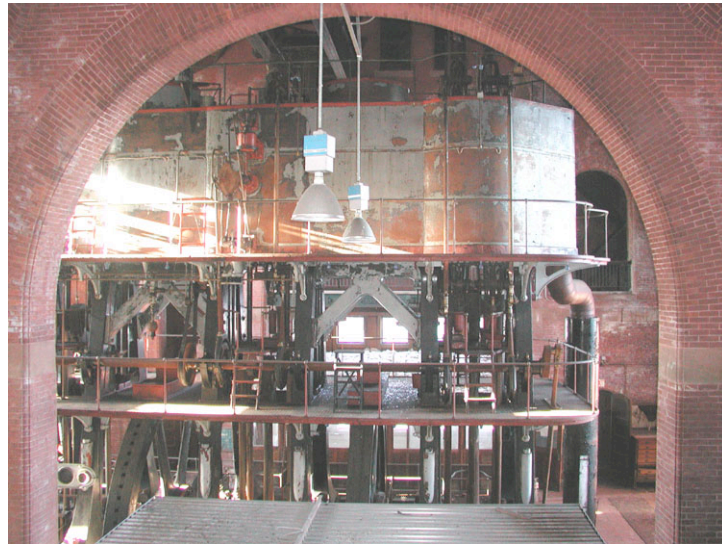


Chestnut Hill Waterworks Hall of Machines

Boston, Massachusetts

Final Treatment Report for Steam Pumping Engines



October 2006

BCA

Chestnut Hill Waterworks Hall of Machines

Boston, Massachusetts

Final Treatment Report for Steam Pumping Engines

Prepared For
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Chestnut Hill Waterworks, Hall of Machines Boston, MA Final Treatment Report for Steam Pumping Engines

INTRODUCTION

Following completion of a preliminary conditions and finishes study, Building Conservation Associates, Inc. (BCA) was retained by Waterworks Park, LLC to conduct conservation treatment of the three steam pumping engines within the Hall of Machines at the High Pump Building of Chestnut Hill Waterworks. As per the agreed upon scope of work submitted to and approved by the HSAB and DCAM the treatment was confined to the engine areas at and above the ground floor level. Initial safety measures in preparation for treating the Allis engine (increasing guard rail height with plywood walls) took place from May 17 to May 31, 2006. Overall treatment of the Allis engine commenced on June 1, 2006 and was completed on June 27, 2006. The central Worthington engine was treated between June 28th and July 25th. The eastern Leavitt engine was treated between July 19th and August 31st 2006. Treatments followed the protocol established by BCA in their March 2006 Conditions Survey, Finishes Study and Cleaning Test Report. The March 2006 Conditions Survey was reviewed and approved by DCAM and by the HSAB.

This report serves to summarize and document BCA's treatment as it relates to the protocol established by the March 2006 conditions survey, finishes study and cleaning test report.

Methods of Work

Storage

BCA utilized an 8-foot by 12-foot storage POD placed near the west elevation of the building throughout the project as their changing station and safety equipment storage space. This storage POD remained at the site from May 31, 2006 until September 15, 2006. Within the High Service building BCA utilized a 60-inch by 37-inch Knaack Stagemaster chest to contain cleaning materials and tools and for attaching moveable equipment such as ladders and lights when not in use. Both the POD and the chest were padlocked for security throughout the project.

Engine Access

Following extensive floor investigation by Odeh, Engineers, Inc. and extensive measuring of paths between engines and engines and between engines and walls, BCA, had to amend their initial plan to utilize multiple scissor lifts for cleaning the upper engine regions (weight and space allowance were comprised by this large lift type). Instead, an individual

UL 40 Portable Personnel Lift was the only portable scaffold used by BCA for the project. This lift was used only for the Worthington engine treatment and only at specific elevations approved by the engineers (the north and west elevations of the Worthington). Following the engineer's directive, the lift was only used at the Worthington elevations after first laying 6x6 cribbing beneath it. This cribbing requirement was due to the inadequate floor framing in the older portion of the building.

The integral spiral stair access to the Allis engine was supplemented for conservation treatment work by plank scaffolding that included a stair tower to the third floor at the northeast elevation and four bed planked stages that spanned the east/west openings below the nine foot ceiling of the first floor.

Along with the UL-40 lift, conservation access to the Worthington engine was supplemented by a bed planked stage that spanned the east west area just south of the large wheel element at approximately eight feet in height.

Access to the Leavitt south suction chambers, six in number, was supplemented by two levels of plank staging, one at approximately 20 feet high and another at approximately 10 feet high. This stage assembly serviced only one row of chambers in width at a time and was erected initially at the north of the two rows, then collapsed and reassembled at the south of the two rows.

Both the UL-40 Personnel Lift and the plank scaffold staging were supplied by Marr Scaffolding, One D Street, South Boston, Massachusetts.

Treatment Sequence

As discussed in pre-planning meetings with the general contractor and Waterworks Park, LLC, the machines were treated from west to east (Allis first, Worthington second, Leavitt third). This phasing, allowed for sequential staging erection as well as safe circulation of other trades within the building during the treatment. Because the treatment required a large amount of soil removal and some loose paint removal, each engine was treated from the top floor proceeding downward to limit the amount of re-treatment required from falling debris.

Treatment Summary

The extremely soiled and corroded condition of the engines required intervention for preservation. Because of the variety and complexity of the previous finishes and the fragile nature of the adjacent materials (glass, leather, wood), preservation of the existing metal coatings was performed as opposed to more aggressive paint removal and repainting. BCA completed a cleaning and corrosion treatment procedure which served to maintain both the historic engine machinery and their finishes. This treatment preserved the engines' current appearances, and retained as much as possible of the existing and previous finishes for future interpretation and education.

GENERAL CONDITIONS TREATMENT

Each engine exhibited deteriorative conditions in the form of: metal corrosion, peeling paint, oil build up and dirt accumulation. The general treatment performed was an initial dry vacuum procedure utilizing Nilfisk Back Vacuum XP vacuums equipped with HEPA filters to ensure that 99.7% of all ultra fine particles were retained down to and including 0.3 microns. Further dirt and grease removal was performed cleaning surfaces with mineral spirits and a nylon scrub pad and/or cotton towel. In the case of heavy grease deposits a Tergitol 15-S-5 emulsion cleaner was utilized. This paste cleaner was applied with a nylon scrub pad, agitated slightly on the surfaces by hand, immediately suspended if any coatings loss was evident and cleared from the surface with cotton rags and a mineral spirits rinse. In order to reduce further corrosion from water, mineral spirits was used to clear the emulsion and to remove both the non-adhered paint and the oily residues.

Nylon scrub pads could not be used for cleaning the heavily corrugated floor catwalks (the rough topography destroyed the nylon scrub pads prior to cleaning completion). Instead, an extended arm scrubber fitted with a battery operated rotary nylon scrub brush was used for cleaning these floor areas.

Representative conditions images before and after treatment are included in Appendix A of this report.

Excessive Rust [iron metal corrosion] (see Figure A1)

Paint spalls and flaky orange deposits indicated the presence of active iron corrosion. Iron is a fairly reactive metal that performs best when coated, protected from high humidity (above 70%) and is kept clean. The engines exhibited two apparent finish/rust conditions prior to treatment. The first of these is exposed iron at surfaces that were originally meant to be painted and now exhibit rust (see Figure B1); the second condition is surfaces that were originally plated that now exhibit rust (see Figure C1). This condition was treated with the vacuum and cleaning procedures mentioned above then coated with Corrosion Suppressant 101 (bare metal only, not intact paint) manufactured by Aervoe Industries, Inc (see Figures A2, B2 and C2).

