U.S. Department of Homeland Security
United States Coast Guard

Commandant
United States Coast Guard

2100 Second Street, S.W.
Washington, DC 20593-0001
Staff Symbol: G-SEC
Phone: (202) 267-1907
Fax: (202) 267-4788

COMDTINST 16500.9
MAY 7, 2003

COMMANDANT INSTRUCTION 16500.9

Subj: CLASSICAL LENS MAINTENANCE

1. PURPOSE. This Instruction contains general guidance for service personnel that maintain lighthouses equipped with classical (Fresnel) lenses.

2. ACTION. Area and district commanders, commanders of maintenance and logistics commands, commanding officers of civil engineering units, commanding officers of headquarters units, assistant commandants for directorates, Chief Counsel, and special staff offices at Headquarters shall ensure that personnel maintaining classical lenses follow the guidelines of this Instruction. Internet release authorized.

3. DIRECTIVES AFFECTED. None.

4. DISCUSSION. Classical lenses are still part of the Coast Guard heritage. No current official material exists on the proper care of these historic treasures. This Instruction documents the procedures for inspecting the condition of classical lenses, cleaning, focusing and provides guidance on stabilization of loose prisms.

5. CHANGES. Recommendations for improvements to this Instruction shall be submitted to Commandant (G-SEC-2).

6. ENVIRONMENTAL ASPECT AND IMPACT CONSIDERATIONS. The procedures for protecting personnel and disposing of hazardous materials present in classical lenses are addressed in Section 2 of the Enclosure.

7. FORMS/REPORTS. None.

J. A. KINGHORN

Enclosure: (1) Classical Lens Maintenance

DISTRIBUTION - SDL No. 140

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
A																										
B		8	20*		2									6	2											
C				2			3		1*														2			
D				2																						
E																										
F																										
G																										
H																										

NON-STANDARD DISTRIBUTION: *B:c MLCLANT and MLCPAC (6 extra); *C:i D1-STA Burlington, D9-STA St. Ignace, and D11-STA Channel Islands Harbor only.

U. S. Department of
Homeland Security

United States
Coast Guard

CLASSICAL LENS MAINTENANCE

Enclosure (1) to COMDTINST 16500.9

TABLE OF CONTENTS

SECTION 1 - INTRODUCTION

A. Purpose. This guide provides information on the maintenance of classical lenses still in use at various U.S. Coast Guard aids to navigation. The guide is not intended to be a restoration manual, but instead provide guidance on the correct procedures for inspecting, cleaning, focusing and stabilizing loose prisms in classical lenses.

B. History. Many classical lenses are over 100 years old. These lenses, comprised of brass/bronze frames and ground glass prisms, were imported from France and England during the mid 1800's to early 1900's. Lenses either rotate or are stationary. Stationary lenses are typically drum lenses similar in construction to Tideland Signal Corporation's 300 mm lantern. An exception is a bull's-eye lens used on a range, commonly called a clamshell lens. These lenses use either a fixed or flashing 120 VAC, 250-watt or 1000-watt lamp. Rotating lenses contain an array of bull's-eyes that determine the flash rhythm, similar to the VRB-25. Fixed 120 VAC, 250-watt or 1000-watt lamps are also used in these lenses. Since the lenses came with clear glass, a red or green light required the use of a colored glass cylinder placed over the bulb, or colored lantern panes. These cylinders, if still in use, are rare, not easily replaced, and should be treated carefully. If a color sector is required, colored lantern panes are generally used.

C. Policy. Guidance for the retention of classical lenses for service in an aid to navigation is provided in the Automation Technical Guidelines, COMDTINST M16500.8 (series). Compliance with Section 106 the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA) and their associated regulations must be completed prior to any major modification, removal, and/or replacement of a classical lens. Compliance with Section 106 will require coordination and consultation with the applicable State Historic Preservation Officer and coordination with other interested parties (i.e., local government, private local and state historic preservation groups, etc.). Coast Guard policy on compliance with NEPA and Section 106 of the NHPA is contained in the National Environmental Policy Act Implementing Procedures, COMDTINST M16475.1 (series). Environmental staff at the Civil Engineering Units can assist with NHPA and NEPA compliance requirements. Most of the Coast Guard's classical lenses have already been removed for restoration and displayed in museums, historic societies and other appropriate settings. Those lenses remaining in service shall be maintained in accordance with the guidance in this instruction.

SECTION 2 - SAFETY

A. General. Classical lenses were built during a period when little was known about the effects of some of the materials used in their construction. Today, we are knowledgeable of the hazards of these materials and must take certain precautions.

