APPENDIX A
SECTIONS B-G
COMMENTARY

Appendix A is provided to enhance and explain various aspects of the guidelines presented in Sections B through G. The capital letters and numbers at the head of each "**Commentary:**" are direct back-references to the material presented in the six sections of the guidelines. The intent is to keep the guidelines fairly brief, but to provide additional information that can be referred to if needed. The six guideline sections address the following topics:

Section B	Water Areas
Section C	Berthing
Section D	Guide Piles
Section E	Utilities
Section F	Shoreside Structures
Section G	Land Areas

The symbol in the right margin beside this paragraph appears at various places throughout the guideline Sections B through G. It is a flag indicating that commentary is provided in Appendix A on the particular subjects flagged. The commentary headings in Appendix A include the section back-references, thus providing a two-way reference system. C

There are no commentary flags in Section A (definitions).

NOTES

B4.1.1 Minimum Water Depth Considerations

Commentary:

In coastal marinas the low water reference will usually be based on MLLW. If the extreme low tide periodically experienced at a given coastal site is -1.0 MLLW, this will probably be established as “design low water.” A 50 foot berth would need a minimum water depth of 8 ft, making the bottom elevation -9.0 MLLW. Additional depth may be necessary for silt retention between regularly scheduled dredging operations. Otherwise, silt buildup might encroach on the minimum berth water depth.

In establishing design low water for a coastal marina, it is probably not necessary or prudent to select the absolute lowest tide reading ever recorded at a given site, bay or regional area. Spikes in the records occur for both low and high tides, and should be disregarded if they are solitary events over a period of many years. For example, hourly tide readings have been recorded at a number of California coastal locations over periods of up to 50 years. Within that vast amount of data, there will be extreme data points at both the top and bottom of the tide range, extremes so infrequently experienced that they perhaps may need to be ignored in establishing design low water. For example, if a site experienced a single low tide event of -2.5 MLLW over a period of 20-30 years, that single low tide data point should not become the basis of determining gangway length and maximum slope. However, such low tide possibilities cannot be ignored from the standpoint of maintaining the integrity of the dock system, preventing gangways from dropping off the edge of a dock, etc. The dock may be out of normal service levels for a few hours during such an unusual infrequent event, including interruption of barrier-free access by persons with disabilities. Such extremely low tides will be predicted in tide tables well in advance, and notices can be posted to alert boaters of upcoming temporary conditions. With the volume of tide data available for the California coastline, establishing reasonable and safe design low water for a given marina should not be difficult.

Predicting low water levels in rivers, lakes and reservoirs is more difficult compared with highly predictable coastal tides. These inland waterways may be impacted by droughts that last for many years, resulting in low water storage, minimal water releases, and extremely low flows in rivers. If minimum berth water depths cannot be maintained during such low water periods, alternative actions become necessary such as moving the marina to deeper water or allowing it to ground out on the bottom until water levels rise. Two times during the 1970s and 1980s, California experienced droughts that lasted seven years. Marinas on Lake Shasta had to be moved several miles from their normal locations in order to keep them floating and in business. This necessitated extending roadways and utilities, and creating temporary parking areas, all of which had to be approved under local, state and federal environmental laws and regulations. A marina at Folsom Lake could not be moved and rested on the lake bottom for much of the boating seasons during those years.

If it is anticipated that berthed boats will come to rest on the bottom during unusually low water periods, steps should be taken to notify boat owners to either remove their boats from the marina, or give permission for marina attendants to remove the boats from the water and store them on shore. A marina parking lot can temporarily be converted into a dry storage area. It addresses boat owner's storage problems during low water, and provides an alternative revenue stream for the marina operation during such extreme conditions.

NOTES

C1.2.1.2 Minimum Main Walkway Width / Uniform Width

Commentary:

On main walkways over 300 feet long, the walkway width needs to be wider to address access to a larger number of berths, and handle the increased traffic load of people, supplies and equipment. However, the walkway width should not be arbitrarily reduced at the far end where the traffic is less. To do so is to introduce structural discontinuities, utility line complications, jogs in the walkway alignment, and irregularities in fairway widths and alignments. The total length of the main walkway and the size and number of berths served should determine the uniform width to be provided throughout the length of a main walkway. This will also address in a positive way the safety of the users. A long, uniform width main walkway will become familiar and predictable to the users, and will not cause confusion and problems at night or during storms when their attention is on other matters and concerns. Additionally, uniform width main walkways are more user friendly and accessible for persons with disabilities, paramedics, fire fighters and marina personnel.

. . . .

C1.2.2 Main Walkways – Maximum Lengths

Commentary:

Considering a main walkway with 30 ft single berths along both sides, 700 ft will accommodate a total of about 84 powerboat berths, or 116 sailboat berths. A similar 800 ft main walkway will accommodate about 96 powerboat berths, or 124 sailboat berths. This amounts to a range of 42 to 62 single berths along each side of the main walkway, depending on the type, length and width of the berths and the width of the fingerfloats. At these maximum lengths, the “neighborhoods” become rather large, and the walking distances add up to over 0.3 mile round trip between the extreme ends of the main walkway. In consideration of carrying supplies, equipment and gear, additional walking distances stack up including the possible length of a marginal walkway, gangways, and the distances to restrooms, parking areas, harbor master’s office, restaurants, etc.

. . . .

C1.3.1 Marginal Walkways – Minimum Widths

Commentary:

A dedicated gangway is one that provides access to a single main walkway. In such cases there is no need for a marginal walkway. A single gangway connected to a marginal walkway that provides access to two or more main walkways, is not a dedicated gangway.

It is probably impractical to increase walkway widths to odd dimensions such as 7.0 ft. On a wood dock structure, there would probably be a lot of waste as wood products typically are supplied in even number length dimensions. If the dock system is cast of concrete or fiberglass, or rotationally molded of polyethylene, attention should be given to the common mold sizes available through regional dock manufacturers. The point is to pay attention to the nominal sizes and lengths of commonly available building materials and make the best and most efficient use of those materials, eliminating waste wherever possible.

Marginal walkways typically have a minimum width of 8 feet based on the primary uses and traffic. The decision to reduce the width of a marginal walkway down to 6 feet should be tempered by anticipated pedestrian traffic patterns which can be influenced by gangway arrangements, location of restrooms and other marina destinations. Often marginal walkways are used for guest side-tie berths, or for special events such as boat shows and regattas. Once a marina is built and put into service, it is very difficult and expensive to widen marginal walkways in response to unanticipated uses and traffic. Such alterations can involve major changes to fingerfloat connections, utility lines, service boxes and guide piles.

. . . .

C1.3.2 Marginal Walkways – Maximum Length

Commentary:

Site conditions and the characteristics of a marina basin will generally dictate the maximum length of marginal walkways. Limited opportunity to provide additional gangways around a marina basin usually results in longer marginal walkways, and impacts parking, walkways, restrooms, lighting, barrier-free access and security.

. . . .

C2.1.3 Cross Slope on Accessible Route

Commentary:

When no smart level or surveying device is available to read a 2% slope, it can be approximated using a 12 inch bubble level and a small stack of 25¢ coins (quarters). Each coin is exactly 1/16 inch thick, making a stack of four 1/4 inch high. Placed on a level base, the 12 inch level supported on one end by four 25¢ coins will be at a slope of 1:48, slightly steeper than a 2% slope (1:50). Applied to an actual dock in the water, the quarters and 12 inch level can be used as a tool to estimate whether the cross slope is within 2%. Lay the level on the dock surface across the width. If it is not level, place quarters one at a time under the low end of the level until the bubble reads level. The number of quarters will indicate what the cross slope is. If it takes eight quarters (½ inch high) the slope is just over 4%; six quarters would be just over 3%, etc. This is a handy tool that can be very useful in the field.

. . . .

C2.2.1 Uniform Live Load

Commentary:

25#/ft^2 is not overly conservative with regard to low-use periods during the week or season, nor is it too liberal to meet occasional circumstances that precipitate high pedestrian traffic during holiday weekends, or emergencies such as a marina or boat fire, oil spill, earthquake or flood event.

. . . .

C2.2.1.1 Uniform Live Load - Application Problems

Commentary:

For example, in highly exposed locations where floating docks are periodically subjected to rough water, the use of thin-deck glue-laminated floating wood docks may be the only practical design choice. Such dock systems consist of a structural deck typically ranging from 3 to 6 inches in thickness to which flotation pontoons are fastened. Done properly, such a float system is flexible, has a low dead weight, and functions well in rough water compared to heavier dock systems.

However, in order to meet a 25#/ft^2 ULL, the attachment of the number and spacing of flotation pontoons necessary to comply with the loading and freeboard requirements effectively stiffens the thin wood deck and diminishes its ability to flex properly in rough water. The more pontoons, and the larger the dimensions of the pontoons, the stiffer the dock.

> **Illustration:** A section of dock 8 ft x 50 ft has a deck area of 400 ft^2. A 25#/ft^2 ULL applied to the deck area results in a total ULL load of 10,000#. Assuming that the entire dock DL plus any applied live point load is about 4,000#, the total DL + ULL of the dock section is about 14,000#. One 12" x 12" x 12" cube (1 cubic ft) of totally submerged flotation material will support about 60#, or 5# per inch of submergence. Thus, 14,000# ÷ 60#/ft^3 indicates the need for about 235 ft^3 of flotation. The size and number of pontoons can now be determined with consideration to pontoon weight, depth and dimensions. Using deeper pontoons, with smaller length and width dimensions, will reduce the number and size of the pontoons, allowing for greater flexibility. Using shallower pontoons, with larger length and width dimensions, will require a greater number of larger pontoons and will stiffen the dock. These are the tradeoffs that the designer faces when using a thin deck flexible dock system.

