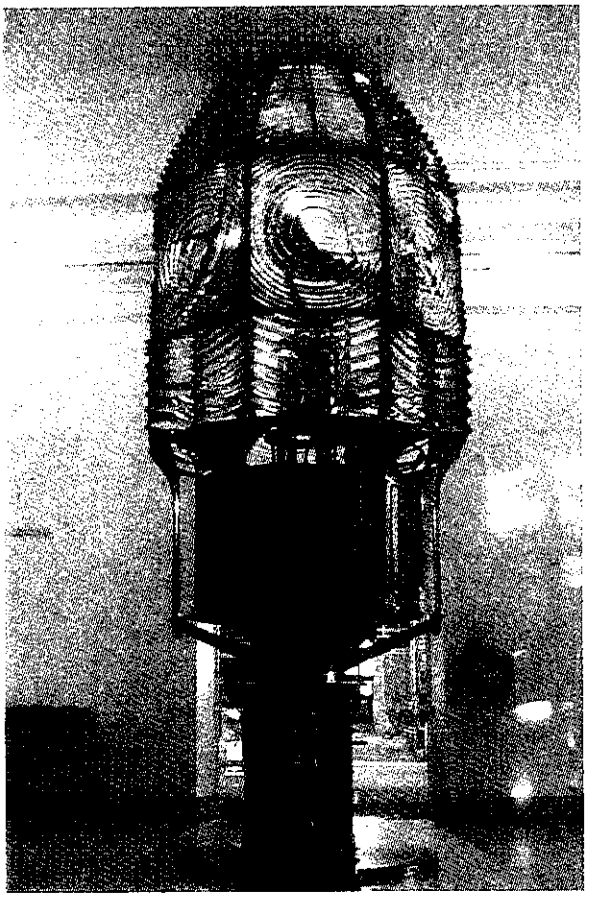
DISASSEMBLY OF FIRE ISLAND LIGHTHOUSE LENS

AT THE FRANKLIN INSTITUTE, PHILADELPHIA, PENNSYLVANIA

DECEMBER 2-9, 2000



Final Report transmitted by Candace Clifford
National Maritime Heritage Program
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PARTICIPANTS

Consultants: Joe Cocking, USCG (lampist)
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Jim Woodward, USCG (lampist)
Gretchen Voeks, NPS (conservator)
Cullen Chambers, Tybee Island Light Station (lighthouse preservation consultant)
Candace Clifford, NPS Maritime Heritage Program (historian)

Other Contributors: Jim Dunlap, Ponce De Leon Inlet Light Station (lampist)
Tony Farr, USCG (lampist apprentice)
Don Canney, USCG (registrar)

On-site staff: Steve Krier, Construction Foreman, Superintendent, C. Erickson and Sons, Inc. (contractor for new exhibit space)
Neil Rourke, C. Erickson and Sons, Inc.
John Alviti, Curator, Franklin Institute
Mark Cochard, C. Erickson and Sons, Inc.

INTRODUCTION

As part of an exhibition gallery renovation conducted by C. Erickson and Sons, Inc., for the Franklin Institute, the disassembly of the Fire Island Lighthouse lens was required. The lens was on display on the ground floor of the 20th street side of the building. Mark Cochard of C. Erickson invited the six-person team listed above under "Consultants" to undertake the project. These lens and lighthouse experts conducted the inspection, disassembly of the illuminating apparatus, documentation of the process, and provided recommendations for future treatment. All were involved in writing this report. Jim Dunlap and Tony Farr each provided a day of assistance during the project; Don Canney also spent a day assisting with the wrap up. C. Erickson provided on-site support, which included supplying tools, obtaining required materials, assisting with heavy lifting, building crates, and packing and securing components in the crates. John Alviti, curator of the Institute, provided background materials on the lens.

BACKGROUND

I. History of Lens at Fire Island Lighthouse[1]

Fire Island Light Station was established in 1826-27; a second tower was built in 1858 and a first-order Fresnel lens installed. First-order lenses are the largest of seven orders of Fresnel lenses. They were used at coastal lights that needed to be visible to mariners from great distances. Fire Island was seen by traffic sailing into New York Harbor. Ross Holland, Jr., in his book, *America's Lighthouses*, describes the principals of a Fresnel lens as being,

> Prisms [catadioptric panels] at the top and bottom refracted, or bent, the light so that it came from the lens in a narrow sheet. At the same time, the light was intensified at the center of the lens by a powerful magnifying glass [bullseye panels]. The result of this refraction and magnification was a bright, narrow sheet of concentrated light emitting from the lighthouse.