The rust resulting from both conditions, but particularly the formerly plated surfaces, appears to be caused by galvanic corrosion. This is a chemical reaction that occurs when dissimilar metals are in fixed contact in the presence of an electrolyte. The metal that is lower on the electromotive scale will preferentially give up ions to the metal that is higher (see Figure D1). It was observed that even the plaque, installed in 1972, which consists of bronze (estimated) on a ferrous metal base, is already corroding at the ferrous surface (see Figure E1). This surface to surface contact assembly of dissimilar metals is considered to be an inherent vice of these pumping engines. Further information from National Park Service Historian, Duncan Hay indicates this construction technique of employing adjacent dissimilar metals to manage machinery movement stresses may have

been the engineer's original design intent. Thus this condition was treated identically to the rusted surfaces mentioned above - cleaned with mineral spirits and nylon scrub pads and coated with Corrosion Suppressant 101 (see Figures D2 and E2).

At the request of Dana Angelo, EA Fish, Senior Project Director, the light gray painted engine components of the Worthington engine at the north end were coated with an alternate corrosion suppressant coating (due to unacceptable yellowish color of Aervoe product on light gray paint surfaces). These surfaces were coated instead with 3-36 Multi Purpose Lubricant and Corrosion Inhibitor manufactured by CRC (see Figures F1 and F2).

Halfway through the engines treatments, a third rusted metal treatment possibility was provided by National Park Service associate Greg Byrne. This treatment consists of heating microcrystalline wax and combining it with a 20% weight to volume portion of CRC 336. Since advisory board member Duncan Hay was a strong advocate of this treatment, BCA tested its use on two of the third floor barrel end elements of the Leavitt engine (the north elevation east one and the south elevation west one). Although satisfactory in appearance, this treatment proved to be impractical to implement given the time constraints of this project (see Figures H1 and H2).

Paint Failure (see Figure G) – Much paint is peeling, chipping and flaking off of the machines' surfaces. The finish analysis study completed by BCA in March 2006 revealed complex paint histories on the various pumping engines as well as on their color coded parts. Neither the contemporary pump schemes, nor the part designation color schemes could be easily disseminated or deciphered in concurrent chronological context. Therefore retention of the paint layers for future research was the goal and the product of this treatment. At these flaking areas, BCA gently eased off non-adhered paint flakes with thin plastic spatulas (softer than the metal to prevent scratching), then vacuumed. The adjacent bare metal was cleaned with mineral spirits and coated with Corrosion Suppressant 101 (see Figure G2). Future engine interpretation will no doubt be aided by BCA's exposure of numbered engine parts previously obscured by grease and grime (see Figures I1 and I2).

Leather

BCA cleaned the leather engine belts with mild gel cleaner containing 1% of the chelator diammonium citrate and 1% of the non-ionic surfactant Triton XL-80N in water gelled with methylcellulose to prevent over dampening of the brittle leather (see Figures J1 and J2).

Oil Build-up (see Figure K1)

Along with pools of standing oil, many of the metal machine elements carry oily surface residues, which contribute to dirt retention. The Tergitol 15-S-5 emulsion cleaner was

effective at dissolving and removing these oil puddles (see Figure K2). BCA also undertook disposal of the numerous oil soaked rags throughout the building (see Figures L1 and L2).

Translucent Wood Finishes (see Figure M1)

Fortunately, translucent wood finishes on the Leavitt engine were also successfully cleaned with the Tergitol emulsion. This was advantageous because wood and metal elements were so integrated at the third floor of the Leavitt engine that some overlap did occur during cleaning. It should be noted that because of the fragile nature of translucent wood finishes the dwell time of the Tergitol emulsion on these surfaces was limited to 1 minute maximum. To protect these surfaces following cleaning and drying a protective coating of Archival Varnish incorporating ultraviolet light filters was applied. This product was Mineral Spirit Acrylic Aerosol (Satin) manufactured by Golden (see Figure M2).

Further Recommendations

During a visit by National Park Service Historian, Duncan Hay, several raccoons were noted at the west third floor balcony of the building. Subsequent trapping initiated by NEI, succeeded in the capture of one of these rodents (see Figure O). Further monitoring of rodent evidence should be performed weekly until the building has been better-sealed post construction phase.

To limit further rust corrosion, BCA recommends that the interior humidity level of the High Service building remain below 50% RH.

Major Product Suppliers

Nilfisk BackPac HEPA Vacuum Cleaners	Safety Environmental Control Inc. P.O. Box 382 Keene, NH 03431
Battery Powered Rotary Motor Scrubbers	Reading Consumer Products Inc. 80 Witman Road Reading, PA 19605
Tergitol 15-S-5 and Triton XL-80N Surfactants, Diammonium Citrate anhydrous chelator	Sigma – Aldrich 330 South Second Street St. Louis, MO 63118
Corrosion Suppressant 101 Liquid and Aerosol	Aervoe Industries 1198 Mark Circle Gardnerville, NV 89410
CRC 3-36 Industrial Lubricant Liquid and Aerosol	Lab Safety Supply 401 S. Wright Road Janesville, WI 53547-1368
Golden Mineral Spirit Acrylic Aerosol Satin Varnish	Jerry's Artarama 5325 Departure Drive Raleigh, NC 27616

Appendix A

Conditions Treatment Figures

Conditions Treatment Figures

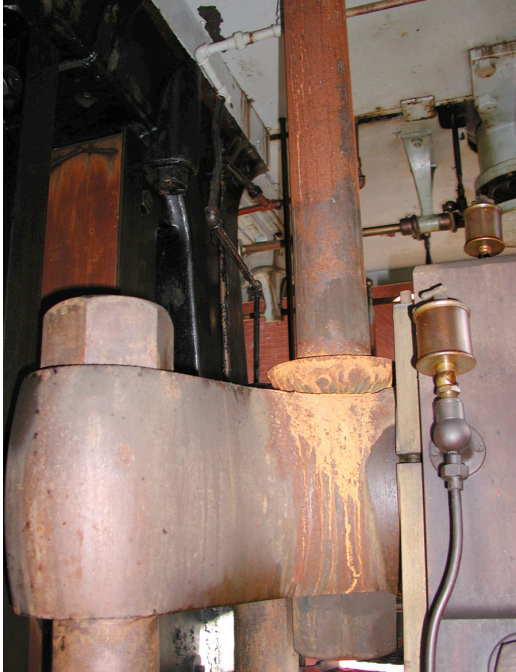


Figure A1. Extensive rust evident on Allis engine before treatment.



Figure A2. Rusted metal surfaces cleaned with mineral spirits and coated with Corrosion Suppressant 101- Allis engine after treatment.



Figure B1. Originally painted surface, exhibiting extensive rust, Worthington engine before treatment.



Figure B2. Originally painted surface, Worthington engine after treatment.



Figure C1. Originally plated surface, exhibiting extensive rust, Leavitt engine before treatment.



Figure C2. Originally plated surface, Leavitt engine after treatment.



Figure D1. Galvanic corrosion (see surround plate) Leavitt engine before treatment.