1. Glass. The glass used in classical lenses is quite brittle. It is common to find prisms chipped, broken or loose. Care must be exercised when working around and cleaning the lens to prevent personnel from being cut or scratched. Use of clean, brown “Jersey Gloves”, latex gloves or equivalent, and long sleeves are at the discretion of the Team Leader. Gloves should be worn if the lens prisms must be touched to prevent skin oils from etching the glass. Loose elements should be secured prior to cleaning. To prevent further damage, personnel should remove metallic watches, rings, bracelets, necklaces and belt buckles (belts may be spun around to the side).

2. Litharge. Litharge, along with wood wedges, is historically the material used to secure lens prisms in place. It is similar to glazing compound, however it is comprised of calcium carbonate, white or red lead and boiled linseed oil. If the litharge is flaking or missing and requires replacement, or there is evidence of loose litharge at the bottom of the lens, the pieces should be collected utilizing a vacuum cleaner equipped with a HEPA filter. The use of a HEPA respirator is required in all cases unless exposure data (or exposure modeling) demonstrates airborne levels of lead for this activity will not be hazardous. Contact your MLC Detached Safety and Environmental Health Officer at your servicing Integrated Support Command to request exposure modeling information or a workplace assessment. Be sure to describe the material, its purpose and the quantity involved. The debris collected must be labeled “lead contaminated” and properly disposed.

3. Mercury. Floating the lens in a circular trough of mercury supported some classical lenses. This was used to reduce the power requirements to rotate large lenses. All active Coast Guard lights were converted to chariot wheels, however mercury was serviced regularly at these lights, which presumes that some may have spilled, contaminating the area. If records show that a mercury float was installed, to ensure the safety of servicing personnel, an air sample of the lantern room should be conducted by your Integrated Support Command and noted in the aid log. Regardless, efforts should be made to ventilate the lantern room (open doors, etc.) when work is performed on the lens.

SECTION 3 – INSPECTION

A. Power & Monitor. Secure power to the rotation mechanism (if equipped) and lamp. Turn off the Aid Control Monitor System (ACMS, if equipped) to prevent inadvertent keying of the radio link.

B. Documentation. Carefully identify any previous damage that has occurred to the lens and document it according to the panel number located on the metal frame. This will prove invaluable if replacement prisms are needed and documents damage due to deterioration and vandalism. Ensure all cracks, chips, and missing prisms are entered into the record. Label the glass prisms from the center (number one) and the remaining prisms in sequence, identifying them as either upper or lower prisms. Corner prisms on flash panels are further identified as left or right. Perform photo documentation of existing conditions, if possible. Make copies of the appropriate sketch in attachment (1) for each lens section or photograph each section and note any damage. Example of lens damage is shown in Figure 3-1.

Figure 3-1. Chipped Glass Prisms

C. Procedure.

1. Inspect the litharge, the original white lead-based compound that secures the prisms in place, to see if it is deteriorated. Evidence of deterioration is loose or flaking litharge, loose lens prisms, and areas lacking litharge where the wood wedges are clearly the only visible support of the lens prism. (In Figure 3-1, the wedges are visible, but the litharge is intact.)

2. Be especially careful when opening the access door to the lens (if equipped). When closed, the door provides structural rigidity to the lens and opening it may cause the frame to sag allowing loose prisms to fall out.

3. Bull's-eye panels may be set in the frame, or supported by adjacent rings. If the frame does not support the adjacent rings, they are nested (see Figure 3-2).

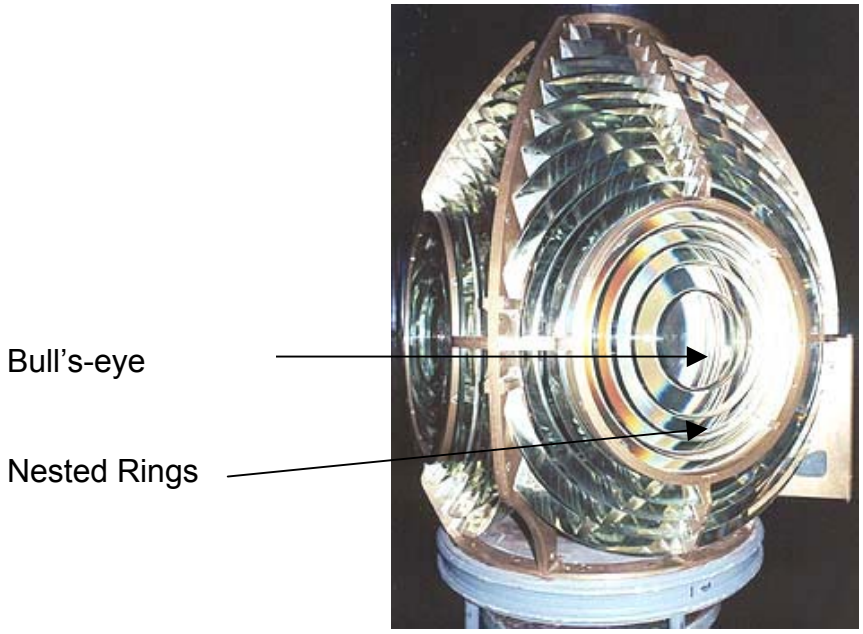


Figure 3-2. Bull's-Eye Lens

4. Nested rings are very delicate. They should not be repaired on-site as it is questionable as to whether they will stay aligned properly when reassembled upright. Qualified personnel perform major repairs to these types of lenses with the lens panel removed and placed on a clean, flat surface.