In such situations, dock designers may be tempted to compromise the 25#/ft^2 ULL requirement in order to provide the desirable flexibility in a dock for a specific site. In past years, a ULL of 12#/ft^2 has sometimes been used to address this problem. However, ***this is not a recommended option***. The 25#/ft^2 ULL has been established to address not only the performance of the dock system, but the needs and safety of the boaters who use the docks as well. During rough water periods, there may be little or no pedestrian traffic on the dock during a storm. When 3 to 4 foot high waves are rolling through such a dock system, it may be very difficult to even walk on the dock, depending of the frequency and height of the waves. However, under less severe conditions, the 25#/ft^2 ULL is necessary in the design of the docks in order to provide for public safety, protection of utilities and services built into the dock, necessary freeboard heights, and a reasonable factor of safety during periods of high pedestrian traffic as described above.

If a particular type of dock cannot be designed for a 25#/ft^2 ULL and function properly under expected site conditions, then it is not the type of dock that should be provided at that site. The solution may lie with operational procedures such as seasonal closures of a marina, or removal of docks from the water because of seasonal flooding, storms, ice, etc.

. . . .

C2.2.2 Snow and Ice Loads

Commentary:

Snow and ice zones are not limited solely to higher elevation lakes and reservoirs. The two-week period of sustained sub-freezing weather that occurred in Central California in 1990 did more damage to public and private property than the 1989 Loma Prieta earthquake. Insurance claims related to freezing damage exceeded those from the earthquake.

Heavy Snow Burden on Boats & Docks

If snow and ice are not removed from marina docks, a continued buildup can gradually increase the load and reduce the freeboard to unacceptable levels. Utilities may become submerged and structural connections may be stressed beyond design limits. Also, snow and ice on moored boats may impart heavy loads to the docks, and boat lines, intended to tie a boat to the dock, may pull a dock under water if the boat(s) is overburdened and begins to sink.

Marina decks should be designed, built and maintained such that snow and ice melt drains off the decks. Decks sometimes slightly curl, creating shallow basins that hold snow melt. Such ponded water may freeze overnight and create a “black ice” safety problem for both marina staff and boaters. Practical ways of addressing this problem include provision of drain holes in the deck, or using decking with openings such as 2x6s with ½ inch gaps between decking planks. Vinyl bumper material along the edge of a dock can also act as a shallow dam causing water to pond on the deck. Leaving ½" gaps between the ends of the vinyl strips will allow some of the snow melt to drain away. Care must be taken to insure that runoff does not drain into the flotation pontoons. This can sometimes be a problem on older docks with polyethylene pontoons fitted with plywood lids.

Serious Houseboat and Dock Snow Job

. . . .

C2.2.3 Higher Uniform Live Loads

Commentary:

Examples of such applications include marina marginal walkways that are used by ferryboats, and scheduled events such as 4th of July marina fireworks celebrations that attract large numbers of people. Under such circumstances, marina personnel will often regulate the flow of people to avoid overloading of the dock system at critical locations. Hot spots need to be identified where people will likely gather and raise the live load.

Boat Show Pedestrian Traffic

. . . .

C2.3.2 Unusually Heavy Live Point Loads

Commentary:

C2.3.2 Some persons with disabilities have a combined body and wheelchair weight of 800# to 900#, over twice the recommended design LPL. However, larger LPLs can be tolerated if they are infrequent, short term (a few minutes), and the dock layout will facilitate spreading temporary live loads. For example, a 12 ft wide marginal walkway has a greater capacity to receive and spread a temporary LPL than a narrow 3 or 4 ft wide fingerfloat. In addressing such temporary live loads, maximum cross slopes (1:50) on accessible routes must be maintained. Momentary reductions in the freeboard can be tolerated if cross slope requirements are maintained, and no electrical or plumbing components are jeopardized.

. . . .

C2.4.1 Wind Loads

Commentary:

Depending on the direction of the wind, and where boats are tied in berths, a shadowing effect may occur. If a berthed boat is upwind of a dock, it is not necessary to apply the 15#/ft^2 WinL to both the vertical projection of the boat and the dock behind the boat. The vertical face of the dock over the length of the boat is in the "wind shadow" of the boat, and does not receive the full impact of the wind. However, good judgment comes into play here, inasmuch as the wind direction is not fixed, and can vary from perpendicular to parallel, relative to the boat and dock. When a berthed boat is on the downwind side of a dock, the boat would then be in the wind shadow of the dock, but only up to the height of the dock freeboard.

When applying a lateral WinL to a berthed boat(s), it is necessary to determine what is often referred to as the boat's profile height. WinL is applied using estimated vertical areas of applied load measured in pounds per square feet. Since boats of various sizes and types do not have clearly defined profile heights, they have to be estimated, considering length of boat, gunnel height, cabin size and height, equipment, masts, rigging, antenna and other projections upon which the wind can bear. For a given marina basin and geographical location, knowledge of the types of boats typically operated in the area and the wind characteristics are essential to good design. Generally, a realistic approximation of a boat's length and profile height can be made that will be accurate enough for application of WinL. In the case of a long dock with several side-tie berths, the profile heights of the berthed boats also must take into account the open areas between the bow and stern of each pair of boats. The final estimation will probably be some uniform height of X ft multiplied by the WinL, applied uniformly throughout the length of the dock.

. . . .

C2.4.4 Impact Loads

Commentary:

The designer must determine accurately the site specific factors involved in developing final design impact loads. Such site specific factors include specific marina conditions, marina layout, vessel characteristics and the type of marina dock system. The impact energy transferred from a large boat to a stiff, heavy concrete dock will be larger than that transferred to a more flexible, lighter weight wood dock. A "domino" effect brings into view the rigidity of the boat hull, how it responds to impacting a boat dock, the location, number and type of guide piles securing the dock, and the resisting effects of the dock pontoons below the water line. Such determinations are as much art as they are science, and require careful and prudent design.

. . . .

C2.5.1.2 River Based Marinas Near Low Bridges

Commentary Background Note:

Actual flood events jeopardized two low bridges in the Sacramento-San Joaquin Delta in central California in January 1997. **In one case**, a section of an upstream island levee failed, allowing the island to rapidly fill with water. The downstream end of the island had no outlet, and filled with water to a level higher than the river outside the levee. This resulted in a levee failure "into" the river which then carried trees, brush, large root balls, propane tanks and other debris into a small marina about 0.5 miles below the levee failure. Consequently, the marina failed and boats, docks, wood piles, levee debris and large masses of other materials washed up against a low bridge about 150 yards below the marina. **In the second case**, a river levee directly across from a marina collapsed into an island, resulting in an accelerated strong flow of water past the marina and into the flooding island behind the levee. The upstream marina piles began to sequentially snap under the growing flood load, and the collective mass of marina piles, docks, boats and debris was swept partially into the flooding island, and partially into a low bridge about 1 mile downstream.

In both of the above cases, levee failures were the original cause of the marina failures that ultimately placed the two bridges in jeopardy. Neither of these bridges failed, but the situations were serious enough to precipitate investigation, study and assessments of how best to address such situations in the future. Clearly, it is imperative that both sound marinas and sound levees be constructed and maintained in river environments in order to avoid the events described above.

Commentary:

During a flood event, a levee failure may create a major diversion of water and cause a temporary reversal of flow direction in portions of a river, or network of rivers. Therefore, *marinas **below** bridges* during normal flow conditions may suddenly become *marinas **above** bridges* when temporary flow reversals occur.

If unusually serious environmental loadings can occur, a marina near a bridge must be totally adequate to withstand the flood level water flow as well as any debris load that may catch on the marina. If the marina fails, a low bridge near the marina may be in jeopardy of failure as well. Huge quantities of debris, including boats and docks, can be washed up against the bridge causing its closure or collapse. In flood events, such bridges may become escape routes for otherwise stranded people and livestock, as well as access to and from flooded areas for emergency and law enforcement personnel, vehicles and equipment. In such marina/bridge situations, the following suggestions should be considered in addressing environmental loadings in the design, construction and operation of a river marina.

(1) The integrity of the marina dock system must be maintained as the marina ages. Wood decays over time, and must be repaired or replaced. Steel rusts and must be re-coated, repaired or replaced as required. Piles have a known service life and must be evaluated periodically to determine if they will withstand the unusually severe applied loads that occur during a flood. And not only must all of the component parts of a marina be inspected and maintained, but the marina dock system as a whole must be maintained such that the various parts work together, and stay together during a crisis.

(2) Depending on soil conditions, the selection of marina piles in flood zones is critical. Marinas near bridges should be held in place with thick-wall steel piles, or pre-stress concrete piles, driven to depths that will allow for the full development of the bending strength of the piles during flood loading events. If a strong pile fails during a flood because of soft mud bottom conditions, the pile is totally worthless. However, if the piles stand during a flood event, a well designed, constructed and maintained marina will likely stand the test as well.

(3) The use of wood piles in river marinas near bridges is not recommended. Wood marina piles have some distinct advantages during normal water flow conditions. They are flexible, and will yield somewhat as river loadings occur, thus allowing other nearby piles to pick up and share the developing loads. They are quiet compared to steel and concrete piles when boats and other objects rub and clang against them. However, with age, wood piles gradually lose their structural strength, may become somewhat brittle, and can suddenly snap under load during a flood. If this happens at the upstream end of a river based marina, a single pile may become overloaded and snap, passing additional load along to the next pile. A zipper effect can occur as one pile snaps after the other, perhaps resulting in the partial or total failure of the entire

marina including piles, docks, boats, gangways, utilities and equipment.

In locations near bridges where it is likely that serious flood events will occur periodically, the marina designer and owner should consider installing a pile cable system that connects the tops of marina piles together in a containment network. The elevation of the cable must be higher than the elevation of the river levees in the area. The cable should be anchored to shore at both the upper and lower ends of the marina to provide a restraining force to the top of the piles to help them carry temporary high water loads. Such a cable system can also keep all of the piles and docks together on site if a failure occurs, thus preventing additional flood debris loading on a nearby bridge. However, such pile cable systems are not without potential problems. If the water gets too high, and the piles are not high enough, the cables themselves may collect and retain debris, causing additional loads on the piles and dock system. Also, the cables may constitute a hazard to marina personnel working on the docks when river levels rise to where docks are less than 7 feet below the cables. The permanent attachment of cables to the tops of marina piles is a concept that can be of great value in an emergency, but must be managed with care and awareness of the pros and cons.