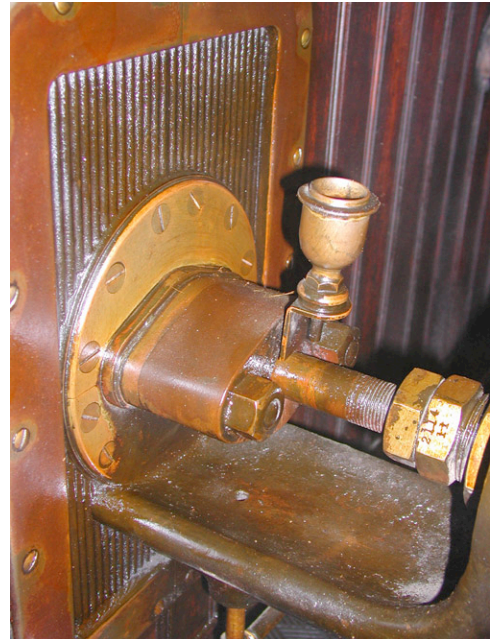


Figure D2. Galvanic corrosion Leavitt engine after treatment.



Figure E1. Galvanic corrosion Leavitt engine before treatment.



Figure E2. Galvanic corrosion Leavitt engine after treatment.



Figure F1. Worthington engine north end with CS 101 corrosion suppressant coating.



Figure F2. Worthington engine with CRC 3-36 corrosion suppressant coating.



Figure G1. Paint failure at wheel of Allis engine before treatment.



Figure G2. Paint failure at wheel of Allis engine after treatment.



Figure H1. Leavitt engine rusted barrel end before CRC 3-36/microcrystalline wax treatment.

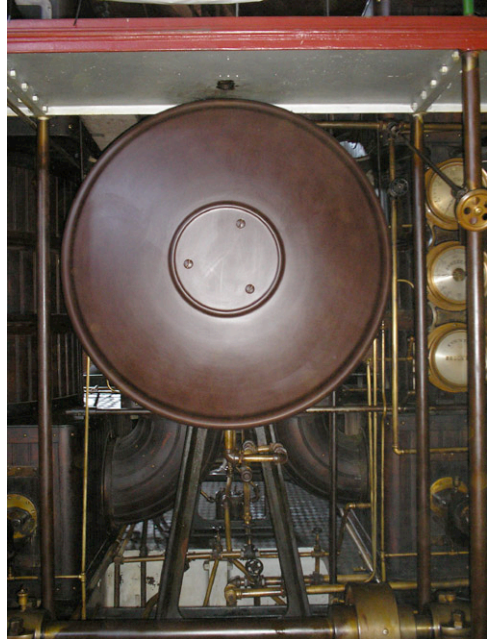


Figure H2. Leavitt engine rusted barrel end after CRC 3-36/microcrystalline wax treatment.



Figure I1. Leavitt engine, first floor bolt, detail before cleaning.



Figure I2. Leavitt engine, first floor bolt detail after cleaning. Note number now visible.

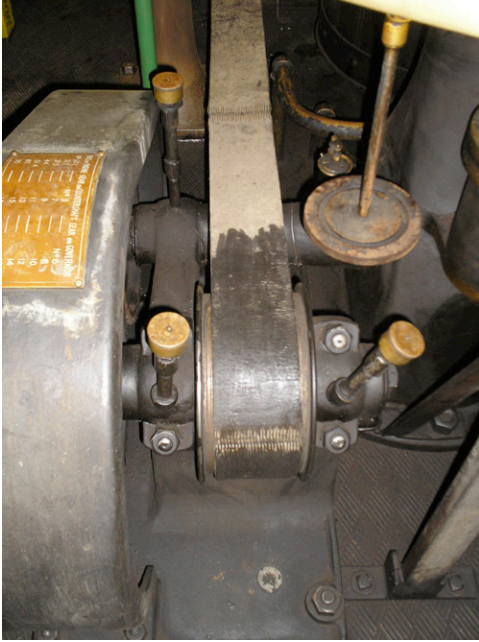


Figure J1. Leavitt engine leather belt during cleaning w/1% diammonium citrate cleaner. citrate.

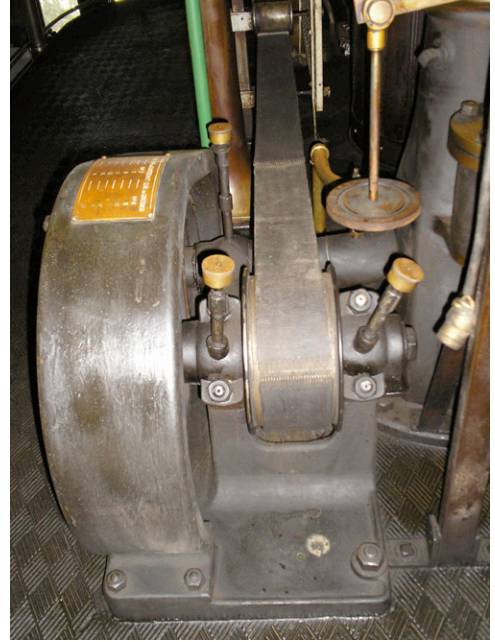


Figure J2. Leavitt engine leather belt after cleaning w/ 1% diammonium citrate.



Figure K1. Standing oil build-up at Allis engine before treatment.



Figure K2. Standing oil build-up at Allis engine after treatment.



Figure L1. Oily rags Leavitt engine third floor before treatment.



Figure L2. Same area after treatment.

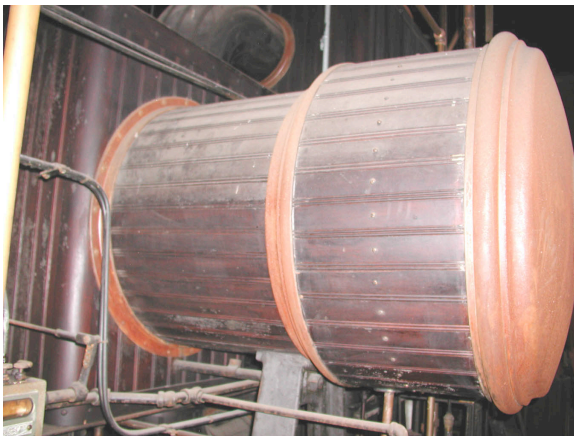


Figure M1. Finished wood elements at Leavitt Engine before treatment.



Figure M2. Finished wood elements at Leavitt engine after treatment.



Figure N1. Finely worked gauges at Leavitt engine before treatment.



Figure N2. Finely worked gauges at Leavitt engine after treatment.

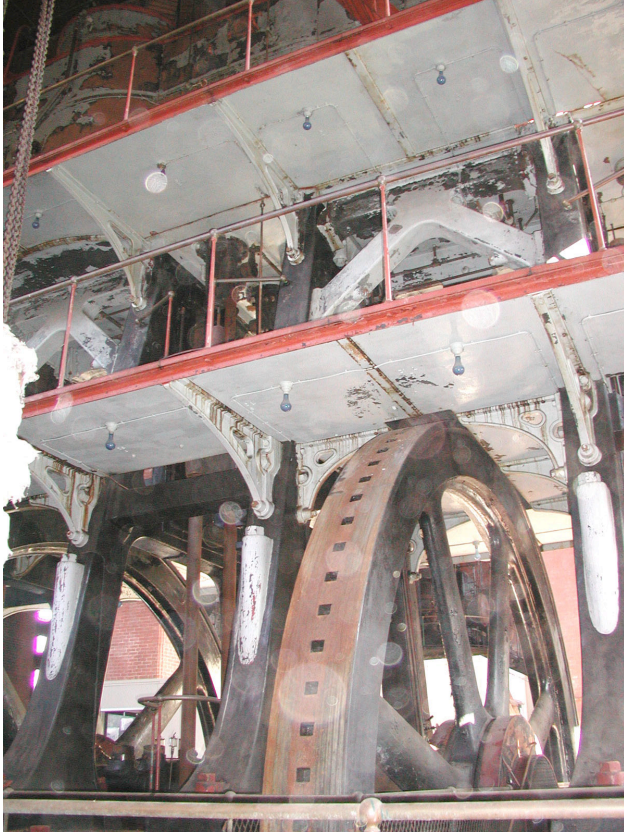


Figure O. Raccoon captured at second floor west balcony July 20, 2006.