According to a *Notice to Mariners* dated July 3, 1858, the light was first displayed from the new first-order lens on November 1, 1858. Its characteristic was "a brilliant flash once in every minute." "The new light should be seen in ordinary states of atmosphere, from the deck of a vessel 15 feet above the water, from 21 to 23 nautical miles."[2] The new lens created a much brighter light than the reflector system it replaced.[3] The lens revolved around the light source by means of a rotation mechanism powered by weights which would be wound up on a regular schedule.

It is assumed that the first illuminant was whale oil. It was changed to lard oil ca. 1867-1869, a Funck lamp replacing the mechanical one.[4] In 1875, measurements were made to repair the revolving machinery of the lens. According to a monthly report in June 1876, the flashing machinery of the lens had new chariot rollers fitted to it, and the apparatus was repaired and put in good running order. A year later the bell springs, lamp reservoirs, and dampers were repaired. A report of injury to the lens was submitted by Engineer J.C. Woodruff on August 27, 1877; it was quickly repaired.[5]

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[1]Much of this is taken from a Historic Structure Report by Carol L. Perrault, prepared by the National Park Service North Atlantic Historic Preservation Center, Boston, Massachusetts, in October 1983.

[2]*Notice to Mariners,* July 3, 1858.

[3]According to the 1839 *Light List*, Fire Island Light consisted of 18 lamps with 15-inch reflectors which revolved, 1 minute, 30 seconds, 89 feet above high water mark. According to the 1849 *Light List*, Fire Island Light was refitted in 1842 to consist of 14 lamps with 21-inch reflectors which revolved 1 minute 30 seconds, 89 feet, 3 inches, above high water mark. According to the 1854 *Light List*, Fire Island Light was refitted that year to consist of 14 lamps with 21-inch reflectors which revolved 1 minute, 20 seconds, 89 feet above high water mark.

[4]Carole L. Perrault, *Historic Structure Report* (National Park Service North Atlantic Historic Preservation Center, Boston, Massachusetts, October 1983), pp 72-73.

[5]Ibid., p. 73.

A mineral oil lamp was installed and put in use on July 8, 1884. The 1894 *Annual Report* indicated that "the illuminant is an oil lamp of 500-candlepower, and the intensity of the flash equals 63,830 candles." That same year, a recommendation was made to install a bivalve lens at Fire Island with electricity used as the illuminant. (The bivalve would rotate more quickly providing a quicker flash.) This decision was never carried out because a lightship was established nine miles away.

The lens was overhauled in 1895-97. According to the monthly report for September 1886, "a new governor, brass brushings for the clockwork of the lens, one drill, and one tool were furnished. The clock was repaired, and the lens leveled. Two damper pipes were overhauled as well."[6] In 1897, the revolving machinery of the lens was overhauled, and necessary measurements were taken for supplying new parts.[7] A new chariot for the lens was furnished and fitted in January 1898 and in October of that same year, four steel set screws for the lens were furnished. In December 1898, two first-order damper rods were installed.[8]

In 1899, repairs included "one steel bolt for the lens pedestal was furnished; a new clock for the revolving lens was made and fitted; and 12 balls for the bearing of the lens chariot wheels were furnished."[9] In 1900, the revolving machinery was overhauled in May and the plunger valve of the lamp required repairs in November. In 1901, one burner and float chamber for the first-order lamp was repaired and two new rachet pawls were made and furnished. In 1902, two oil carriers and first-order burner repaired. In 1903, one first-order lamp repaired and two rachet pawls for the lens furnished. In 1906, two new dampers and rods for the first-order lamp furnished.[10]

A new oil vapor lamp was placed into operation on December 3, 1907. The duration of the flash was reduced to four seconds and the dark interval was increased to 56 seconds. The illuminant was changed from oil to incandescent oil vapor.[11]

A campaign by steamboat companies and marine-insurance companies was launched in 1908 to increase the intensity of the light. Their petition stated,

> That it is of the greatest importance to the safety, and the uninterrupted course, of navigation that the light on Fire Island should be of a character equal to that of the best lights in existence elsewhere;

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[6]Ibid., p. 75.