5. Upon visual inspection of the interior side of bull's-eye panels, all rings should be flush with adjacent rings. Run your finger gently along surface to identify inconsistencies. Do not exert pressure. If any ring is out of alignment or cocked, the lens must be repaired or catastrophic failure will occur. Carefully, using your fingers, lightly tap on the **outside** of the prisms. When tapping on a bull's-eye, ensure that you do not tap on the inside of the lens. Always tap from the outside. The bull's-eye sections are installed with a tapered fit in adjoining lens elements and can become dislodged by exerting force on the inside of the lens. Listen for a solid sound in response to your tapping. This tells you that the prisms are solidly seated. If a rattling sound is heard, the prism is loose and may become dislodged from the frame or adjoining bull's-eye pieces. Record your findings.

6. Always ensure that your lens is level and plumb. To determine whether the lens is level, place a torpedo level on the base. Check in two places using the “T” method. Larger lenses require that a line be stretched tightly across the base ring of the lens. A hanging level (line level) is used to determine if the lens is plumb. Repeat at 180 degrees to ensure that the lens is level in both directions. By looking up from the center of the larger lenses, you can determine if the lens is out of plumb (with respect to the lantern room; see Figure 3-3). Care must be used when leveling as any torque applied to the lens may cause it to twist or rack causing lens elements to loosen and possibly fall out. Some large lenses use roller supports at the top of the lantern room. Be sure that the chariot wheels on these upper supports move freely, do not have excessive clearance, or bind on the race as it may cause the lens frame to twist allowing lens elements to loosen. If problems are apparent, contact your CEU for assistance.

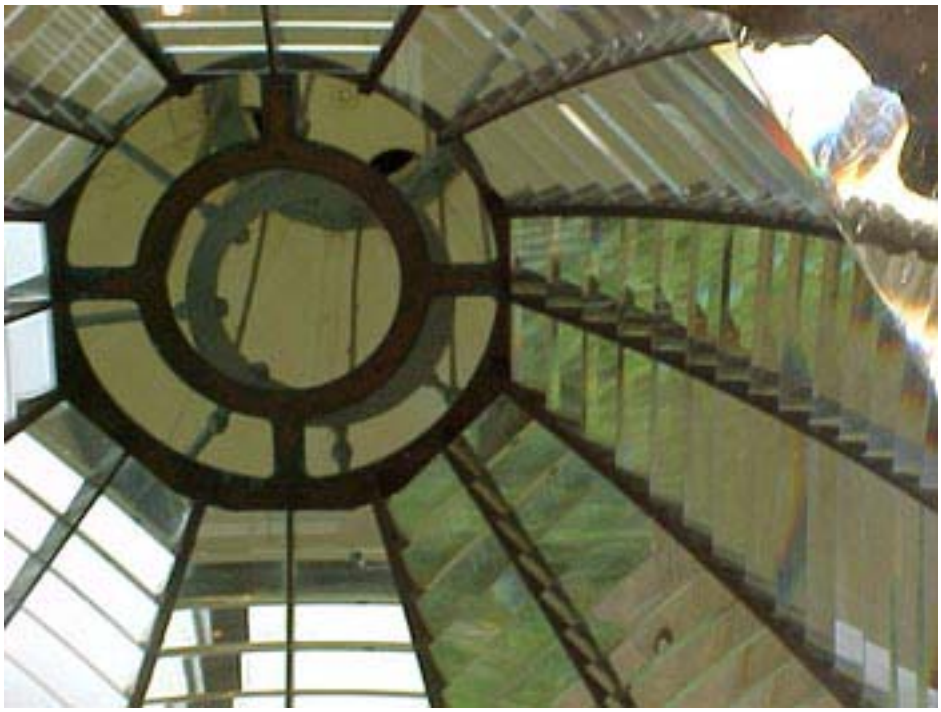


Figure 3-3. Out of Plumb

7. Inspect the chariot wheels and bearing surface for indications of abnormal wear. Observe the rotation mechanism in motion, listening for any noise such as creaking, chatter, groaning, or squeaking that may indicate improper wear. Ensure all wheels are rotating freely and not dragging, and look for metal shavings and uneven wear spots on wheels and bearing surfaces. Some wheels are crowned to minimize wear while traveling in a circular path while others are tapered. Once this crown or taper is worn off, the horsepower requirements to rotate the lens increase and evidence of wear (metal shavings, see Figure 3-4) is more apparent. Measure the

diameter of the weight bearing wheels and note in the aid log. This can be used to predict when wheels will have to be replaced as interference between the turntable and base as well as meshing problems with the drive mechanism will occur as the wheels wear down. Consult with your CEU when you determine replacement of the chariot wheels are necessary.