Appendix B

Overall Engine Treatment Before and After Images

Overall Treatment Images



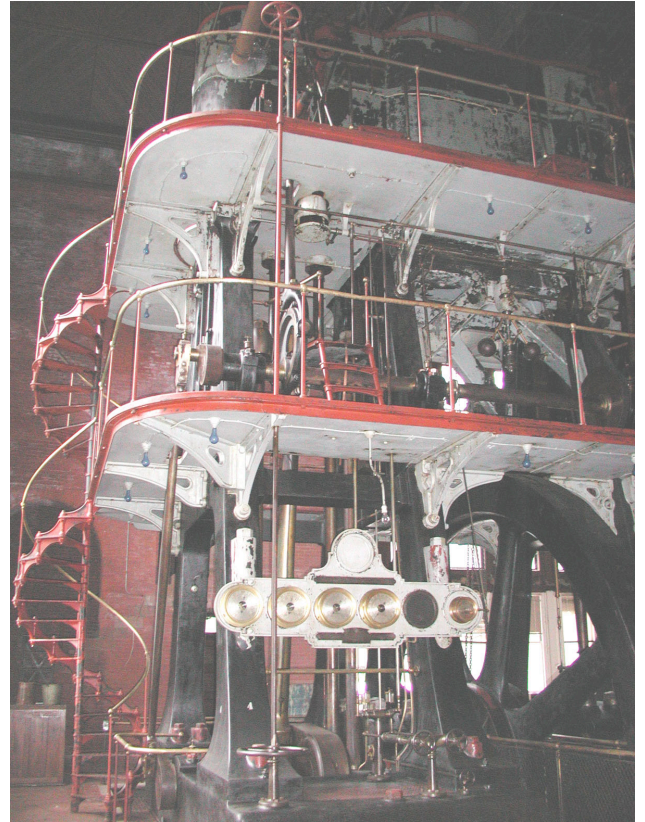
Allis engine (west elevation) before treatment November 21, 2005.



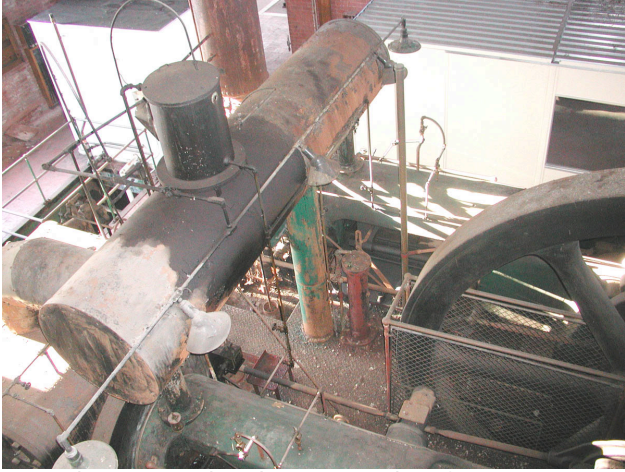
Allis engine (west) after treatment August 30, 2006.



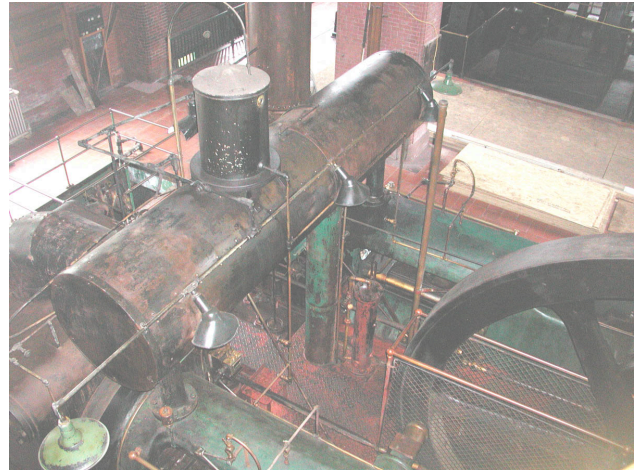
Allis engine (southeast elevation) before Treatment November 21, 2005.



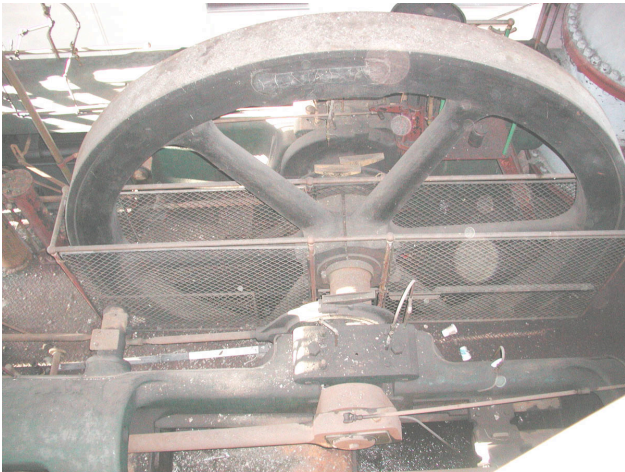
Allis engine (southeast) after treatment August 30, 2006.



Worthington engine (south area) before treatment
December 8, 2005.



Worthington engine (south) after
treatment August 30, 2006.



Worthington engine (middle area) before treatment
December 8, 2005.



Worthington engine (middle) after
treatment August 30, 2006.



Leavitt engine (northwest elevation) before treatment November 21, 2005.



Leavitt engine (northwest) after treatment August 30, 2006.



Leavitt engine (northeast elevation) before treatment November 21, 2005.



Leavitt engine (northeast) after treatment August 30, 2006.



Leavitt engine (southwest) before treatment June 28, 2006.



Leavitt engine (southwest) after treatment August 30, 2006.

Appendix C
Allis Engine Treatment Before and After
Images Floor 4



Allis Floor 4 North detail A before treatment.



Allis Floor 4 North detail A after treatment.



Allis Floor 4 North detail B before treatment.



Allis Floor 4 North detail B after treatment.



Allis Floor 4 mid detail C looking north before treatment.



Allis Floor 4 mid detail C looking north after treatment.



Allis Floor 4 North detail D barrel looking south before treatment.



Allis Floor 4 North detail D barrel looking south after treatment.

Appendix D
Allis Engine Treatment Before and After
Images Floor 3



Allis Floor 3 North detail A, west side looking north before treatment.



Allis Floor 3 North detail B, west side after treatment.



Allis Floor 3 South detail C, east side looking south before treatment.