[7]Ibid.

[8]Ibid.

[9]Ibid.

[10]Ibid., p. 76.

[11]Ibid.

> That the present light on Fire Island has not been changed for many years, is not a modern light, and is not of such power as should be provided in this important position.[12]

The U.S. Light-House Board recommended that Fire Island be equipped with a "modern high power illuminating apparatus"[13] in its 1908 annual report, but no immediate action was taken. In 1929, the Office of the Superintendent of Lighthouses noted that "...the present apparatus is obsolete type and beyond economical repair; it has been giving trouble for several years and has now reached the point where replacement is necessary."[14] In June 1933, the old first-order lens was transferred to the Franklin Institute and the Fresnel lens from the discontinued Shinnecock Bay Light Station replaced it.[15] Because it could rotate more rapidly, the Shinnecock lens produced a flash at more frequent intervals and thus was of more use to mariners.

An electric cable was not installed on Fire Island until 1938 after the first Fresnel lens had been removed.

II. Lens at Franklin Institute

Museum records at the Franklin Institute, Philadelphia, Pennsylvania, indicate that the Fire Island Lighthouse lens was acquired from the U.S. Light House Service, Third District, Staten Island, New York. It was first displayed on the ground floor of the Franklin Institute on June 10, 1933. The parts not used were stored at the Lafayette School (this probably included the spider and the weights) on November 10, 1943. The vapor lamp was placed in the lighting exhibit in 1964 and is now part of the Electricity Gallery. The property card for the lens indicates number 2573 and gives the history as:

> The flasher is taken from the Fire Island Lighthouse on the south shore of Long Island and is the first light seen by incoming Trans-Atlantic liners bound for New York. The lens is this [sic] Fresnel, of the 1st order, and was operated on a cycle of 5 sec. flash 55 sec. eclipse. The light inside of this lens was an incandescent, oil vapor lamp, operated by pressure supply to the burner. The light, of 280,000 candle power was located 167 feet above high water, and was visible 19 miles. It was in service from 1858 to 1932.
>
> This exhibit includes lens, clockwork, oil reservoir, platforms, supports, panels, etc., but not protection housing, necessary for a complete indoor set-up of the flasher.

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[12]Reprinted in Perrault, p. 76.

[13]Perrault, p. 76.

[14]Ibid., p. 77.

[15]Steve Czarniecki at Fire Island National Seashore believes the Shinnecock Bay lens was returned to the Staten Island Depot when it was replaced.

According to an article in *The Institute News* (August 1938)[16]

> When the lens now to be seen on the ground floor was in active service, it was operated by the accurate clockwork which still runs it, except that a tiny electric motor has been substituted for the elaborate system of weights which ran down a tube through the middle of the lighthouse, around which a spiral staircase ran. These weights required rewinding every four hours.

The article also describes the installation:

> The great lens, weighing between four and five tons, was brought to the Institute in pieces in 1933. It was first assembled in sections in the old Franklin Institute's workshop, so that it might be checked up. It was then again disassembled, and brought to the new museum for its final assembly. When it was put together, it was found that there had been a miscalculation in the height of the ceiling, and that there was five-eighths of an inch less than had been anticipated. The result is that, at the present time, there is just about one-quarter of an inch clearance at the top of the huge lens.

The article concludes, "With some exhibits in other parts of the building, this lens has been lent to the Institute by the Bureau of Lighthouses of the Department of Commerce."

CONDITION OF THE ILLUMINATING APPARATUS

In general the lens is in good condition and most original parts appear to be present.

Overall

- There is a general accretion of dirt and oil on all components.
- Many fasteners are not original and are inappropriate.

Missing Elements

- The IOV lamp is on exhibit in the Electricity Gallery and will be stored with those artifacts when the gallery is renovated.
- Missing parts include the spider (top brace for upper lens panels) and weights for operation of clock mechanism for rotating lens. A circular sheet-metal panel was attached to the top of the upper catadioptric panels and was acting as a replacement spider because the ceiling was too low for installation of the original spider.

[16]Copy on file at the Franklin Institute.

Glass Panels

- A bullseye panel numbered 3-4 that has some broken annular prisms is a replacement for the original panel numbered 5-6.