Figure 3-4. Evidence of Metal Shavings.

D. Electrical. Servicing procedures for the CG4P and CG2P lampchangers are discussed in the Alternating Current Aids to Navigation Servicing Guide, COMDTINST M16500.17 (series)

E. Servicing. Servicing nonrotating classical lenses will be dictated by the rated lamp life. Semiannual servicing of these lights is required if the lamps are fixed-on and continuously operated (no daylight control). Flashed lights may go longer depending on the duty cycle of the flash rhythm, however it may be prudent to check the condition of the lighthouse on a regular basis. Rotating classical lenses require quarterly servicing, more often if experience shows that lubrication of the rotation mechanism warrants it.

SECTION 4 - CLEANING

A. Dust. Light dusting of the lens is acceptable. Feather dusters work well. Use tools with wood or plastic handles, never metal, to avoid chipping the glass.

B. Glass Prisms. To clean the glass, use a mixture of Isopropyl alcohol, water and Woolite (three parts distilled water, one part alcohol, and two drops of Woolite (per quart of solution)) and a soft lint-free cloth or paper towel. Do not spray the cleaning solution directly on the lens. Wet the cloth, carefully remove all dirt and grime, and then polish with a clean lint-free cloth.

   Only use enough pressure to clean the glass as excess pressure may loosen lens prisms. It is suggested that when the inside of the bull's-eyes or any nested annular prisms not supported by the brass frame are cleaned, an assistant stand outside the lens and exert light pressure to the panel/ring to prevent it from being pushed out, falling to the floor and breaking. Any lens elements that are loose shall not be cleaned until they are resecured.

   Use caution when cleaning prisms so as not to disturb the litharge.

C. Brass. In the days of lighthouse keepers, brass was kept highly polished to satisfy the inspector. It is safe to say that most bright work at lighthouses has not been polished in many years. For this reason and others, it is requested that Units refrain from polishing the brass frames. The oxidation actually forms a protective barrier to the brass and attempts to remove it result in loss of material and possible damage to the prisms. Portions of the lens that are steel or cast iron and are painted should be maintained to ensure protection from corrosion. Be aware that paint applied before 1978 may contain lead and if flaking and removal is required, proper safety precautions and regulations should be followed.

SECTION 5 - ROTATION MECHANISMS

A. Types. There are several types of rotation mechanisms found on Fresnel lenses--carriage (chariot) wheels, ball bearing, and mercury-float types. Even within these categories, they are not all alike, depending on the manufacturer and the year they were constructed. As with any industry, every year a new model came out and design improvements were made. NOTE: Power shall be secured when servicing the drive mechanism to prevent personnel and cleaning materials from being caught or crushed by the mechanism.

1. The carriage type of rotation mechanism (Figure 5-1) consists of large bronze wheels riding on an upper and lower bearing surface known as a road. In conjunction with the large wheels are small guide wheels around the shaft of the pedestal assisting in the stability of the rotating lens by preventing an orbiting motion of the lens. The wheels are all attached to steel shafts by a pin or nut, and several washers were installed for radial alignment of the wheels. The wheels have oil ports where a small amount of clock oil can be inserted on a quarterly or more frequent basis. An alternative to clock oil is non-detergent 30W motor oil. It is very important to keep the road clean and free of debris so the rollers can rotate freely and prevent them from being wedged and dragged around the road causing flat spots. Excess oil should be cleaned off the roads and wheels as it will attract dust and dirt that will increase wear on the mechanism.