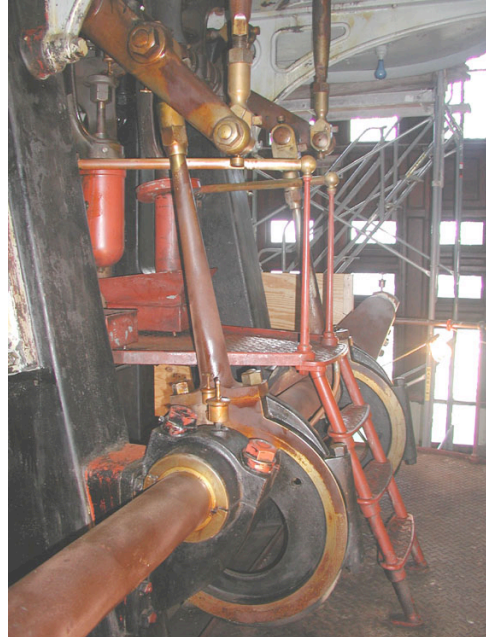


Allis Floor 3 South detail D, east side looking south after treatment.

Appendix E
Allis Engine Treatment Before and After
Images Floor 2



Allis Floor 2 South detail A, west side looking south before treatment.



Allis Floor 2 South detail B, west side after treatment.

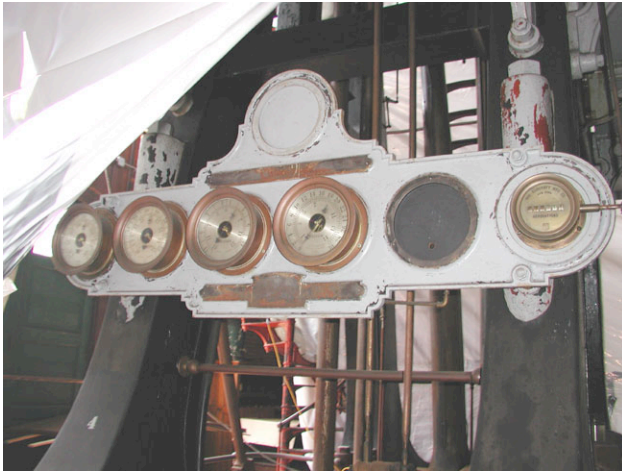


Allis Floor 2 mid detail C east side before treatment.

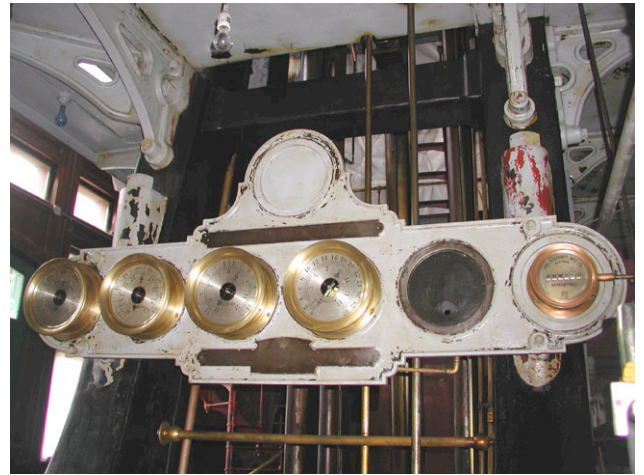


Allis Floor 2 mid detail D east side after treatment.

Appendix F
Allis Engine Treatment Before and After
Images Floor 1



Allis Floor 1 South detail A, east side before treatment.



Allis Floor 1 South detail B, east side after treatment.



Allis Floor 1 North detail C, east side before treatment.



Allis Floor 1 North detail D, east side after treatment.



Allis Floor 1 North detail E, east side before treatment.



Allis Floor 1 North detail F, east side after treatment.



Allis Floor 1 South detail G, east side before treatment.



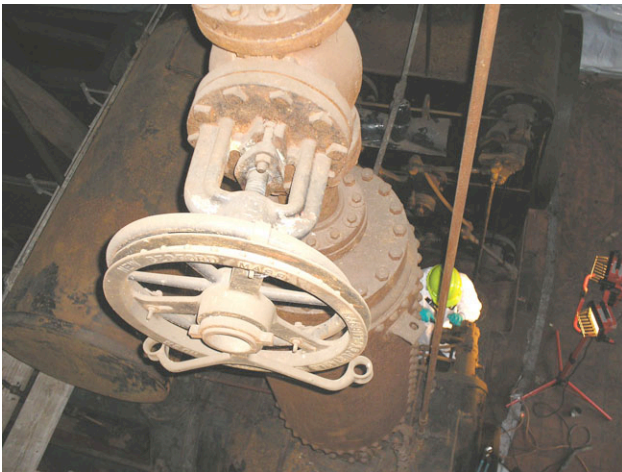
Allis Floor 1 South detail H, east side after treatment.



Worthington Floor 3 North detail A,
before treatment.



Worthington Floor 3 North
detail B, after treatment.



Worthington Floor 3 South detail C,
before treatment.



Worthington Floor 3 South
detail D, after treatment.

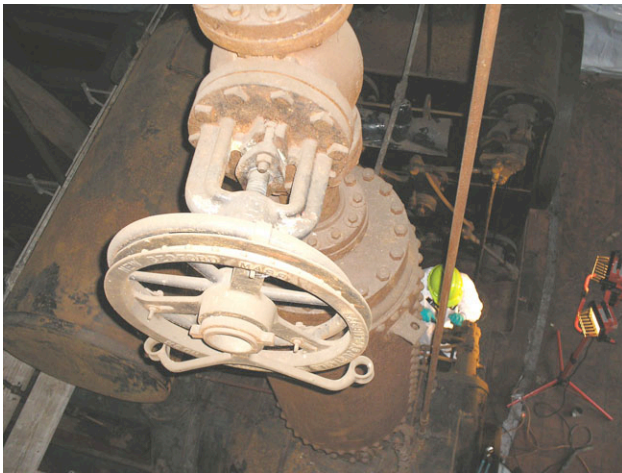
Appendix G
Worthington Engine Treatment Before and After
Images Floor 3



Worthington Floor 3 North detail A,
before treatment.



Worthington Floor 3 North
detail B, after treatment.



Worthington Floor 3 South detail C,
before treatment.

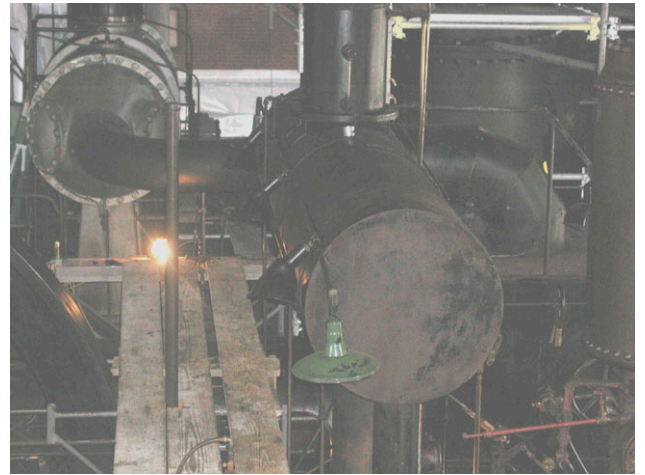


Worthington Floor 3 South
detail D, after treatment.