Marina Pile-Cable Restraint System

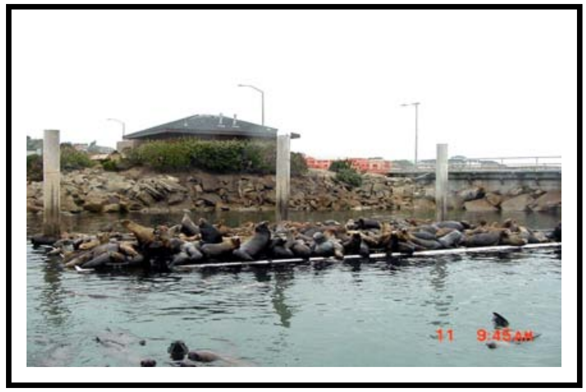
An operational procedure should also be considered for river based marinas near bridges. A river level threshold can be established to act as a referee when river levels begin to rise to flood stage. For example, a river elevation of +20 feet, based on the local water level datum, might be a reasonable threshold that dictates preventive actions. Once the river hits + 20 feet, all boats should be removed from marinas in close proximity to river bridges. This will assist in keeping the various emergency loadings on a marina dock system within reasonable limits, and help insure that a failure does not occur to either the marina or the bridge. Boats removed from a marina under such an arrangement can be temporarily relocated to other nearby marinas not near bridges, or removed from the water and stored on land in pre-planned secure storage locations. The water level threshold and boat removal policy must be determined and agreed upon with the full cooperation and input from marina owners/operators, land owners, reclamation districts, and local, state and federal water agencies, as applies at a given site.

. . . .

C2.5.2 Wildlife Loading

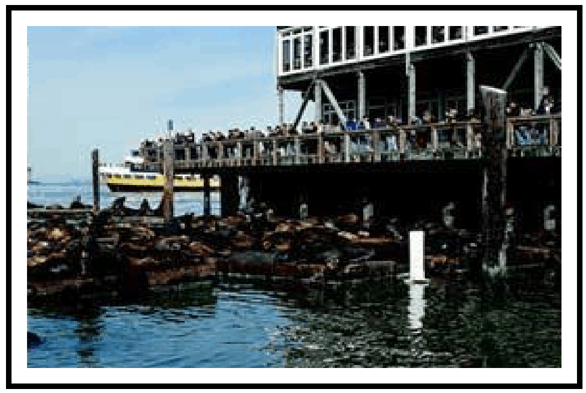
Commentary:

The photo shows sea lions that have completely taken over a boarding float at a boat launching ramp in Monterey Harbor. The sea lions caused the boat ramp to be shut down for several weeks in May and June, 2003, including portions of the parking area near the top of the ramp. They will also occupy marina docks and boats on moorings. Working with federal and state personnel, experiments that seemed to work included gently hosing off the docks near the sea lions, jingling car keys on a key chain, and spinning buoys on the docks in front of the animals.



Sea Lions on Boarding Floats

It was also learned that the sea lions are highly intelligent and are able to accommodate new experiences (spinning buoys) once they realize that they will not be harmed or unduly inconvenienced. So, what worked this week may not work next week, or next year. It is a ongoing problem that must be addressed as a moving target. This can be a seasonal problem to some extent, and some years seem to be worse than others. The population of sea lions is declining worldwide, but is growing in the Monterey/Central California coastline areas.



Sea Lions at Pier 39 Marina - San Francisco

The sea lions are notorious for fouling any area that they stay in for any length of time. They can occupy a dock or large boat(s) for days or weeks, and leave behind serious cleanup chores. Therefore, harbor staff must clean the boat ramp, docks, boat slips, etc. in preparation for allowing public use to resume when the sea lions migrate to other locations as their available food resources change.

. . . .

C3.1 Minimum and Maximum Freeboard under DL only.

Commentary:

The minimum freeboard is to be sufficient to prevent walers, fender boards and utility lines from being in direct contact with the water surface under still-water conditions. It is advisable to provide a minimum 4 inch freeboard to the bottom of all walers and fender boards. This will extend the service life of these dock components that are so exposed to intermittent wet and dry conditions in the splash zone just above the waterline.

It is to be understood that these freeboard guidelines are general, and are intended to address typical recreational boat/berth needs and conditions found in California marinas. Where unique needs and conditions exist, freeboard specifications may need to be altered accordingly. The users should always be kept in mind as well as the types and sizes of boats that will be berthed in a given marina. A freeboard of 24 inches is impracticable at a lake marina that primarily berths only low-profile aluminum fishing boats. 24 inches is too large a step down from the marina deck into such fishing boats, particularly for senior citizen boaters, but may be perfectly suited for large yachts and cruisers berthed in urban coastal marinas. The term “freeboard” addresses the vertical distance from the water surface to the marina deck. However, it also addresses the practical aspects of enabling boaters to be “***free***” to “***board***” their boats in consideration of boat type, size, and dock freeboard.

. . . .

C3.2 DL + ULL

Commentary:

Using the DL only minimum freeboard of 14" as a baseline, a dock designer has 4" of freeboard reduction within which to pick up the ULL applied throughout the dock system without going below a 10" freeboard. This can be addressed through selection of the flotation pontoon shape, wall thickness, weight, length, width, depth, number and distribution. A cubic foot of fresh water weighs about 62.5#, and a cubic foot of flotation pontoon weighs about 2.5 pounds. Therefore, each cubic foot of pontoon displacement will support about 60#. This provides a practical rule-of-thumb that every 1" of displacement of a 1 ft cube of pontoon flotation will support a load of about 5 pounds.

$$[62.5\ \#/ft^3 - 2.5\ \#/ft^3] \div 12\ in/ft = 5\#\ \text{per inch of displacement of a } 12"x12"x12"\ \text{cube}$$

In coastal marina applications, use 64 $\#/ft^3$ for the weight of salt water.

A word of caution is in order here. In some dock designs, the pontoons are attached to the bottom of an open frame such as a steel truss. The decking is attached to the top side of the frame, and the utilities are run through the frame. The buoyancy capacity of the pontoons may be entirely adequate to carry 100% of the design dead and live loads and fully meet the freeboard requirements. However, if the pontoons are fully immersed under full design load, they have no reserve flotation capacity for emergencies. Additional loads can sink the pontoons all the way to the bottom but no additional pontoon buoyancy capacity will be realized.

In contrast, some other types of dock systems, such as those built on enclosed pontoons that extend well above the waterline, not only provide the necessary freeboard and fully meet the demands of dead and live loads, but also provide reserve buoyancy capacity should an emergency need arise.

Thus, there are tradeoffs between the various types of dock systems, and the conditions under which they will be expected to perform. Consideration of all of the above elements is essential to good design and construction of safe and long lasting marina docks.

. . . .

C3.3 DL + LPL

Commentary:

Using the DL only minimum freeboard of 14 inches as a baseline, a dock designer has 4 inches of freeboard reduction within which to pick up the LPL which can be applied at any point on the deck not closer than 12 inches from any free edge, without going below a 10 inch freeboard. However, maximum cross-slope and minimum freeboard requirements must be met concurrently.

. . . .

C4. Maximum Slopes

Commentary:

The difficulty of achieving and maintaining the maximum cross slope varies between marginal walkways, main walkways and fingerfloats, primarily because of the difference in widths. Marginal walkways must be at least 6 feet wide, but are usually 8 to 12 feet wide, are very stable, and usually do not present any problems with regard to cross slope listing under reasonable live loadings. Where gangways land on marginal walkways, additional flotation often is required to support the gangway DL, ULL and LPL, and well as maintain the cross slope and longitudinal slope requirements.

Main walkways must be at least 6 feet wide, are usually stable, but subject to slope problems related to storage box overloads on fingerfloats, and imbalances that can occur when fingerfloats are attached along only one side of a main walkway.

Appendix Table App-1 Fingerfloat Length to Width Ratios

Finger Width	Length Range	L/W Ratio	Finger Width	Length Range	L/W Ratio	Finger Width	Length Range	L/W Ratio
2.5 ft	16	6.4	4.0 ft	36	9.0	5.0 ft	62	12.4
	18	7.2		38	9.5		64	12.8
	20	8.0		40	10.0		66	13.2
3.0 ft	22	7.3		42	10.5		68	13.6
	24	8.0		44	11.0		70	14.0
	26	8.7		46	11.5		72	14.4
	28	9.3		48	12.0		74	14.8
	30	10.0		50	12.5		76	15.2
	32	10.7		52	13.0		78	15.6
	34	11.3		54	13.5		80	16.0
				56	14.0			
				58	14.5			
				60	15.0			

Fingerfloats are the more difficult problem since they are relatively narrow in comparison to their length. As the length increases, the length to width ratio (L/W) increases as well, making it more difficult to maintain cross slope requirements. As seen in the table above, a 16 foot fingerfloat 2.5 feet wide is very stiff with a L/W ratio of 6.4. However, an 80 foot long fingerfloat 5.0 feet wide has a L/R of 16.0. Consequently, it may be necessary in certain cases to widen the fingerfloat widths to maintain cross slope stability. This decision will be influenced by the type of dock construction, the dead weight of the docks in comparison to the applied live loadings, and the types of boats expected to be berthed.

The cross slopes of walkways becomes critically important when they are part of an accessible route. Under no circumstances are the cross slopes along accessible routes to exceed 1:50 (2%). Since accessible fingerfloats are required to be at least 60 inches wide, this nicely addresses the cross slope problem. However, fingerfloats in the longer ranges may have to be widened to ensure compliance with the cross slope requirements, particularly with regard to the application of a LPL of 400# as addressed in C2.3.