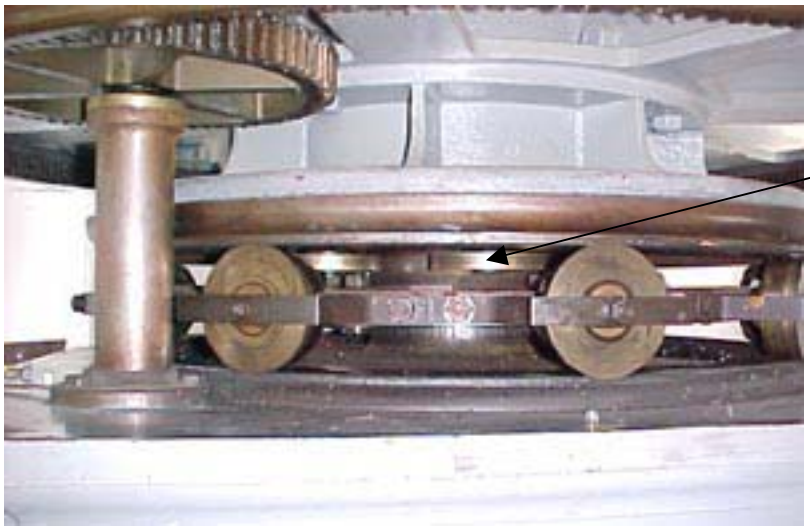


Figure 5-1. Carriage Mechanism

2. Ball-bearing rotation mechanisms (Figure 5-2) usually have a dust guard installed and are easily maintained. As mentioned above, light oil is required for lubrication purposes but care is required when lubricating because the ball bearings ride in a machined grove called a “road”. The groove in the road also acts as the reservoir for the lubricant and if overfilled will force out oil, making a mess and a safety hazard when it runs onto the floor. Check the aid file to determine if specific oil is

recommended, otherwise non-detergent motor oil should be used as it is compatible with nearly all materials used in the lens.

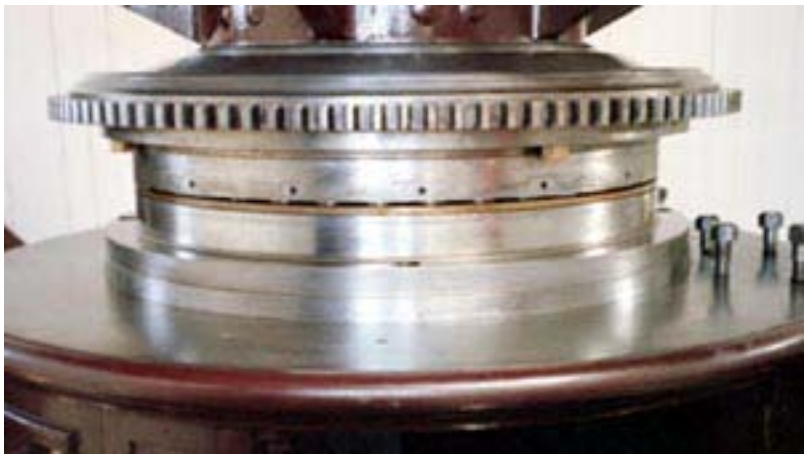


Figure 5-2. Ball Bearing Mechanism

3. Drive mechanisms are nonstandard. It is likely that a custom drive mechanism was built after the clockwork mechanism was removed, or a hybrid unit was constructed using old/new technology. Follow the lubrication instructions of the motor and speed reducer detailed on the nameplate or from documentation maintained in the aid file. Otherwise, lubricate all bearings and gearboxes. Exposed gears should be lightly lubricated, but clean to prevent the accumulation of dirt. Regular cleaning & lubrication will ensure the longevity of the components. Try to keep spare parts at the ANT and locate a source of supply for replacements. If none are available and the drive mechanism is failing, contact your Civil Engineering Unit (CEU) for assistance in designing a new drive mechanism or replacing the lens with a modern signal.

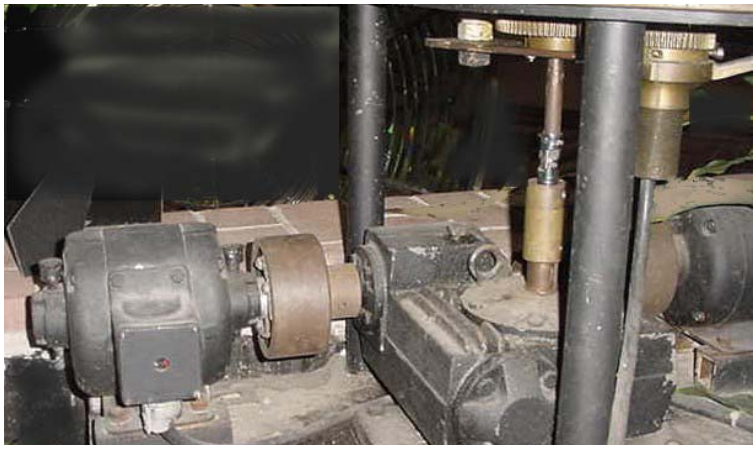


Figure 5-3. Dual Motor Speed Reducer

SECTION 6 - FOCUSING

A. General. The most accurate way to focus a classical lens is to find the exact center and align the center of the filament to that point. The enormity of the lens makes this task somewhat difficult. Placement of the filament lower than desired will cause the light to shine above the horizon. Misalignment along the optical axis (vertical centerline) will cause a reduction of intensity.

B. Method. Most lenses contain either machine screws or tapped holes inside the frame at the center of each bull's-eye or center drum section. If screws are not inserted, determine the tread size and install an appropriate machine screw or threaded eyebolt into each hole. Attach string to one screw and span across to the opposite frame. Pull tight enough so that the string will not sag or be influenced by a string passing over it and secure. Install strings on all frame rails to insure accurate determination of the center of the lens.