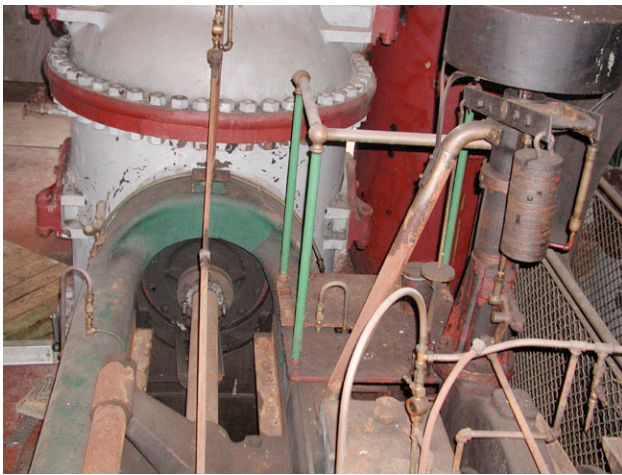
Appendix H
Worthington Engine Treatment Before and After
Images Floor 2



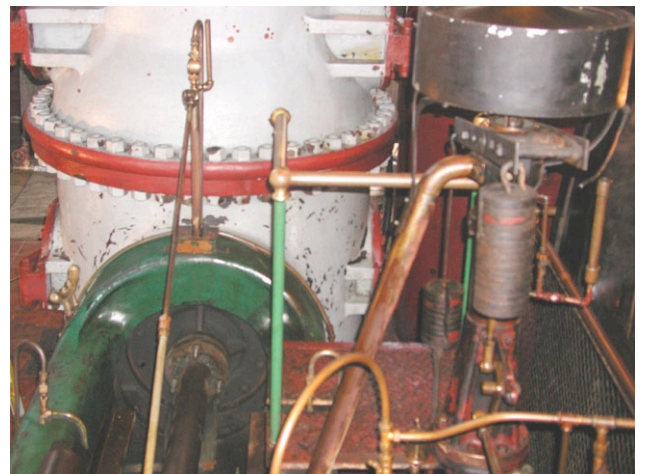
Worthington Floor 2 mid detail A,
looking east before treatment.



Worthington Floor 2 mid
detail B, after treatment.



Worthington Floor 2 mid detail A,
looking north before treatment.



Worthington Floor 2 mid
detail B, after treatment.

Appendix I
Worthington Engine Treatment Before and After
Images Floor 1

Appendix I: Worthington Engine Treatment Before and After Images Floor 1



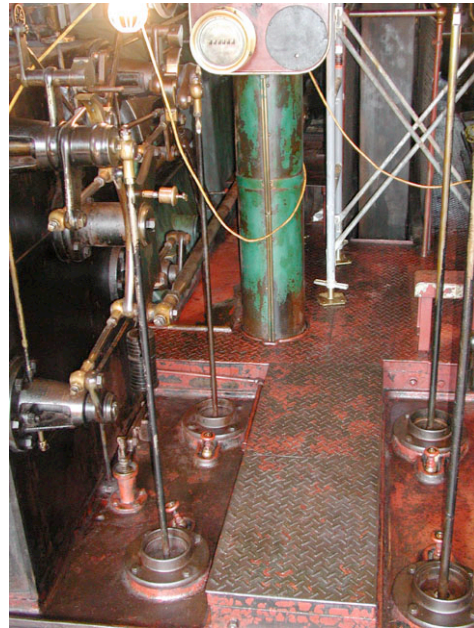
Worthington Floor 1 mid detail A, looking north before treatment.



Worthington Floor 1 mid detail B, after treatment.



Worthington Floor 1 North detail C, looking north before treatment.



Worthington Floor 1 North detail D, after treatment.

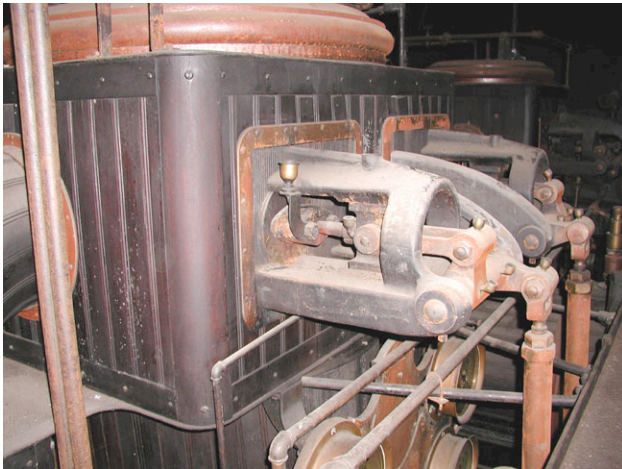
Appendix J
Leavitt Engine Treatment Before and After
Images Floor 4



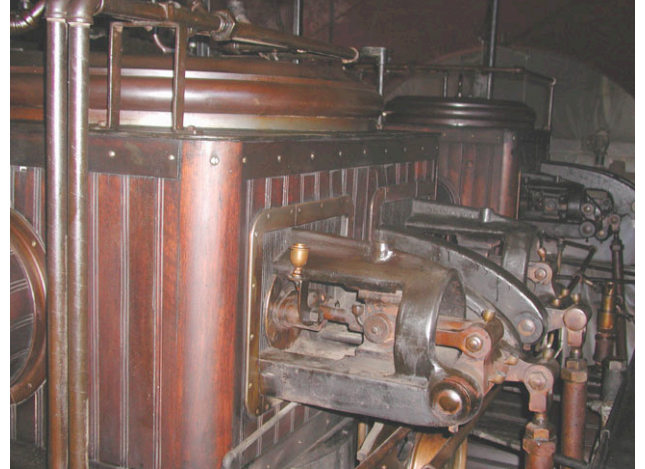
Leavitt Floor 4 North detail A,
looking south before treatment.



Leavitt Floor 4 North
detail B, after treatment.



Leavitt Floor 4 North detail C,
looking south before treatment.



Leavitt Floor 4 North
detail D, after treatment.



Leavitt Floor 4 South detail E,
looking south before treatment.

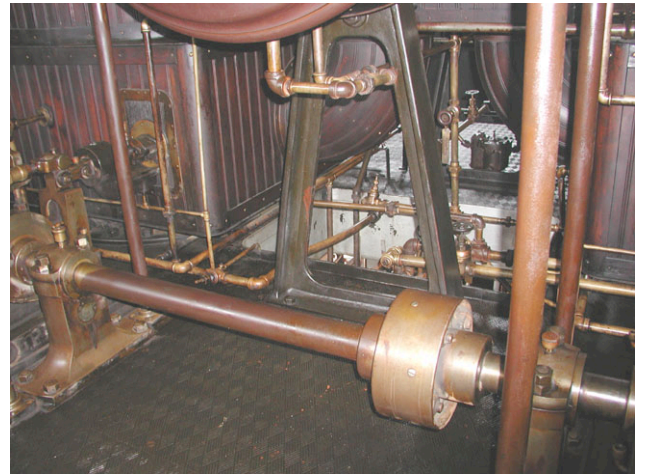


Leavitt Floor 4 South
detail F, after treatment.

