3. Harbor Electrical Construction Phase

3.1. Background

The typical boat harbor electrical system as shown in Exhibits A and B is not common to any other system except perhaps a ship. The majority of the items are specialty items selected for a marine environment to maximize safety and minimize corrosion.

An electrical contractor who has never installed the electrical system in a boat harbor may have considerable difficulty, and the contractor's and the individual worker's qualifications should be carefully evaluated before approval. Similarly, the inspector should have working knowledge of electricity and applicable codes. If all the parties involved are familiar with marine work and boat harbors, the project will be smoother with a minimum of problems.

As a minimum, the inspector should have the following reference material: National Electrical Code (NEC); National Electrical Safety Code (NESC); and the National Fire Protection Association (NFPA), 303 Marinas and Boatyards.

3.2. Plans and Specifications

The plans and specifications should be prepared by an electrical engineer specializing in marine related work. The inspector should be thoroughly familiar with these documents.

The symbols normally used in an electrical design are shown in Exhibits A & B. The one-line diagram as shown in Exhibit B, sheet E-7, identifies all the wire sizes and types, conduit, transformers, panels, circuit breakers and accessories for the system assembly and function. The reference to an assembly followed by a number such as "C-7" refers to the Rural Electrical Authority (REA) standards. "C-7" is a 3-phase 7.2/12.47 KV dead-end with two cross arms. Similarly, M2-1 specifies the grounding assembly with a ground rod. Typical assemblies are shown as Exhibits C and D.

The aerial lighting circuits should be substantially as shown in Exhibit A and B. An intermediate support as shown in Exhibit A, sheet E-3 should be used to maintain clearance over adjacent piling. A clevis or dead-end assembly is required at each corner or end. A piling is required for support of the aerial lighting circuit at each intersection. If there is no other alternative, a midpole tap can be used. The circuit should not cross any usable waterway. The span between the shore support and float piling should be minimal to reduce the side tension on the piling.

3.3. Shop Drawing Process

Contract specifications normally require the electrical contractor to submit a manufacturer's brochure with literature (usually called a "catalog - cut") and shop drawings for approval. The purpose is to insure that the electrical contractor has a firm understanding of the design concept contained in the contract drawings and specifications. Each item in the submittal should be checked and approved or rejected with applicable notations by the electrical design engineer. The submittals are generally submitted by the electrical contractor through the general contractor, if any, through the state's (or city's) project engineer to the electrical design engineer.

After the review is completed, the reverse procedure is used to insure that each entity will be familiar with the design and comments. The evaluation of proposed substitutes is the responsibility of the electrical design engineer with the concurrence of the state (or city).

3.4. On-Site Inspection

The materials specified and incorporated in the electrical project should be all new and, where appropriate, packed in the original containers. Each item in the project should be checked for conformance to the specifications and submittal. Any item which does not conform to the submittal or specific notation should not be incorporated in the project without a new submittal and approval.

Damaged or used material should be rejected and not installed in the project. Minor scratches or abrasions can be repainted or refinished with Galvcote, or equal.

The minimum overhead clearance for 120 volt wires as shown in the National Electrical Safety Code is 10 feet above the float at extreme high tide. A clearance of 12 feet is recommended for additional clearance and to leave room for a telephone circuit at 10 feet, if

required. These clearances are at the midspan at 90° F. The sag of the overhead conductor should be as shown or noted on the design drawings. The sag of wire has many variables; however, the approximate sag for 4/c #6 with messenger based on 25% factor of the tension strength will result in the following sags:

Temperature (°F)	50'	75'	100'
30°	5"	11"	l9"
60°	6"	13"	23"
90°	7"	15"	27"

The sag may be increased or decreased approximately 0.5% per degree of temperature change.

The pedestal clearances are covered in NFPA 303. The clearances within panels is covered by Article 384, NEC. Where type W cable is terminated within a panel, additional side clearance is required. The clearance outside and around electrical equipment is covered by Article 110, NEC.

The splicing of conductors, either type W or aerial, should not be permitted. Taps for overhead light fixtures should be made with split bolt bronze connectors and taps. Type W cable should terminate only at the circuit breaker or lugs in the meter stands. The connection of type W cable to the service at the junction box should be split bolt bronze on a connector such as Burndy Variline taped and covered with a heat shrink cover.

Connectors of any type should be marked "CU" (copper) or "AL/CU" (aluminum/copper). Connectors marked "AL" (aluminum) should not be used. All wire insulation should be trimmed to be flush with the terminal, the wire assembly inserted in the connector body and the nut or bolt tightened to the torque recommended by the manufacturer. Loose connections are the primary cause of marine electrical system problems, and the proper tightening of the connectors is important.

3.5. System Tests

After the system is completed, it is recommended that the following checks be made.

ii. Turn the Hand-Off-Auto selector of the lighting contactor to the Hand position and observe that each light operates. Turn one circuit breaker off and observe that every other light for single phase or every third light for 3 phase is off to insure that the load and distribution is balanced. Observe that the system operates in the automatic mode.

jj. The voltage at each transformer should be checked by the contractor and recorded. The taps may require adjustment for a nominal voltage.

kk. The ground current at each ground should be checked by the contractor and recorded. Any reading in excess of 0.5 ampere should be corrected.

ll. Each outlet should be tested with a circuit device such as a panel Woodhead tester to insure that the receptacle is wired correctly. An adapter and additional receptacles will be required.

The bolts and other fasteners should be spot checked with a magnet to insure that steel or cadmium plated bolts have not been used. Stainless steel or brass bolts are not attracted to a magnet.

3.6. Mistakes and Short Cuts

The majority of the mistakes by either the contractor or inspector have been the result of lack of experience on marine related facilities. This problem can also extend to the supplier who may offer substitutes which are not equal as the result of lack of experience or for cost savings.

The inspector should be on the site full time when the type W cable is installed. The end of the cable should be sealed to insure that no salt water enters the cable ends. Each run of cable should be inspected to insure that the cable is adequately supported, is not immersed or does not droop in salt water, or is not subjected to damage from floating debris. The clamps used to support type W cable should be either wood or PVC coated clamps. The cable at the intersection of each float should not be subject to chafing, particularly if any float movement is anticipated.