Insert the appropriate focus fixture in the lampchanger. Fixtures for the 250-watt lamp in the CG-4P are available from Tideland Signal Corporation. Fixtures for 1000-watt lamp for the CG-2P may be constructed in accordance with the sketch shown in Figure 6-1:

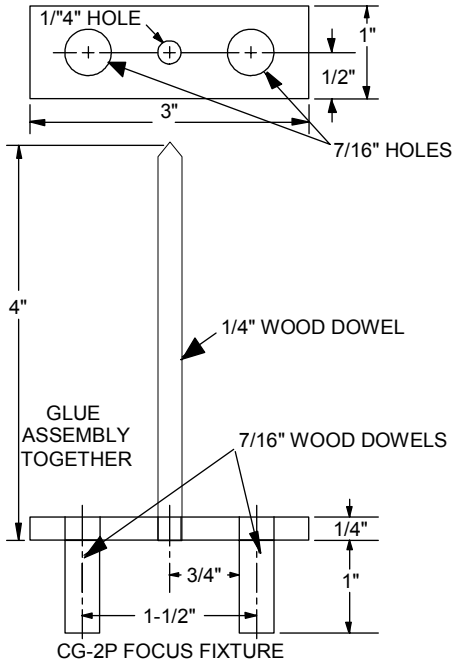


Figure 6-1. 1000 Watt Focus Fixture

Insert the focus fixture into the lampchanger and align the lampchanger so that the tip of the fixture just touches the intersection of the strings, as shown in Figure 6-2.

Figure 6-2. Focusing

C. Lamps. The electric lamps that replaced the oil burners in classical lenses must be large enough to replicate the flame of the burner. For that reason, 120 VAC 250 Watt, 500 Watt and 1000 Watt lamps are used (the 500 Watt lamp is no longer in production). Use of 12-volt lamps, or 120-volt lamps other than listed above, can lead to chromatic aberration (poor optical coupling of the small light source to lens causes the light to broken down into its wavelengths (colors)).

SECTION 7 – LENS FIRST AID

A. Identification. Loose prisms must be stabilized to prevent catastrophic damage. There are two parts to this procedure, one dealing with a barrel-type (onmidirectional or drum lens) lens panel and the other dealing with the bull's-eye panels. To stabilize loose prisms, have on hand a roll of Tyvek tape (available from book restorers), a supply of tongue depressors or Popsicle sticks, and exterior vinyl spackle (EVS).

B. Litharge. Litharge, or putty, is made of white or red lead, linseed oil and calcium carbonate (lead-oxide replaced white lead after approximately 1900) and is a health concern for people working around lenses. As this material ages, it becomes brittle and if crushed may become airborne and can be inhaled by all that come in the vicinity of the lens--especially those who provide maintenance. When performing your lens inspection look carefully at all of the glazed joints to determine the condition of the litharge. DO NOT DIG AT THE LITHARGE! If it looks intact, leave it alone. If powdering, flaking, crumbling, or otherwise deteriorating, encapsulate the litharge using the following method. Apply Tyvek tape near the edge of the prism where the repair is being made. This allows a much faster cleanup to the lens elements after this procedure is completed. Using very thin strips of soft wood (tongue depressor) or a flexible artist spatula (do not use metal implements), apply Exterior Vinyl Spackle (EVS) to the surface of the litharge (an individual's gloved little-finger may also be an acceptable tool for application of EVS). Shape into a narrow fillet between the frame and prism. DO NOT ATTEMPT THIS PROCEDURE ON BULL'S-EYES. EVS dries fairly quickly and is easy to use. When the EVS is dry, take a small paintbrush or Q-tip and paint the joint with an exterior flat white latex paint. This will help seal the porous surface and protect it from absorbing too much moisture. We recommend coating all the litharge to prevent it from becoming airborne and to tighten minor cracks in the glazing. This process is meant for someone with a lot of patience; however, the end result accomplishes a safer environment to work in and is reversible for future work. Remember to wear the proper safety equipment and dispose of all contaminants as prescribed by Federal and State regulations.

C. Barrel Lenses. On a barrel-type lens (drum lens), the litharge and wedges secure all prisms, protecting them from falling out of the frame. To stabilize loose prisms, run a strip of Tyvek tape to conform to the shape of the prisms. Do not remove any wedges. Leave them in place if possible, as they serve two very important functions. The wedges keep the prism in focus and also act as a shock absorber so the glass doesn't contact the metal frame. If wedges are missing, try to locate them at the base of the lantern. If none are found, cut a tongue depressor or Popsicle stick to an appropriate size to support the prism in the frame. Old wedges are sometimes tapered so that excess clearance can be taken up by sliding two opposing wedges together to make them thicker. The wood may be cut so that it is thick enough to

support the prism. Although the lenses were typically assembled indoors using an optical source projecting an image on a screen, this is not practical in the field and attempts to center the prism in the frame should yield satisfactory results.