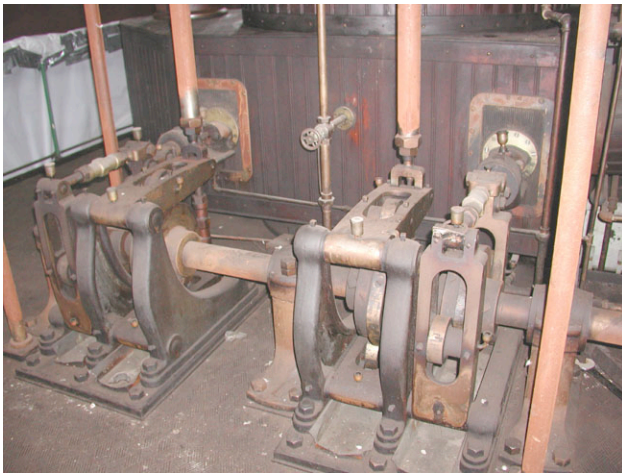
Appendix K
Leavitt Engine Treatment Before and After
Images Floor 3



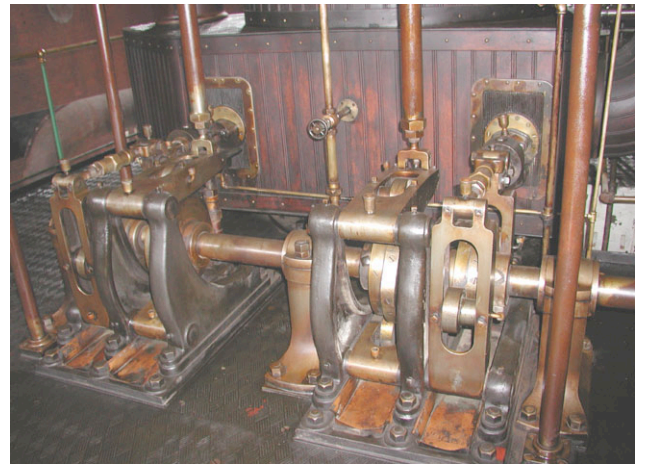
Leavitt Floor 3 North detail A,
north side before treatment.



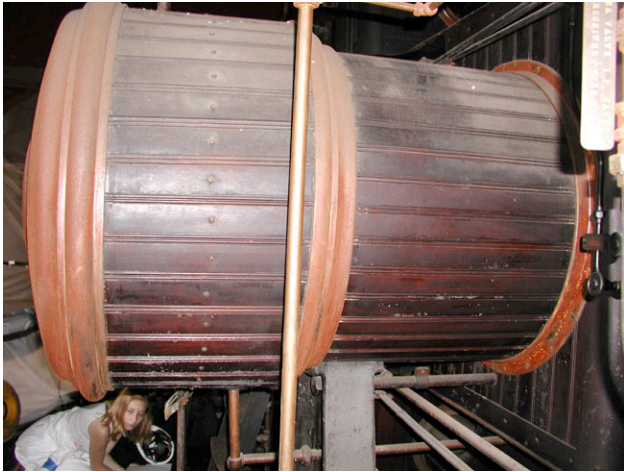
Leavitt Floor 3 North
detail B, after treatment.



Leavitt Floor 3 North detail C,
north side before treatment.



Leavitt Floor 3 North
detail D, after treatment.



Leavitt Floor 3 North end detail E, south side before treatment.



Leavitt Floor 3 North end detail F, south side after treatment.

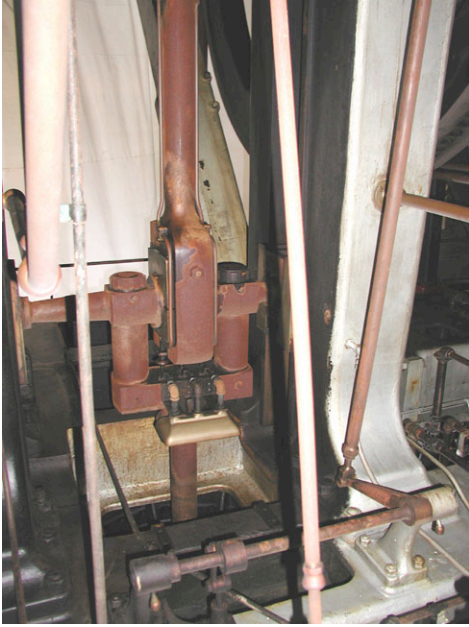


Leavitt Floor 3 South detail G, looking east before treatment.

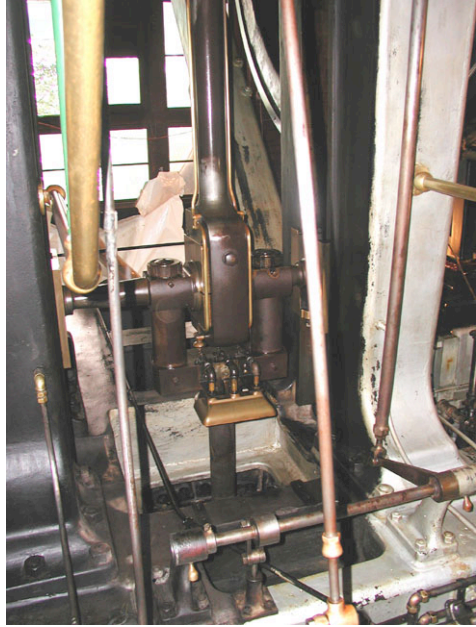


Leavitt Floor 3 South detail H, after treatment.

Appendix L
Leavitt Engine Treatment Before and After
Images Floor 2



Leavitt Floor 2 North end detail A, south side before treatment.



Leavitt Floor 2 North end detail B, south side after treatment.



Leavitt Floor 2 North end detail C, east side before treatment.



Leavitt Floor 2 North end detail D, east side after treatment.



Leavitt Floor 2 North end detail E, north side before treatment.



Leavitt Floor 2 North end detail F, after treatment.

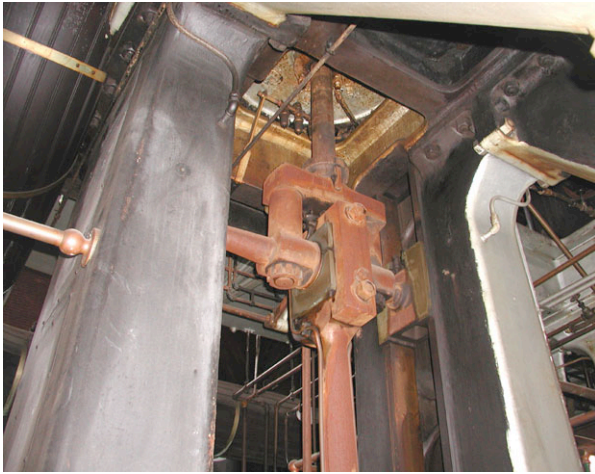


Leavitt Floor 2 North end detail G, east side before treatment.



Leavitt Floor 2 North end detail H, after treatment.

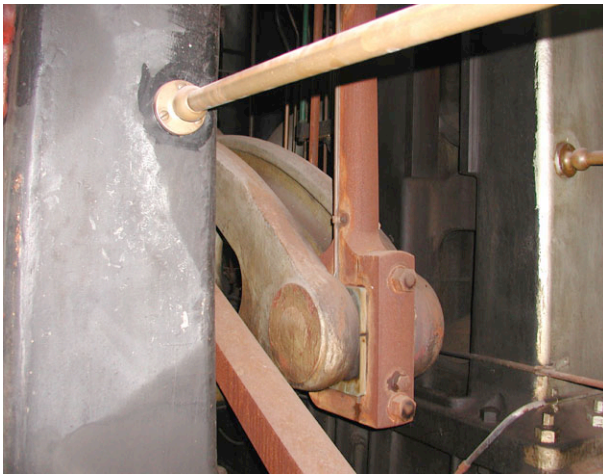
Appendix M
Leavitt Engine Treatment Before and After
Images Floor 1



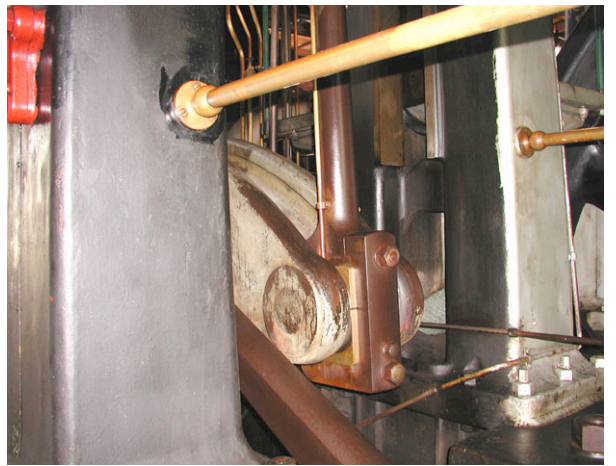
Leavitt Floor 1 North end detail A, north side before treatment.