It is one thing to comply with the required maximum cross and longitudinal slopes at the time of construction and acceptance of a new dock system. However, time, nature and use are hard on dock systems. Wood warps, checks and cracks, materials expand and contract, and fittings and connections loosen. Therefore, maintenance is critical in keeping marina docks within the required slope parameters. Not only will it keep a marina in good working order, but regular scheduled maintenance will also maintain an attractive appearance and keep the berths safe and convenient for boaters who use the facilities. Appropriate dock slopes must be provided and maintained during the service life of the docks.

. . . .

C5.1 Material Considerations

Commentary:

Corrosion resistance is of particular concern in salt water applications. Steel and iron products must be coated or painted to avoid or control rusting. Because of its high strength characteristics, steel is commonly used in the manufacturing of piles, pile yokes, cleats, bolts, fasteners, brackets, utility cabinets and other marina components. Typical steel protection includes galvanizing, powder coating, painting, wrapping and encapsulating.

SS Screw and Corroded
Cadmium-Coated Steel Washer

Another type of corrosion to be aware of is the destructive interaction between dissimilar metals known as galvanic corrosion. When dissimilar metals of different potentials are joined together by an electrolyte, such as rainwater or splash water from a marina basin, the more anodic metal will corrode. Connecting copper water pipe to a galvanized water tank, for example, will cause the galvanized tank to corrode very quickly. The use of stainless steel screws and bolts in direct connection with cadmium coated steel washers will corrode the washers. Also the direct contact between aluminum and steel in marina dock connections will also result in galvanic corrosion.

Solutions to galvanic corrosion problems include:

1. Avoid making connections between dissimilar metals.
2. If such connections cannot be avoided, refer to a "galvanic series of metals" and only join metals that are near to each other in the series, i.e. copper and brass.
3. Provide an inert insulator washer, sleeve or barrier between the two metals.

Other metals used in marinas include stainless steel, copper and aluminum. Although they do not rust in salt water environments as does steel, they still need to be protected. Sea gull droppings are corrosive and can cause damage to pile rollers, pile caps and other non-ferrous metal components that are located directly below where sea gulls perch. Care must also be exercised to avoid conditions that lead to electrolysis which can destroy metal boat fittings, dock parts, steel piles, and the steel reinforcement in concrete sea walls and breakwaters.

Thermal expansion and contraction of materials is of critical interest in locations subject to extreme ranges of daily and seasonal temperatures. Steel is very elastic, and "grows" on hot days. When used on long railings on piers, for example, the sockets that connect the railings to posts, walls, etc., must be designed to allow the steel railings to slip and relieve the expansion and contraction stresses that occur. Alternative wood products used for marina decking, made of polyethylene and wood fibers, also expand and contract. The use of slotted bolt holes and washers, and appropriate gap spaces between the ends of decking boards, helps allow these composite materials to grow and shrink without buckling and the shearing of connectors.

Impact resistance is important for any marina component exposed to impact loads imparted by moving boats, equipment and/or people. Materials selected for pontoons, fenders, bumper strips, storage boxes, utility outlet cabinets, fire hose cabinets, etc., should be tough enough to do the job, but not brittle. They must have reasonable flexibility to resist impacts without breaking. A classic case is the bow of a boat striking the back of a utility storage box when entering the boat slip. In selecting decking material for docks, keep in mind the "heel loads" imparted to the deck by persons running on the docks during an emergency or special event. A 300 pound adult man running on a dock or gangway imparts a significant vertical impact load to the deck.

Weight of materials is important in addressing needed pontoon flotation capacities and required freeboard heights. Consideration must be given to the accumulated dead weight of bolts, nuts, washers, brackets, conduits, railings, gates, hinges, light standards, transformer housings and other metal components commonly used in marinas. Every 5# requires another 1/12 cubic foot of pontoon capacity.

Strength of materials must be kept in mind when selecting steel, aluminum, wood, plastics, composites and other materials. Aluminum is corrosion resistant in most atmospheres, but may not be strong enough for hinge barrels on gates, gangways and storage boxes. Douglas Fir is difficult to pressure treat, but is much stronger than cedar or redwood, and can be used with longer span distances. Cedar and redwood are rot and decay resistant, but are relatively soft, are subject to faster wear on deck surfaces, and are not generally suitable for structural members on a dock. Objective consideration of the strength characteristics of the various materials being considered is necessary to good design and satisfactory service.

Past performance of materials is a great tutor and school master. If a material doesn't work in one setting, find out why before importing failure to another setting. Not all materials work well in all environments. Failures of materials often provide opportunities to make improvements in products and grow in the understanding of their applications. What works well in the cool moist environment of Crescent City may not work so well in the hot, intensive ultraviolet environment of the Mojave Desert. Attention to such factors should be applied to metals, plastics, wood and composite materials.

Minimum thickness of materials is often overlooked from the practical standpoint of durability and service life. For example, experience has proved that use of 1/4 inch diameter steel bolts in a dock system is usually not smart or cost effective in salt water environments. The cross section area of a ½ inch diameter bolt is about four times the cross section area of a ¼ inch bolt. For the difference in cost and weight, it is prudent to use ½ inch or larger bolts for various connections. This is even more important if the bolts pass through pressure treated lumber, a corrosive environment for steel hardware components even if they are coated or galvanized. The same minimum thickness principle is in view with regard to galvanized steel knee brace brackets, pile yokes, utility hangers and brackets for supporting various equipment such as fire hose cabinets.

Flexibility of materials is often important to both performance and durability. A marina dock system is a dynamic structure constantly moving under the influence of winds, currents, waves, tides, boats and people. Materials must be selected that will not become brittle when cold, and still retain their shape and strength when unusually hot, i.e. during a fire or unusually hot summer afternoon. For example, water supply lines in a dock system must flex with the movement of the docks, yet remain intact while under pressure, including the fittings and connections. In rough water applications, a flexible wood dock system may provide superior performance and length of service as compared to a heavy, rigid concrete system.

Ultraviolet (UV) resistance is important to the service life of materials and appearance. Plastic products have been dramatically improved over the last 20-30 years with regard to UV damage resistance. UV blockers and other "miracles of modern chemistry" have extended the life of plastic products installed in full-sun applications. Dock storage boxes installed in southern California marinas in the 1970s had a service life of only six to eight years because they became brittle and discolored, and had to be replaced. Electrical outlets and water supply hose bibbs were often installed on the face of the storage boxes, making replacement of the boxes difficult and expensive. Other examples of UV sensitive materials include building windows, utility towers, bumper materials, signs, recycled plastic decking, pile caps, and an array of cabinets for hoses, utilities and equipment.

<u>Availability</u> of materials should not be overlooked. New products become available, but may not be readily available in all regions and markets. Shipping costs may be unreasonably high for initial construction, and future lack of availability may make it difficult to obtain repair and/or replacement parts and materials. If interested in new materials and products, it is prudent to use them on a trial basis on relatively small projects to find out how they actually perform, and see if the manufacturer will follow through on guarantees and warrantees. If not, the company probably will not be in business in the future to provide products and materials for repair, replacement or expansion. A track record of continued availability of product materials should be demonstrated by manufacturers and suppliers.

. . . .

C6.1 Pontoons

<u>Commentary:</u>

Water weighs from 62.4#/ft^3 to about 64.1#/ft^3 for fresh water and salt water respectively. Assuming that a cubic foot of pontoon weighs about 3#, including the pontoon hull and flotation foam, one cubic foot of totally submerged pontoon will support approximately 60 pounds of dead weight. Therefore, each inch of submergence of a 12"x12"x12" pontoon will result in a “rule of thumb” buoyant capacity of 5#. Thus, a 3'x5' rectangular vertical-wall pontoon has a 15 sq ft horizontal cross section area, and will provide a buoyant capacity of 75 pounds per inch of submergence. This rule-of-thumb figure makes it very easy to calculate the general requirements for pontoon floatation once the loadings are known on a particular marina dock system.

. . . .

C6.3 Pontoons and Structural Frames

<u>Commentary:</u>

The difference in stiffness of the dock frame and the pontoons can be a problem. Long, stiff, rigid pontoons do not work well when attached to a highly flexible glue-laminated wood dock system, particularly when the length of the pontoon is aligned parallel with the length of the dock. During periods of sustained high wave activity, the wood deck will flex in response to the wave height and period, but the connections with the pontoons will likely fail, ripping off or cracking the pontoon flanges, and causing progressive damage to the entire system. In such environments, use smaller, short length pontoons fastened with the pontoon length across the width of the dock. This will lessen the stiffening of the dock system along its length, and allow it to flex to a greater extent when necessary.

. . . .

C6.6 Pontoon Specifications

Commentary:

Some older pontoon shells that are still in service were made of roto-cast polyethylene. Made two at a time, they came out of the molds much like two bread pans connected at their rims. They were cut apart, resulting in two open-top rectangular hollow pontoon shells. Such shells were filled with pre-expanded foam snugly inserted into the shells, and capped with pressure treated plywood. 10 mill polyethylene sheeting was placed over the open-top foam-filled pontoon before the plywood cap was put on. This procedure helped stiffen the pontoon flanges, strengthened the connection to the dock frame, and helped ensure a watertight seal along the lip of the pontoon.

When this type of polyethylene pontoons are attached to the bottom of the frame, typically with galvanized lag screws and washers on 4 to 6 inch centers, a 2"x2" pressure treated wood backing strip should be used to insure that the pontoon flanges and covers are secured perfectly flat against the dock frame. This will guard against puckering of the pontoon flanges that tends to occur during warm weather as the result of thermal expansion. Such puckering forms small “mouths” between the lag screws that literally drink water in the splash zone around a pontoon and allow it to enter into the pontoon, filling existing air gaps, and progressively altering the buoyant characteristics. For example, where wind chop occurs primarily on the warm sunny side of an existing dock, pontoons will “sip” water on that side only, and the growing internal hydraulic pressure will gradually push the pontoon walls away from the foam cores. This can result in severe listing of the pontoons, a situation that is not usually self-righting.