If the prism falls out of the frame during handling, or if it is found on the floor intact, it may be reinstalled using the following procedure. Remove all litharge from the prism and cavity in the frame. Try to locate and save any wooden wedges, if possible. Apply approximately 1/8" thick layer of EVS to the ends of the prism and insert into the frame. Use Tyvek tape to temporarily hold the prism in place. Insert wooden wedges between the frame and prism, as shown in Figure 7-1.

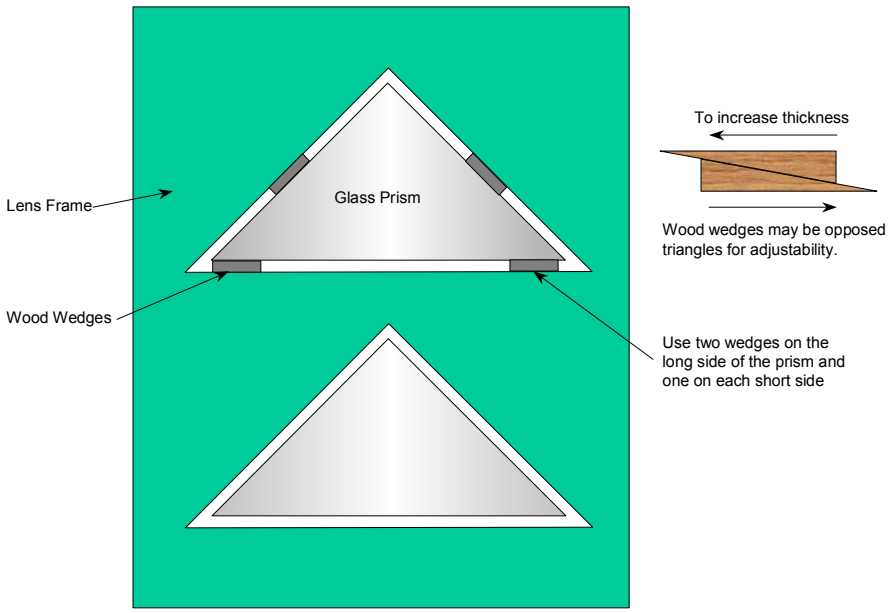


Figure 7-1. Wooden Wedges

Apply EVS to the crevice between the prism and frame. Use nonmetallic or shaped wooden tools (from tongue depressors or Popsicle sticks) to smooth the EVS. Remove excess before it dries by using a damp cloth. After the EVS sets, remove the tape and gently clean the prism, if necessary.

If the wedges are in place, fill the gap with EVS, as described in section 7B, allow to dry, remove the Tyvek tape and gently clean the prism, if necessary. Apply paint to the EVS after it dries (may require a later visit).

D. Bull's-eye. A bull's-eye lens panel present different challenges. The construction of the lens is very precise, and considering the age of these lenses, they must be handled very delicately. Inspect the bull's-eye rings to determine whether they are starting to separate from the other rings. Note how far the ring has dislodged from its supporting members and identify its ring number. Beware that loss of one loose ring may cause a domino effect

and dislodge all the rings all the way to the frame. A simple inspection procedure to determine a loose ring is to look at the panels from the backside. The joint between any two adjacent rings should be flat and even. Do not tap or knock on the backside of the bull's-eye. Gently run your fingers down the length and width of the panel feeling for any member that may be out of place. If your fingernails get caught on an edge, examine the depth of the edge and see how much the ring has moved. Many times the rings start to shift to one side and become cocked as they move out of their seat. If you find this occurring, carefully apply TYVEK tape to inner surface with a second person supporting the outside surface. DO NOT APPLY A GREAT AMOUNT OF PRESSURE ON THE BACK OF THE BULL'S-EYES AS YOU WILL DISLODGE THE RINGS AND PUSH THEM OUT. The tape will obscure a small percentage of light from the flash panel, but still provide a suitable signal until professional assistance can be obtained.

E. Replacement Prisms. Replacement of broken prisms may be necessary to restore the rated intensity of the light. One or two broken prisms in a barrel lens lantern will have a minor impact on the rated range of the lantern. A general approximation for the reduction of intensity of a flash panel (that contains a bull's-eye) is equal to the area lost divided by the area of the flash panel. Lenses that are prone to vandalism may eventually need to be removed from the lighthouse; however, compliance with NEPA and Section 106 of the NHPA must be completed prior to removal of lenses. Such compliance must include initiating consultation with the applicable State Historic Preservation Office (SHPO) and coordination with other interested parties as stated previously in Section 1.C. of this Guide.