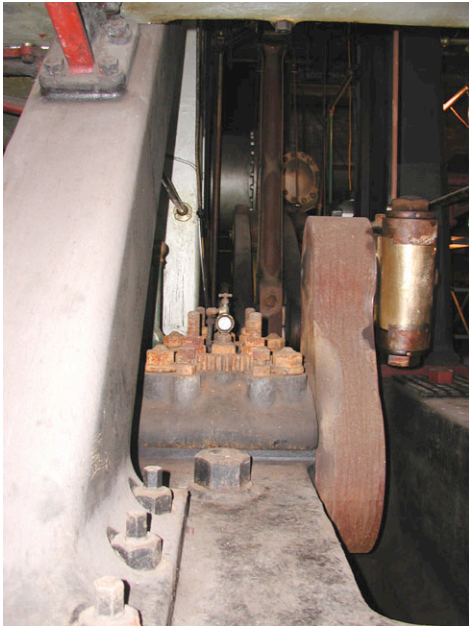
Leavitt Floor 1 North end detail B, after treatment.



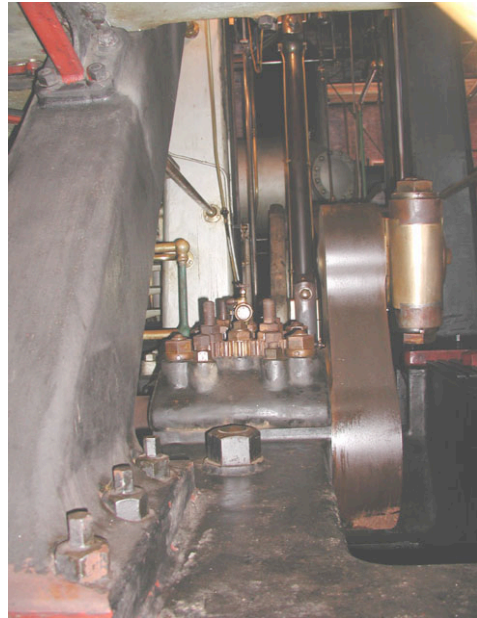
Leavitt Floor 1 North end detail C, north side before treatment.



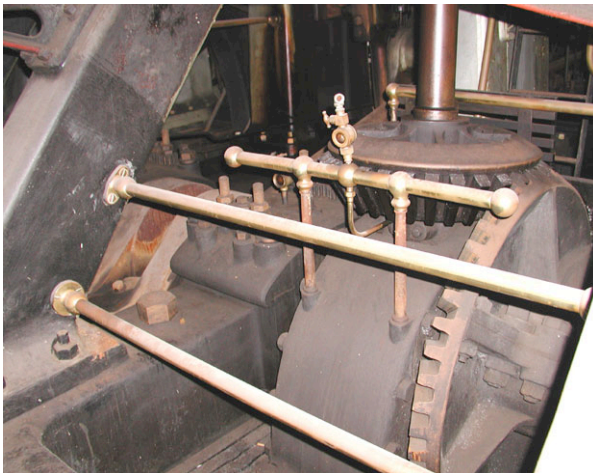
Leavitt Floor 1 North end detail D, after treatment.



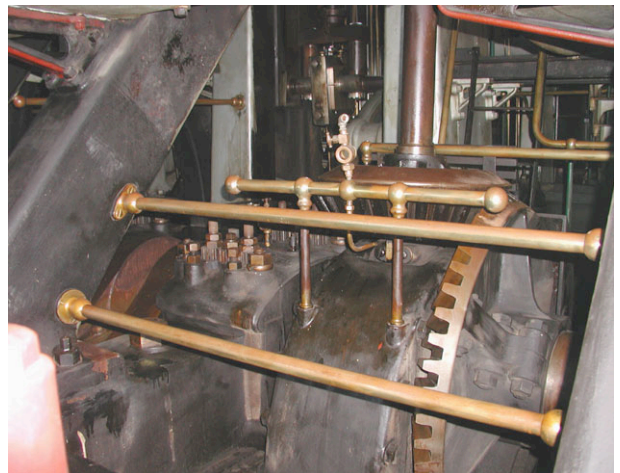
Leavitt Floor 1 North end detail E, north side before treatment.



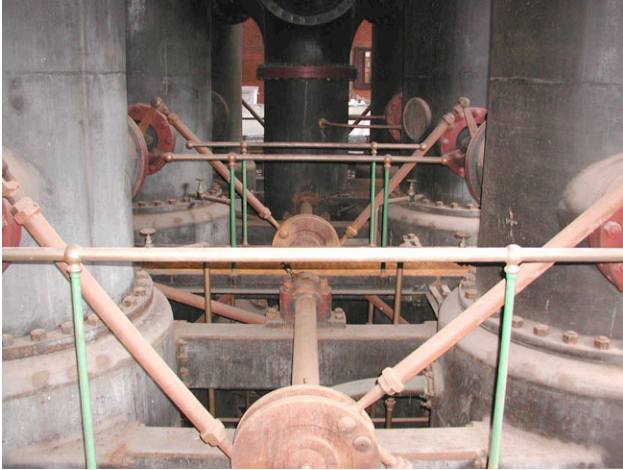
Leavitt Floor 1 North end detail F, after treatment.



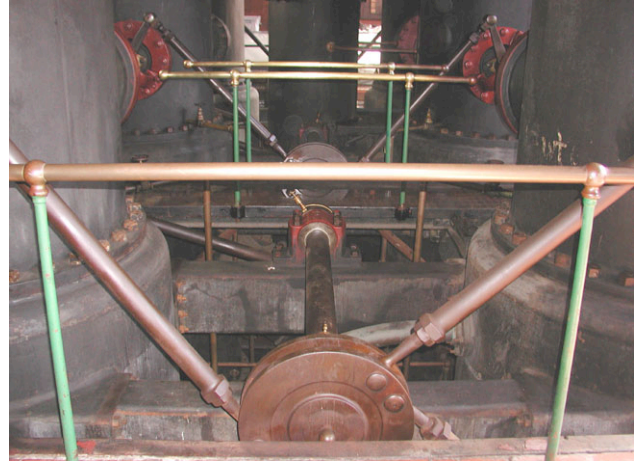
Leavitt Floor 1 North end detail G, north side before treatment.



Leavitt Floor 1 North end detail H, after treatment.



Leavitt Floor 1 South end detail I, west side before treatment.



Leavitt Floor 1 South end detail J, after treatment.



Leavitt Floor 1 South end detail K, west side before treatment.



Leavitt Floor 1 South end detail L, after treatment.