Roto-cast polyethylene pontoons presently being used on marina docks are molded as self-contained units that are completely enclosed. The flotation foam has to be injected into the pontoons after the molding process is completed. Such pontoons are tough, reliable, and versatile for use on marina docks.

A suggested field method of addressing water filled polyethylene pontoons is to drill 1 inch diameter holes vertically up through the bottom of each pontoon shell about 2 inches diagonally from each corner. This will allow water both inside and outside the pontoons to equalize. The bottom of the pontoons will be several inches below the waterline, so no fuel, oil or other chemicals floating on the surface will be able to enter the pontoons and gradually “melt” the foam. This is an easy, effective, and inexpensive method to stabilize older “puckered” plastic pontoons as well as newer ones that may have taken on water. Since the primary function of the pontoon shell is to protect the foam core, drilling holes in the bottom, well below the water line, does not diminish the integrity of the shell or the foam. Do not drill drain holes through the sides of the pontoons.

The above commentary gives clear evidence as to why pontoons should not be partially filled with foam. If water gets inside a partially filled pontoon, the foam core may very well float to the top of the pontoon shell, allowing even more water to enter the pontoon. This will diminish the effectiveness of the pontoon and cause further problems in maintaining freeboard and cross slope requirements.

. . . .

C6.7 Concrete Pontoon Reinforcement

Commentary:

Care must be taken to insure that reinforcing steel, wire fabric and other ferrous metal elements are not cast into the pontoons too near the surface of the top, bottom and sides such that rusting of the reinforcement will occur. If it does, iron oxide will begin to form on the surface of the steel, and continue to grow causing the concrete bond with the steel to fail. This will lead to the concrete spalling and being pushed away from the reinforcement, gradually destroying the effectiveness of the reinforcement. The use of additives to increase density and reduce porosity of the concrete can give added security against water intrusion and its effects on steel reinforcement, particularly in salt water applications.

. . . .

C7.1 Decking

Commentary:

Untreated softwood decking includes redwood and cedar. Heart grade redwood is resistant to rot, dry rot, and insect damage. However, it is low in strength, turns a dark color, can be used only over relatively short spans, is very expensive and hard to obtain. It is not recommended for marina decking use. In past decades, Port Orford cedar was used extensively for marina decking. It weathers to a silvery gray color with a feathery texture, and is not prone to splintering, splitting or checking. However, it too is expensive, difficult to obtain and has nearly vanished as a marina decking material.

<u>Untreated Wood Decking</u>

Species of untreated hardwood decking include a variety of tropical hardwoods such as Ipe and Brazilian Rosewood. They are very dense, heavy, and when applied properly will give a good long service life. However, these hardwoods are extremely expensive, greatly add to the dead load on a dock system, usually require stainless steel screw fasteners, and are impacted by the growing concerns over harvesting wood products in equatorial rain forests. Such decking is an option, but consideration of the above factors must be taken into account.

<u>Pressure Treated Wood Decking</u>

Softwood species such as Douglas Fir, Southern Yellow Pine, pine, and Hemfir can be pressure treated for use as marina decking. Recommended levels of chemical retention must be obtained during the pressure treatment process for decking applications in salt and fresh water splash zones. Pressure treated wood that comes directly in contact with the water has a higher retention requirement than wood used in the splash zone. The chemical treatment specification applies to “the zone of treatment” and varies with the dimensions of the lumber being treated. Refer to local pressure treatment associations for information and guidance in the use of pressure treated wood for marina use.

Pressure treated lumber is typically incised to enable the treatment chemicals to penetrate deeper into the wood cross section, thus providing better treatment. Incising is accomplished by running sawn and surfaced lumber through a roller assembly fitted with thin steel teeth that punch long thin holes into the surface of the lumber, typically on all four sides. When incised lumber is used for marina decking, it can become an unforgiving surface as it drys. At the points of incision, short stiff splinters often raise up and are unfriendly to shoes, bare feet, knees and hands. The treatment chemical is toxic and can cause various kinds of skin problems when the splinters penetrate the skin. Therefore, it is recommended that pressure treated marina decking not be incised. Since decking is less than 2 inches thick, this will not appreciably lessen the penetration and retention of the treatment chemical, but will enhance the usability of the product by boaters.

<u>Recycled Plastic Lumber Decking</u>

Recycled plastic lumber (RPL) is a product that is growing in use and popularity as a marina decking option. Manufactured from a variety of recycled polyethylene products, ranging from baby diapers and milk bottles to commercial grade manufacturing trimmings, RPL is available in a variety of dimensions, grades and colors. An extruded product, it can be made with various finishes, including grooves and serrations to improve foot traction when wet.

RPL is available in a pure form known as High Density Polyethylene (HDPE), as well as in a composite form combining wood fibers and sawdust with recycled polyethylene. Many generations of these products have been manufactured over the last 20 years, and some have been field tested by installing them in test sections in marinas. Initially the products were generally soft and pliable, and “grew” in length on hot days. A 2x6 decking board 16 ft long would grow up to 1 inch in length on a hot August day. Although that is a growth of only 0.52%, it caused buckling of deck boards and shearing of attachment screws. Additionally, the product would sag between supports on warm days, resulting in a poor appearance and unreliable surfaces for foot and cart traffic. The introduction of wood fibers into the decking solved some of the growth problems, but caused other problems such as delamination and deterioration. Over the years, new and improved recycled plastic lumber products have been developed that are stiffer, provide improved performance, and have a longer service life.

One of the drawbacks to RPL is its typical short span. Most RPL products have a manufacturer’s recommended maximum span within the range of 16 to 24 inches for 2" x 6" boards under a load of 80 psf. Marina decking is typically designed for loads of 20 to 40 psf. However, because of the basic characteristics of RPL, the recommended maximum spans should be complied with to provide the required support and avoid sagging.

The current industry standard for thermal expansion of RPL is 3/8" in 12 ft, a growth of 0.26%. Thus, product improvements have cut the typical growth rate in half over the last 15 to 20 years.

Many RPL product advertisements claim that such products will not stain and will last for decades without maintenance. The fact of the matter is that most of the wood fiber-poly decking will stain and must be maintained by regular removal of leaves, oil, and debris, and regularly scheduled washing and cleaning.

When selecting a RPL product for marina decking, a lighter color is probably best. It will be more prone to showing stains, but the lighter colors will not absorb as much heat as darker colors, and will be cooler and more user friendly to bare feet on hot sunny days. Darker colors will fade to some extent, but will probably be more resistant to UV damage.

<u>Aluminum Decking</u>
Extruded aluminum metal decking is a viable option to wood and plastic, depending on the application and location. Aluminum radiates heat exceptionally well and is typically a cooler decking material than wood or plastic decking products. It does not rust or rot, and is available in its natural color, or may be color coated with various products. It is light weight and does not appreciably add to the dead weight of the dock system. Various aluminum alloys are available, a critical element when selecting aluminum decking for salt water applications.

Aluminum decking typically is extruded with interlocking edges that improve the transfer of point loads not only longitudinally to the cross supports but to adjacent decking members as well. One disadvantage however, is that the continuous interlocking surface may not always drain well.

If aluminum decking is installed in its natural color, the decking should be lightly mineral blasted to eliminate the bright aluminum mill finish. Bright aluminum can be blinding on a sunny day and will not be well received by marina dock users or marina staff. Mineral blasting will also remove manufacturing stains and deposits of foreign materials, leaving a clean uniform slightly dull appearance.

<u>Fiberglass Decking</u>
Fiberglass decking is now available in channel-shaped cross sections. It is more resistant to UV damage than polyethylene plastic products, and is fairly easy to repair as necessary using fiberglass resins. Improved traction in wet situations can accomplished by throughly cleaning the deck, liberally coating it with wet resin, and broadcasting it with small grain silicon sand, finely ground walnut shells, Carborundum, or other hard durable gritty substances. The resin will set and capture the grit, forming an improved traction surface. Finely ground walnut shells are porous and allow the wet resin to not only coat the walnut grains, but also to be absorbed into the walnut grains creating a high quality bond.

One drawback to fiberglass is that it can be damaged from impact loads and not immediately show visible evidence of such damage. Internal fibers may have been broken or otherwise damaged, and not be visible under casual observation. The application of another impact load at the same point may result in a “sudden” failure of a deck board which in fact is not sudden, but rather is progressive. Therefore, fiberglass decking should be inspected at regular intervals and repaired as necessary.

Fiberglass decking can be manufactured by extruding it through an orifice concurrent with pulling strands of fiberglass through the orifice. Known as “pultruded” fiberglass products, they are exceptionally strong, and can be ganged together using small “T” bar or “I” bar elements to form composite decking panels 3 to 4 ft wide and up to 20+ ft in length. They are commonly used in chemical plants for their strength, reliability and resistance to corrosion. By virtue of their shape and characteristics, they drain very well, and can be coated with resin and grit as discussed above to improve traction as required. However, pultruded fiberglass decking is several times more expensive than more traditional types of decking, but may be the decking of choice for specific applications.

Concrete Decking

Concrete pontoons consist of relatively thin walls, bottom, and a thicker top that serves as the marina deck, cast around a core of marine grade expanded foam. Formed in steel forms that impart smooth finishes on the sides and bottom, the top is hand finished to provide an attractive, uniform, roughened texture that is easy to clean but provides good foot traction. The finish is typically a low to medium broom finish applied perpendicular to the direction of travel, with a steel trowel tooled edge 2 to 3 inches wide. This gives the pontoon a finished picture frame appearance, and avoids the jagged look of a broom finish that goes to the edges of the pontoon. Care must be taken to identify each pontoon as it is made with regard to its position and location in the marina layout in order to insure that the broom finish is imparted in the correct direction.