- Damage to lens panels includes numerous chips and several breaks and fractures, the location of which are documented in Appendix 3.

- The litharge in all panels is desiccated and friable because of its age. It is crumbling and requires replacement on all panels.

- There are cocked and loose rings in bullseye panels numbered 2-3, 3-4, and 4-5.

- There are prism breaks on lower catadioptric panels numbered 8-1, 1-2, and 4-5; bullseye panels 3-4 and 6-7; upper catadioptric panels 2-3 and 3-4.

Metal Frame/Support System

- The arm of the fan leg numbered 1 where it joins number 8 is broken off.

- Cast, and some machined-iron, surfaces are painted with red lead primer and white or green oil-based enamel paint which is not original.

- The shaft and internal surface of the drive gear on top of the clockwork case is scored.
- The pedestal was mounted by pumping lime mortar into the base.

- Two interpretive signs were screwed into fan legs numbered 5 and 2. The signs have been removed and discarded.

Rotation System (clockwork and chariot)

- The chariot wheels were replaced with steel-centered brass wheels which have created a deep grove in the chariot table top and the underside of the bull gear (road).

- A wire mesh safety cage secured with plywood covered the chariot assembly. This is not original.

- The chariot wheels were worn to 6/10th of an inch beyond minimum requirement for proper installation causing the bull gear to abrade and erode the brass lid to the clockwork case. The chariot wheels are replacement and were modified to include steel centers causing the damage to the road.

RECORD OF ACTUAL WORK

Day 1: Saturday, December 2, 2000

A. Inspection/documentation of glass

1. Noted cracks and fractures in prisms. (Note: A scissors lift was used when working with upper panels throughout process.)

2. Ascertained prior repairs and replacement material (one bullseye panel is not original).

B. Disassembly

1. Took lid off gear housing at the top of clockwork to remove gear to allow free lens rotation.

2. Took apart electrical system.

3. Removed brass oil vapor lamp fuel reservoir and dusted to prevent potential corrosion. from moisture attracted by dust.

4. Loosened screws using AERO KROIL:
   a. screws that join cabinet to the deck flanges
   b. screws that join cabinet to the platen
   c. screws on the inside of the cabinet
   d. screws holding lens panels starting from bottom and working up (loosening and tightening in anticipation of dissembling them the next day)

   Note: painted screws are more difficult to loosen.

5. Dismantled electrical cable.

6. Dismantled reservoir pedestal (part of lamp assembly):
   a. tapped on upper plate (cast iron) to loosen the thread of flush nuts (iron alloy)
   b. flush nuts were removed from upper plates
   c. upper plate removed
   d. removed four cast iron columns (numbered 1 to 4) which held upper plate (note: upper cast iron pedestal deck is numbered according to the columns)

7. Disconnected electrical system under clockwork mechanism.

8. Disassembled brass cabinet rail (inner rail screws placed in ziplock bag).

9. Prepared wooden crate for a platform inside the lens. (This platform was required to reach the tops of upper panels to be dismantled).

10. Used Dremel tool to grind a bolt installed by museum to attach upper lens panels at ceiling.

DAY 2: Sunday, December 3, 2000

Removal of upper catadioptric panels, documentation, and crating

1. Inspected panels to figure out which to remove first (panel 1-2 was taken out first so there are twice as many screws for reinstalling that panel).

2. Prepared wooden crate for storage of a panel:
   a. placed a tight-fitting sheet of STYROFOAM in the bottom of the crate (not recommended for long term storage; conservator prefers ETHAFOAM which is a polyethylene sheeting that doesn't off-gas and is more stable long-term)
   b. layer of bubble wrap with bubble side down placed atop STYROFOAM (not recommended for long-term projects; conservator recommends a thinner ETHAFOAM sheet or VOLARA sheeting for long-term stability and no off-gassing)
   c. next, a sheet of TYVEK large enough to wrap back over the lens. TYVEK is white, soft, breathes (allows moisture transfer to outside), and captures loose litharge or glass chips

3. Removed screws with one person on the inside and two people on the outside of the lens; started removal from lower edge of catadioptric panels and then from the sides and finally top (top bolts were a larger size, so stronger, and panel leans in, so top supports are removed last). Put screws in ziplock bag, labeled, and eventually stapled bag to inside of crate with corresponding panel. (Note: Iron screws may not be original.)