   Some replacement prisms may be maintained at the light. They may have been included in the original shipment, or salvaged from another lens. Sources of replacement prisms and Bull's-eyes are available if a sample of the damaged piece is available, however the lead-time and cost are high. Expect to pay approximately $5,000 per element. Contact Commandant (G-SEC-2) for sources of supply.

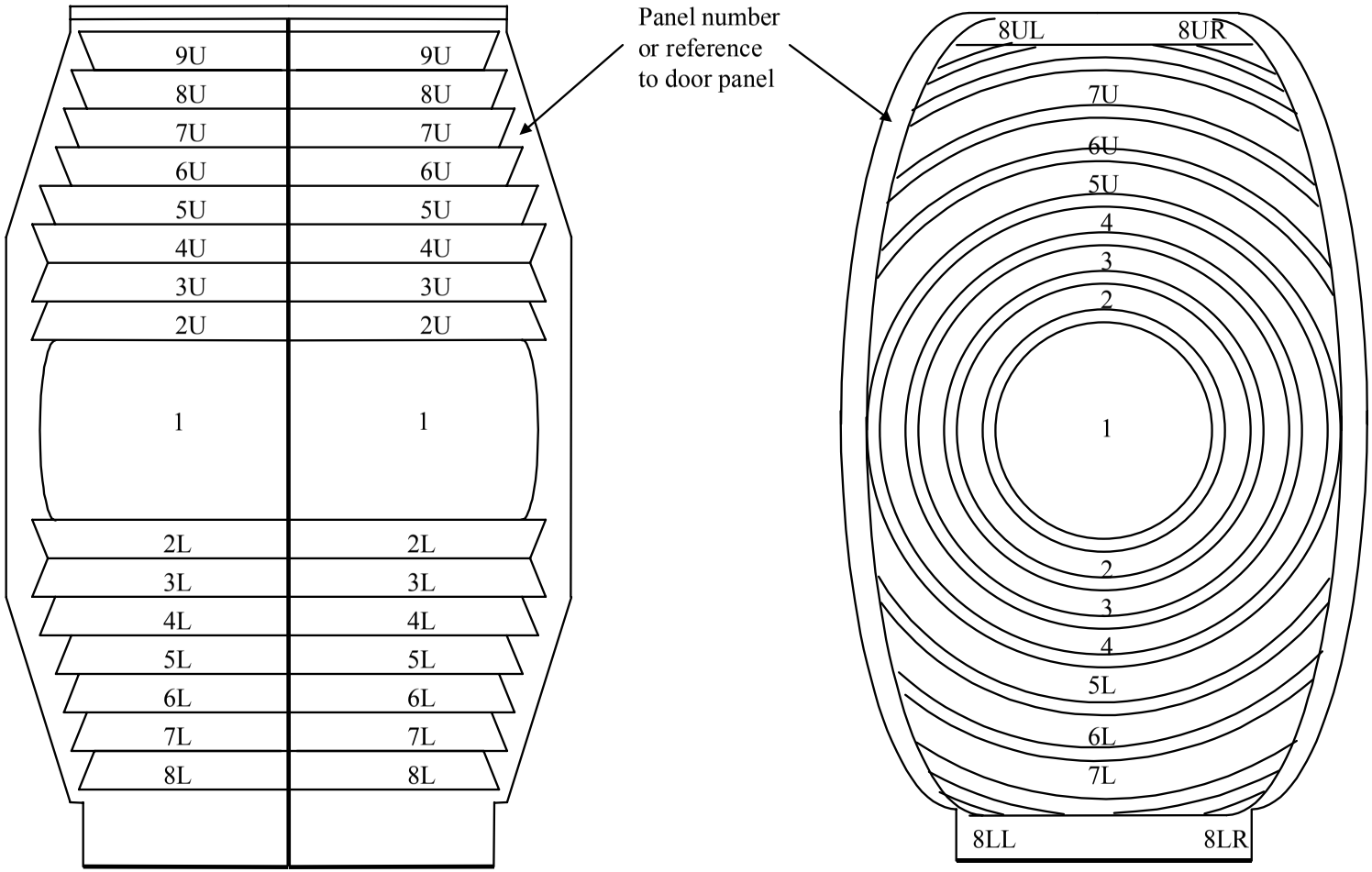
F. Fasteners. Many classical lenses use unique fasteners to secure the lens frames, latches, covers and braces as well as parts of the drive mechanism. Be sure to retain all fasteners, as replacements are difficult to obtain.

G. Additional Assistance. There are resources for those Units not feeling comfortable performing repairs on classical lenses. There are few Coast Guard employees considered experts in the field of lens repair. Utilization of their services generally requires permission from their command and funded orders to the site. Outside assistance is available on a contract basis. Contact Commandant (G-SEC-2) for details.

LENS DAMAGE DOCUMENTATION

(example)

Date:_____



Drum Lens

Flash Panel

Attachment (1)

Lighthouse name:_____