Concrete pontoons are typically manufactured in casting yards and shipped to the marina site on trucks or barges. Often stacked four high for transporting, the pontoons must be stickered in such a way that the pontoon on the bottom will not be cracked or otherwise damaged from the weight of the pontoons stacked above. Cracked pontoons should be rejected at the job site and returned to the casting yard.

The edges of the deck should be rolled over with an edge finish tool to avoid chipping during transport and assembly, and to provide a pleasing appearance. The pontoon casting forms should be fabricated to impart a chamfered edge to the vertical corners of the pontoon sides and the horizontal edges of the bottom, also to avoid chipping. This also facilitates removal of the pontoons from the forms.

Steel reinforcement placed in the pontoon forms must be carefully positioned and secured to insure maximum concrete cover when the pontoon is cast. Otherwise, when the wet concrete is introduced into the form, vibrated and finished, the foam tries to float to the surface of the concrete, moving the steel with it. This may result in the steel being too near the concrete surface, and rust will gradually occur, especially in salt water. Iron oxide will grow and eventually break the bond between the steel and the concrete and gradually ruin the pontoon. Diligent care to detail and competent inspection during the manufacturing process can avoid costly and unnecessary premature repair and replacement costs.

Care in placement of the flotation foam inside the form is also of critical importance. If the foam shifts in the wet concrete during the casting operation, it may cause the walls, bottom and/or deck to be too thick or too thin. Also one side of the pontoon may be thicker and consequently heavier than the other side, causing the pontoon to list in the water to one side or the other. Some manufacturers actually weigh each pontoon after removal from the form and determine if the pontoon is balanced, or is heavy on one side. If the minimum thicknesses are achieved, slightly out of balance pontoons can be assembled into walkways and fingerfloats, turning them end for end as necessary to balance out the side to side weight differences. Such effort provides essentially level floats with little or no cross slope.

Concrete decking panels are sometimes used on wood frame and steel frame dock systems. They have the advantage of being removable for repair, replacement, or access to utility lines and pull boxes. Such panels must be seated flat in the dock framework, be small enough for handling during construction, but large enough to discourage or prevent removal by vandals. A utility chase down the center of a marina in the Bay Area was covered with 12"x1.5"x36" removable lightweight concrete covers which worked very well until vandals took great delight in removing them and throwing them into the Bay. It is recommended that removable concrete deck panels be cast with small square blockout holes toward the ends of each panel, through which small diameter steel rods pass. The blockout holes should be large enough to allow a special hook to be inserted and hooked around the steel rod for lifting the panels by marina personnel, but small enough to prevent the insertion of fingers for lifting and removal by vandals.

. . . .

C7.2.1 Gaps in Decking

Commentary:

Gaps wider than ½ inch are not permitted along an accessible route, and should be avoided everywhere else as well. Wider gaps cause problems for persons using crutches, canes and walkers, and can also cause problems for women wearing high heel shoes and small children walking or running barefoot. The shoe heels and small toes catch in wider gaps and can cause a person to trip and fall.

Utility Lines in Walkway Deck Gaps

There is a temptation to leave a wide gap between 2x6 decking at particular places on walkways to allow the placement of a water hose or electrical cord across a walkway. This may be an easy and inexpensive way to place utility lines across a walkway, but the extra wide gaps can cause problems for people using the docks.

. . . .

C7.3 Direction of Decking

Commentary:

Docks are always subject to some degree of torsional twisting. Dimensional lumber decking applied longitudinally will be subjected to torsional twisting, which will impart extra loads on the deck fasteners at the end corners of each decking plank . The planks will be torsionally twisted both clockwise and counter clockwise, which will gradually cause the corner screws or nails to loosen or break, allowing the opposing corners to lift up temporarily, or even permanently, creating a tripping hazard that is dangerous, hard to see, and is in the direct path of people moving on the dock. The application of the decking transversely essentially eliminates these problems. The shorter lengths of decking are perpendicular to the axis of the torsional twisting and the fasteners are subjected to significantly less stress. The corners of each piece of decking are also along the edge of the dock and are essentially out of the normal pedestrian path. The gaps between deck boards provide some degree of traction, and are compatible with the gap requirements on accessible routes.

. . . .

C8.3.1 Fore and Aft Moorings

Commentary:

Fore and aft moorings of this type only work well in clean waterways that are free of any kind of foreign greasy substances that can foul the pickup buoy and stern tie rodes. The handling of fouled buoys and rodes will result in soiled hands, clothes, gunnels and decks. Boaters do not like this, especially when they are unaware of the condition of the moorings, and suddenly have cleanup problems that are usually difficult and messy.

. . . .

C8.4.1.1 Increase of Scope

Commentary:

To illustrate, a heavy chain rode, even when being pulled laterally by a buoy, will hang nearly vertical below the buoy and gradually assume a catenary curve as the rode approaches the anchor. As the buoy is pulled horizontally away from the anchor by a moored boat, any slack will be taken up and a portion of the chain rode will be lifted off the bottom until equilibrium is achieved between the pull on the buoy, the weight of the chain rode and the holding power of the anchor. The weight of the chain rode will have a dampening effect on the forces involved, and will act as a type of shock absorber. In contrast to a heavy chain rode, a nylon rode will be much lighter, have less dampening effect, and require a much larger scope in order not to negatively effect the direction and magnitude of loads imparted to the anchor.

. . . .

C8.4.3 Anchors

Commentary:

<u>Concrete Anchor Blocks</u>

Concrete anchor blocks (not concrete cinder blocks) are relatively inexpensive and can be cast in a variety of sizes and shapes. Pyramid shaped blocks, with a low center of gravity, work well on boat moorings, providing four sloped faces that cause the block to plow into the bottom when dragged horizontally by the mooring rode. Unless they are toppled over, the harder they are pulled, the deeper they dig in. With time, they will also “mud in” and bury themselves into the bottom to some extent, increasing their holding power. However, concrete anchor blocks are only about 60% effective as dead weight anchor blocks. Concrete weighs about 150 pounds per cubic foot out of water, but only about 90 pounds under water, thus reducing their effective dead weight as an anchor block. Concrete anchor blocks are also heavy to transport to a mooring site and require large cranes and equipment to handle and place them. They work better in a soft mud or sandy bottom as opposed to a rock bottom where sliding may occur.

<u>Recycled Heavy Metal Anchors</u>
Recycled heavy metal objects used for anchors include automobile and truck engine blocks, railroad trucks, and railroad tracks. For use in dead load anchors, steel is more efficient than concrete, weighing about 490 pounds per cubic foot out of water, and about 430 pounds under water. Each cubic foot of steel under water weighs about 340 pounds more than concrete, or about 4.8 times as much. Engine blocks work well as anchors, can be ganged together with chains or cables to make a larger anchor mass, but tend to roll around on the bottom more than a concrete pyramid. Railroad trucks are the sets of unitized steel axles and wheels that railroad cars roll on. They are typically available as surplus items, and can be used as they are, connecting the rode directly to the axle. Or, the axle can be cut in the middle to create two mushroom shaped anchors that are heavy and dig in when dragged. Surplus railroad track is also frequently available in sizes ranging from 60 to 90 pounds per yard. The rails can be cut in 4 to 6 foot lengths, cross stacked and welded in layers as required to create a specified weight maze that holds well in deep water situations.

Mushroom anchors are made commercially and are available in various sizes, weights and designs. They hold well in soft bottom conditions, but only hold in one direction. Thus, they should not be used on swing boat moorings.

<u>Pile Anchors</u>
Piles can be used as mooring anchors through the use of full length piles extending up above high water, or as stub-piles driven below the mud line.

Full length piles can be driven and fitted with mooring rings at various elevations on the pile to meet mooring needs at various water levels. However, this tends to corrode the hardware, is not always suitable to the boaters, and the rings and connecting hardware constitute somewhat of a protruding hazard to boats and boaters. Also, in applications where water levels change rapidly, a fixed pile mooring ring might be convenient and easy to use at low tide in the evening, but cause the bow of a moored boat to be pulled under water at high tide during the night. Conversely, a boat tied up at high tide could result in a situation where the boat is hanging from the mooring line at low tide, or the boater cannot reasonably reach the mooring ring at low tide. These kinds of situations can occur in tidal areas as well as rivers and rapidly fluctuating water storage reservoirs. As seen below, the extreme tide ranges along the California coastline increase from south to north. At certain times of the year, a tide change of several feet can occur within a few hours.

Location	Extreme Tide Range (ft)
La Jolla	10.3
San Francisco	11.2
Alameda (San Francisco Bay)	12.0
Crescent City	13.8

An alternative is to provide a floating ring around the pile that rises and falls with the water level, and to which a boat mooring line can be attached. Foam-filled rubber tires have been successfully used in this way. They are tough, provide a good long service life, can be fitted with galvanized eye bolts and rings for mooring boats, and can be size selected for fitting over various types of piles of specific diameters. However, they may not be suitable in certain locations because of appearance and environmental permits may not allow their placement in a waterway.

Short stub-piles can be fitted with galvanized caps, heavy steel rings, lengths of heavy galvanized chain, and rode connectors. The top of the pile is driven a couple of feet below the bottom surface and the rode connected to the chain. Such piles need only be 6 to 10 feet long, depending on the bottom soil conditions. These stub-piles are buried below available oxygen in the water, and will last for many years. Such stub-piles can be made of recycled steel, plastic, wood or concrete piles, provided they are approved for such use in the required environmental and construction permits.

<u>Steel Anchors</u>
Steel anchors with flukes are commercially made and available in various sizes and designs. These anchors may be available as military surplus from the U.S. Navy or U. S. Coast Guard. Single anchors are commonly used to anchor vessels, but only hold in one direction, and cannot, therefore, be used on 360^{o} swing boat moorings.