4. Pressed panel from bottom, pushing out. During removal, panel was torquing and litharge was crumbling. Attached two straps at the top of panel with one person holding lens. Lowered panel with additional people supporting panel at bottom. Gently lowered panel into crate (avoiding torque).

5. Placed STYROFOAM under center of central brace (panel slopes) under bubble wrap for additional support of prisms. Positioned and secured lens panel in crate by placing two wooden blocks at base and four wooden wedges at top.

(Repeated steps 2 -5 for each of seven remaining panels.)

6. Measured first panel to prepare diagram template; made copy for each panel and recorded damage (see Appendix II.).

7. Photographed each panel, including a label in each photo.

8. Packing crate:
   a. drilled a screw from outside of crate into double wedge which have been tightened with a hammer
   b. covered lens with TYVEX sheet, taping it snug around the lens
   c. added another layer of bubblewrap, securing it with tape
   d. filled voids with pieces of STYROFOAM around the edges
   e. sprayed White DAP TEX insulating foam sealant to fill the voids around the edges–sticks to wood and pieces of STYROFOAM–stopping movement of the lens
   f. added STYROFOAM layer slightly thicker than the crate to sandwich the lens in the crate tightly, preventing movement
   g. drilled screws into lid to secure top

Note: Crates were labeled with arrows, "GLASS," and "FRAGILE," and are to be stored standing up to allow the lens panels sit in the same position they would have been while assembled in the illuminating apparatus.

DAY 3: Monday, December 4, 2000

1. Removed eight bullseye panels and eight lower catadioptric panels beginning with broken panel number 3-4 because it appeared to be the most fragile (same procedure as day 2).

Note: Loose rings on bullseye panels and severe breaks on lower catadioptric prisms were secured using TYVEK tape.

2. Began loosening screws on upper frame and cabinet.

DAY 4: Tuesday, December 5, 2000

Removal of Upper Lens Frame

1. Loosened bolts and removed two halves of steel octagonal ring which forms the top of the frame (numbers are stamped onto ring which correspond to the frame uprights) .

2. Eight steel frame uprights were labeled and removed. Their hardware was placed in ziplock bags and taped onto them. Frame uprights are stamped on the underside to correspond with numbers on the lower steel ring attached to the top of the fan legs. Removed ring in two half circle sections.

3. Temporary wooden platform was removed from cabinet top. Safety cage around chariot assembly (plywood circles above and below chariot and mesh) was removed.

4. Loosened bolts on chariot assembly. Chariot assembly includes table, wheels, axles, guide rollers and iron ring into which axles are screwed.

DAY 5: Wednesday, December 6, 2000

Removal of cast-iron lens support system

1. Loosened bolts and removed six cast-iron fan legs. Removed six machine steel cantilevers from above chariot assembly. All were stamped with numbers. Loosened bolts inside cabinet. Removed two cast-iron steps. Removed two interior cabinet doors.

2. Removed four glass doors from clockwork case. Clockwork case was bolted atop the clockwork table. Removed drive motor from clockwork.

3. Removed cabinet deck. The screws were removed from the sides of the cabinet. Deck was pried off and wedges were placed under to allow lifting with fork lift. Removed cabinet core (one piece). Removed 11 cabinet plates (side panels).

4. Sprayed AERO KROIL into joint between cabinet platen and center post of the pedestal. Removed platen.

Note: the chariot wheels were so worn that the bull gear was scraping the brass top of the clockwork case.

5. Transformer was unscrewed from under clockwork. Top of clockwork case taken off. Sides of clockwork case taken off. Clockwork lifted from table. Pulled off bull gear and bull gear plate. Removed chariot assembly. Then chariot wheels were lifted from pedestal post. Clockwork table dismantled. Four very long screws bolted each corner to the base.

6. Lime-based mortar was found in the hollow of the pedestal. AERO KROIL was sprayed inside to see if concrete is attached to pedestal. Holes on exterior of cast-iron base were drilled out of concrete to see how concrete is used.

DAY 6: Thursday, December 7, 2000

1. Removed the pedestal and base ring using fork lift.

2. Metal parts were crated. Note that platen, table, and bull gear were secured to a pallet without being crated and the pedestal and base ring were secured to another pallet without being crated.

