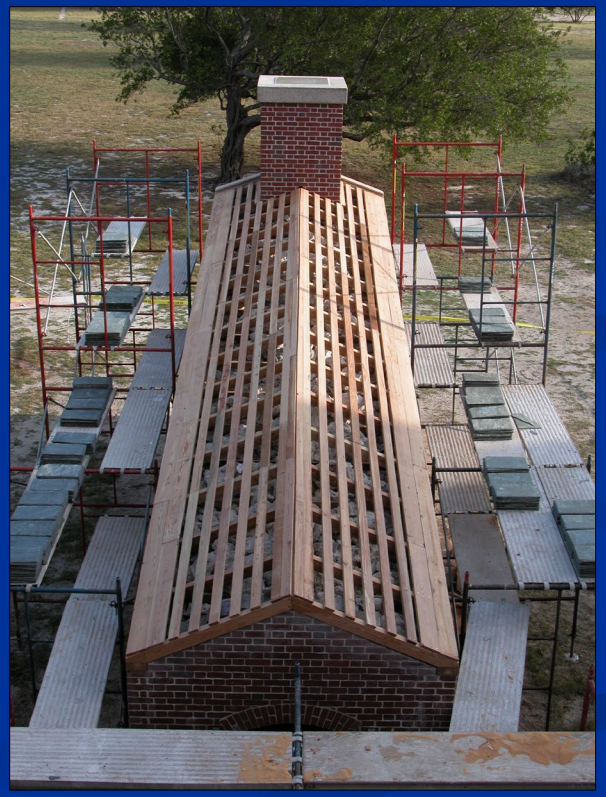
Fort Griswold

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly and other sources

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly and other sources



Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly and other sources

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 6 – Develop roof system plan and implement based on evidence gathered during disassembly and other sources

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Step 7 – Fire it up!

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Post-Project Assessment – March 2008 (4 years and 4 Hurricanes)

Mortar dye is fading from UV exposure

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Post-Project Assessment – March 2008 (4 years and 4 Hurricanes)

Patina has faded – This was expected and re-application is cyclic maintenance need

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Post-Project Assessment – March 2008 (4 years and 4 Hurricanes)

Areas of undisturbed brick-work, repointing mortar has eroded. Damage may have been from Hurricane Wilma

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Post-Project Assessment – March 2008 (4 years and 4 Hurricanes)

Three of the four sliding outlet covers have been stolen

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Post-Project Assessment – March 2008 (4 years and 4 Hurricanes)

Efflorescence is occurring under the chimney coping stones

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Post-Project Assessment – March 2008 (4 years and 4 Hurricanes)

Slate Roof survived all four 2005 hurricanes, likely due to the use of Chatter Damper adhesive and ring-shank nails in selected areas

Fort Jefferson Hot Shot Furnace Rehabilitation Project – 2001-2004

Discussion