Spiral steel anchors can be used at locations with suitable bottom conditions. They are installed by divers who screw the anchors into the bottom and connect the mooring rodes. They are light weight relative to concrete and steel gravity anchors, easy to transport and handle, and have excellent 360^{o} holding power for all types of mooring applications. They are commercially available from marine suppliers.

. . . .

C8.4.4 Boat Rafting on Moorings

<u>Commentary:</u>
The rafting of boats on moorings and docks can become a serious problem if not addressed and managed by local authorities. During special events such as boat shows, or during seasonal celebrations such as spring break, floods of people can descend upon a facility or site and temporarily cause serious overloading.

Extreme Example #1: The original mooring system installed in 1973 in Ayala Cove on Angel Island in San Francisco Bay consisted of 39 fore and aft sets of moorings, each designed for one boat. However, over the next 10-15 years, as many an 400 boats sometimes rafted together on those 39 moorings, usually on a holiday weekend such as July 4th. You could literally walk across the cove stepping from boat to boat. Such gross overloading of the mooring system resulted in the dragging of the concrete anchor blocks, and a confusion of the previously organized layout of the moorings in rows by boat length sizes. The problem was eventually addressed by modifying the moorings, and the instigation and enforcement of mooring management by staff working at the cove.

Extreme Example #2: During spring break, thousands of college students typically flock to the stretch of the Colorado River known as Parker Strip to camp, picnic, swim and boat. Hundreds of boats raft together to form a floating bridge across the entire width of the flowing river. This can cause extremely dangerous conditions leading to destruction of equipment, injuries, drownings, and access difficulties for officers who are charged with boating law enforcement, rescue and first aid.

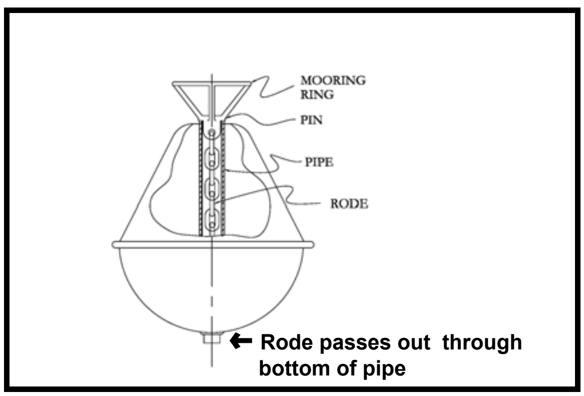
Boat Rafting at Copper Canyon, Colorado River

. . . .

C8.5.1 Connections

Commentary:

A potential trouble spot is the mooring buoy. The mooring rode should pass up through the buoy and connect directly to the bottom of a mooring ring on the top of the buoy. Tension loading will then be transferred from the boat mooring line to the mooring ring on the top of the buoy, and then directly to the rode and down to the anchor. The buoy is neutral regarding transfer of load. The mooring ring must be loosely pinned to the top of the buoy to prevent inadvertent removal of the mooring ring from the buoy. A good and effective design utilizes a buoy manufactured with a galvanized steel pipe that provides a vertical conduit through the buoy. The rode can be passed up through the pipe and connected to the lower end of the mooring ring. The connection and rode can then be lowered back down into the pipe conduit and the mooring ring pinned to the top of the pipe. The connection is out of sight, is protected from the elements, and does not develop a bending moment. Many



Mooring Buoy, Ring, Pin, Pipe and Rode

mooring buoys with rigid solid steel rods and threaded or welded connections between the mooring ring, buoy and rode have failed over the years. Such designs should be avoided.

NOTES

D2.2 Mooring Piles

Commentary:

The decision to provide mooring piles in double berths should be done after careful consideration of the local circumstances, the types of boats being berthed, and the needs, habits and opinions of the potential users. Some will utilize mooring piles to good advantage to secure their boats and will value them as increased protection against damage from other boats entering or leaving the other side of a double berth. Others will insist that the mooring piles are in the way and unnecessarily constrict the open width of a double berth.

A relatively inexpensive enhancement to a mooring pile is a floating mooring ring that rides up and down on the pile with changing water levels. Foam filled rubber vehicle tires of the proper diameter work well for this purpose. They are tough, long lasting, provide a means of securing a boat line (heavy eye-bolts & washers fastened through the tire sidewall), and may act as a bumper between the pile and the boat, depending on the type and size of the boat and the diameter of the pile and tire. Check with the local permitting authority to see if flotation-filled recycled vehicle tires are environmentally acceptable for this type of application.

. . . .

D2.3 Cut-off Elevations

Commentary.

The pile cut-off elevation is a critically important design detail. Marina basins subject to surge, storm waves, sudden inflow of storm and/or flood waters, and water level build up from strong and sustained winds, can be subject to unusual temporary increases in water levels over and above normal seasonal and/or tidal high water levels. If these conditions are not considered and addressed, there is the risk that during unusually severe conditions, marina docks may actually float up and over the top of the guide piles, resulting in severe damage to or loss of the docks, the utilities, the boats, and perhaps even boaters who may be trying to secure and save their vessels. Do not under estimate the importance of sufficient guide pile height. Local conditions may require pile cut-off elevations of 6 to 8 feet above normal high water levels.

The critical importance of accurately addressing pile cut-off elevations cannot be overstated. Marinas with guide piles too short for local conditions have suffered damage and near catastrophe. The public marina at Redondo Beach rose precipitously high during a severe storm in the 1980s when waves overtopped the breakwater and nearly took the berthing system up and over the tops of the guide piles. The concrete piles were subsequently extended several feet. Portions of a private marina in the San Francisco Bay Area actually came off the tops of the guide piles during a springtime situation when (1) high flows of snowmelt fresh water were entering San Pablo Bay through the Carquinez Strait, (2) an unusually high tide occurred, and (3) sustained strong off-shore winds “piled up the water” on the bay. That event also backed water up the Petaluma River and “floated” steel access covers off the storm sewers in Petaluma. High water levels in conjunction with strong sustained winds have also caused serious problems at marinas on the Salton Sea and other lakes that have no natural outlets.

. . . .

D3.1.1 Precast Concrete Piles

Commentary:

Precast concrete piles are not recommended for marina use. In comparison to the extended service life of most dock systems, the expected service life of a precast pile is too short. The cost to remove and replace a damaged pile is very expensive, interrupts marina operations, is highly inconvenient to berth renters, and is easily avoided by using prestressed piles during original construction. Under design loads, the concrete in prestressed piles will always be in compression because of the prestressed steel strands cast into the pile when manufactured. Concrete is strong in compression but relatively weak in tension. It would be an unusual event in a marina that would flex a prestressed concrete pile to the point of damage or failure.

Concrete piles are heavier than other pile types of the same nominal size. For example, a 12-inch diameter round concrete pile weighs about 118# per foot, while a 12-inch steel pile with a 3/8 inch wall thickness weighs 47# per foot, only about 40 percent of the weight of the concrete pile. Therefore, depending on site soil conditions, the weight of the pile may be an important design and material selection consideration.

. . . .

D3.1.2 Square Concrete Piles

Commentary:

If square concrete guide piles are specified, attention to the following details will provide better piles. Concrete piles are usually cast in long horizontal steel beds that provide a smooth form finish on three faces. The fourth face, which is exposed at the top of the form, is finished with a screed and float that often results in a rather rough finish. Such a finish is suitable for a building or bridge bearing pile, but that same rough finish on one face of a marina guide pile will grind away at pile rollers and rub pads, resulting in accelerated wear, maintenance and expense. Specifications must call for a smooth steel trowel finish on that fourth face, and the inspector at the

Rough Face on Square Concrete Pile

casting yard must be diligent to insure that the piles are finished as per the specifications. If jetting pipes and fittings are cast into the piles, care must be taken to clearly identify the top end of the piles so they are not accidentally driven upside down (true for circular and octagonal concrete piles as well).

Additionally, the pile specifications and the inspector should require that during driving operations the trowel finished face of each pile be turned away from main and marginal walkways for the least visibility to provide the best overall uniform pile appearance. All four edges of square concrete piles should be chamfered approximately 1 inch to diminish chipping of the edges and damage to boats and equipment that may come into contact with the piles.

. . . .

D3.2 Steel Piles

Commentary:

Steel piles in salt water applications must be carefully designed with attention to proper steel alloys, coatings and protection systems to reduce pile corrosion. Steel piles are straight, uniform in diameter, relatively easy to drive, have predictable strengths, and can be field welded to meet varying length requirements as site conditions dictate.

In the past, marina designers usually avoided the use of spiral welded steel pipe in lateral loading applications such as marina guide piles. However, with contemporary computerized welding technology, there is no reason not to use spiral welded steel pipe piles in marinas, provided the specifications call for (1) complete penetration welds, and (2) smooth finished pile surfaces free of bumps and burrs that will accelerate pile roller wear and/or cause injury to persons who may come into contact with the piles.

UHMW Rollers on Round Steel Guide Pile

When ultra high molecular weight (UHMW) polyethylene rollers are used with round piles, new rollers quickly wear until they “wear in” to the round pile shape as the rollers gradually assume full contact with the round pile. In doing so, the diameter at the middle of the roller becomes smaller, thus reducing the life of the roller. Additionally, the grinding movement of the pile relative to the pile yoke and rollers tends to work also on the corners of the rollers as they are subject to three degrees of continuous motion that is greatly amplified during severe weather and wind conditions. However, such wear factors are much less on a relatively smooth round steel pile than on a round concrete pile.

Steel piles can be very noisy when docks, boats and rigging clang against them during windy and stormy periods. Marina managers who operate facilities that have steel piles, liveaboards and residential housing nearby, often receive noise complaints. Creative steps may have to be taken to dampen the noise as necessary.