3. Team prepared report recommendations.

4. Inspected storage space and found it to be satisfactory.

DAY 7: Friday, December 8, 2000

1. Labeled remaining crate contents and numbered consecutively. (There were 29 crates and two pallets.)

2. Performed outbrief with curator.

3. Put clockwork assembly back together on pallet.

RECOMMENDATIONS FOR STORAGE AND FUTURE TREATMENT

A. Storage

The crates should be stored in a secure, cool, dry, well-ventilated area with minimal vibration from traffic, machinery, air conditioning, etc. Area should be free of airborne pollutants (chemical cleaners should not be used in the vicinity of the crates). Do not stack crates or store other objects on top of them. Humidity and temperature should not vary excessively. Keep collection together.

The lens should not be stored more than five years in the present crating system because of the potential for corrosion of the bronze from the buildup of moisture in the cases and adverse reactions to the packing materials.

B. Future Treatment

Note: This proposal is based on the assumption that the lens will be an operational display.

It is strongly recommended that highly qualified individuals who are recognized lens experts uncrate the components, provide initial inspection and cleaning, conduct restoration, and reassembly. Contact the National Lighthouse Museum at Staten Island, New York, for recommendations of qualified individuals.

Do not underestimate the fragility of glass and the litharge joints! (The litharge is extremely deteriorated. It has far exceeded its working life.)

It is recommended that cleaning and restoration of all components be conducted before reassembly. This should include:

Glass panels

- inspect for loose prisms and structural integrity of each panel
- gently clean brass frame with solvent (mineral spirits) to clean off oil, dust, dirt, and other residue using soft lint-free cloth
- dust prisms with soft lint-free cloth and wipe down with isopropyl alcohol and water
- reset bullseyes

- repair or replace litharge
- repair and secure breaks in glass

Cabinet Assembly and Lens Frame

- wipe down the brass toe rail on top of the cabinet with mineral spirits and a soft lint-free cloth.
- the fasteners that attach the toe rail were not original and inappropriate and should be replaced.
- screws on both sides of the tread (steps) mounts were snapped off and others missing—all should be replaced.
- remove the paint to a white metal surface in a non-abrasive manner (do not recommend sand blasting, ice blasting, or black beauty blasting). Use non-abrasive methods so as not to damage original metal surface. If using chemical cleaning, it must be thoroughly neutralized. Do not use mechanical methods such as grinding or a pneumatic needle scaler.
- recommend that cast parts should be blast cleaned and machined steel part should be chemically cleaned and neutralized
- repaint in historic color scheme

Oil Reservoir (this is most complete example seen by consultants)

- wipe it down with mineral spirits with lint-free cloth
- extreme care should be taken to protect filtering screen located beneath the door on top

Rotating Ironwork (fan legs, cantilever arms, and bull gear)

- remove paint from fan legs in same manner as cabinet assembly
- remove paint from cantilever arms and bull gear mounting plate by chemical methods so as not to damage machined surface

Chariot

- replace chariot wheels and roads and undertake a complete overhaul of the chariot assembly

Pedestal

- remove lime mortar
- separate base plate from pedestal by removing nuts on underside
- chemically clean pedestal and blast clean base plate

Clockwork Assembly (clockwork case, clockwork, clockwork table, and drive gear)

- complete tear down and overhaul of clockwork
- remove paint from clockwork case and table using chemical methods

Other

- Locate spider (the brace for the upper catadioptric panels that was removed prior to installation of the lens at the Franklin Institute) or fabricate a replacement. If

fabrication is required, the lenses for both Cape Canaveral and Hog Island have similar spiders which could be copied.
- Locate weights for clockwork

Upon reassembly a scheduled maintenance plan will be required.

MATERIALS

1. AERO KROIL (penetrating lubricant used for loosening screws)
   - made by Kano Laboratories, 1000 S. Thompson Lane, Nashville, TN 37211; phone: 615-833-4101; fax: 615-833-5790; http://www.kanolabs.com

2. SONY Digital Still Camera MVC-FD95 "Digital Mavica"

3. Packing
   - White Latex DAP tex insulating foam sealant (Advanced Latex Technology)
   - Dow STYROFOAM 1- and 2-inch-thick boards
   - TYVEX sheets and TYVEK tape (University Products)
   - Bubble pak
   - Crates are white pine and exterior is B-C plywood