Steel piles are usually coated or galvanized prior to driving, and care must be taken to protect these protective coatings when shipping, handling, driving, cutting and/or welding the piles. Pile caps are a necessity on steel piles to protect against the accidental or intentional deposition of trash, debris, oil, water, human waste, birds and animals into the top of an open pile.

. . . .

D3.3.1 Pressure Treated Wood

Commentary:

Creosote treated piles cannot be used in California waters as per California Fish and Game regulations which prohibit use of oily substances.

Preservative retention rates in pressure treated wood piles must be in accordance with industry standards and recommendations for both salt and fresh water applications. Retention rates are to be specified in pounds per cubic foot in the zone of treatment, which is a ring of wood a few inches deep from the outside skin of the pile. Therefore, it is critically important that bolt holes and cuts not be made in the pile after treatment to avoid exposing the core of a wood pile. If the pile core is compromised by boring or cutting, marine organisms will gain entry and begin to consume the vertical core inside the zone of treatment. This gradually weakens the pile, and the structural strength will not be present when needed. Such compromised piles may appear to be sound, but can fail suddenly and leave the marina dock system in jeopardy.

Pressure Treated Wood Pile

If a pressure treated wood pile is bored, cut or otherwise damaged prior to driving, the integrity of the zone of treatment must be restored using industry recognized techniques.

Wood piles are not uniform in diameter throughout their length, but are generally tapered with the large end being the “butt” and the small end being the “tip”. They are commonly driven “tip first” for ease of driving and keeping the pile on location. It is similar to driving a tapered spike into a large timber. However, a guide pile is subject only to lateral loads, imparting a maximum bending moment in the pile just below the mud line. From a strength standpoint, it is usually better to drive wood guide piles “butt first” in order to locate the largest possible pile diameter at the point where the bending moment is greatest. Considered to be unconventional in the pile driving industry, butt first driving can still be accomplished if called for in the specifications. However, the piles may tend to drift, and the frictional bond between the pile and soil will initially be less. This might be important in soft unconsolidated soils such as San Francisco “bay mud” in which the friction is a major component in holding a pile at a specified elevation. In such soil conditions, the weight of the pile becomes an important design factor as well.

Wood piles are not perfectly straight. Therefore, tolerances must be included in wood pile specifications for use in determining their suitability for use as guide piles. If the piles used are not within specified tolerances, the piles may impart highly undesirable lateral and vertical dragging loads on the marina docks as water levels rise and fall. This can result in severe wearing of the face of the piles and damage to the docks.

Pile yokes for wood guide piles must be designed to operate within clearance tolerances dictated by the straightness of the wood piles.

NOTES

NOTES CONTINUED

E2.4 Utility Line Clearance Above Water

Commentary:

The object is to keep utility lines permanently out of the water to help insure a safe, reliable and durable service life. However, in cases where larger utility lines such as fire lines are required to cross other lines, and where connections and routing of lines get complicated, it may not be physically possible to meet the desired 6 inch clearance above the water surface. However, the goal should be to keep the utility lines above and out of the water to the maximum extent reasonably possible.

There may be applications where it is desirable to place water lines below the water surface to “insulate” them from freezing during the winter months. Such applications in California will probably be limited to relatively small marinas located on high altitude lakes and reservoirs in the mountains.

. . . .

E2.5 Utility Lines Passing Through Structural Members

Commentary:

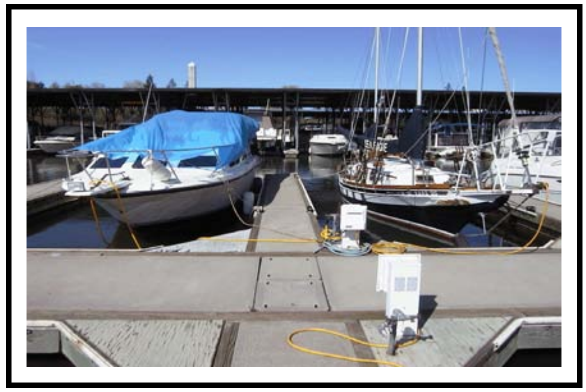
PVC pipe is frequently used for water lines and electrical conduit within the structural frame. Where it passes through framing members, the holes on each side of each member are to be chamfered ¼ to ½ inch. A floating dock is a dynamic system that is constantly moving, and the utility lines within the structural frame will creep back and forth relative to the structural frame itself, thus causing a sawing action to occur that will eventually wear through a PVC water line or electrical conduit. By providing more forgiving edges and smooth points of contact, the life of the utility lines will be extended.

Another solution is the insertion of trumpet-shaped polyethylene plastic inserts into bored holes in structural members prior to insertion of the utility lines. This will provide smooth bearing surfaces, softened wearing edges and long utility service life if the utility lines and inserts are made of materials that have similar characteristics of hardness and wear resistance. If the inserts wear out or are damaged, new inserts of flexible material can be slit along one side, spread open, placed over the utility line, and tapped into the hole with the slit on the bottom side. As it is tapped into the hole, the slit should close up and the insert will lock into the structural member.

E3.5 Risers And Hose Bibbs Per Berth

Commentary:

To keep utility construction costs down, one riser and two hose bibbs are typically provided on a fingerfloat that serves two adjoining berths. Pedestrian traffic on such a fingerfloat is essentially limited to occupants of the two adjoining berths. It is recommended that water hoses be highly flexible in order to lay flat on the deck and be of a contrasting color for visibility.



Utilities on One Side of Fingerfloats

E4.8 Fire Hose Cabinet Placement

Commentary:

A typical installation consists of the placement of fire hose cabinets at intervals of 75 to 100 feet along marina walkways. The interval between fire hose cabinets depends on the type and length of the dock being protected, as well as the length and diameter of the fire hose in the cabinets.

On side-tie docks, fire hose cabinets must be placed such that fire hoses can reach to all points along the length of the dock with appropriate extra hose length to address a fire on any part of a berthed boat.

On docks with fingerfloats, fire hose cabinets must be placed such that at least one fire hose will reach to the end of every fingerfloat, including enough extra length to manage the hose and address a fire on any part of a berthed boat.

Marina fire hose cabinets are available with fire hose racks for 1½ or 2½ inch diameter hoses in lengths from 75 to 125 feet. If we assume for a particular project that fire hose cabinets with 75 feet of hose will be used on a section of dock that has 30 ft fingerfloats, the cabinets could not be spaced more than 90 feet apart. The 75 ft hose could reach 45 feet in either direction and still have 30 feet in reserve to reach to the end of a fingerfloat. As the length of the fingerfloats increases, the intervals between fire hose cabinets decreases unless the length of hose is increased. A balance must be struck between the cost of installation, efficiency of use, and adequate fire protection for a marina.

Each fire hose cabinet should have a lockable access door, break-window for emergency access, a hand-operated valve, at least 75 feet of hose and a nozzle. Fire hose cabinets should be made of aluminum, fiberglass, polyethylene, Kevlar or other durable material that is colorfast and resistant to impacts and ultraviolet deterioration. They are typically red or yellow in color for high visibility and should be marked with reflective tape and materials that “wink” reflected light at night.

. . . .

E4.11.1 Charged Standpipes

Commentary.

There are some important aspects to charged standpipes that must be kept in mind:

- Standpipes are large in diameter, must be located below the deck, and must pass through, or just below, the structural elements of the dock system. This can cause serious design problems with regard to the structural design of the dock, and its performance and reliability during storms and emergencies.

- Standpipes are heavy and must be considered in the calculations for minimum walkway deadload freeboard. In situations where charged fire lines cannot be located along the centerline of a walkway, serious listing problems can occur, especially if there are fingerfloats on only one side of the walkway. In the case of side-tie docks where there are no fingerfloats to stabilize potential listing, it is critical that any charged fire lines be located down the centerline of the dock. Otherwise, the dock tends to roll, especially if the dock is 6 feet or less in width.

- Charged standpipes are subject to freezing in some locations, and may not be in operative condition should a winter fire occur.

- Standpipes charged to 200-300 psi are difficult to maintain. Under the dynamic movements of a floating dock system, these lines are highly prone to joint failures and leaks. They are distinctly different from similar charged water lines on shore in buildings that do not move. And when they do break or leak, repairs are difficult and expensive to accomplish.

- The presence of high pressure lines in close proximity to the public is not without potential safety problems. High pressure leaks are potential hazards, and sudden joint failures can be explosive in nature resulting in personal injury. This is a primary reason that standpipes must be located below the deck to guard against accidental damage, vandalism, and personal injury to the public and marina staff in the event of a sudden rupture.

. . . .

E4.11.2 Dry Standpipes

Commentary:

When considering installation of dry standpipes, the following should be considered:

- Dry standpipes are difficult to inspect for necessary service integrity without charging them and testing for sustained pressures and absence of serious leaks. If not properly maintained, a dry line may or may not be in serviceable condition when needed in an emergency.

- Even if a dry stand pipe is available, a local fire department may or may not use it. They may opt to connect to fire hydrants on shore and roll out their own hoses to fight a marina fire.

. . . .

E4.12 Drafting Fire Hydrants

Commentary:

Drafting fire hydrants should be a last resort option for the following reasons:

- Local fire departments need a reliable supply of clean water for fire suppression. Water drafted from a marina basin is considered to be contaminated with debris, salt and/or particulate matter that can potentially block and/or inhibit the flow of water through pumps, lines and nozzles.

- If potable water supply and fire suppression water are provided through a common supply line, the use of a drafting fire hydrant may contaminate the entire system unless protected by back flow prevention valves. Contamination will result in shutdown of all potable marina water supply until the entire system is purged, tested and restored to required public health standards.

. . . .

E4.14 Strategically Located Calling Device

Commentary:

Acceptable devices include proprietary alarm systems, fire department alarm boxes, or non-coin operated public telephones. Such telephones will also serve as additional security in situations other than a marina fire.

. . . .

E4.16 Foam Suppression Capability

Commentary:

Film forming foams (FFF) may be an appropriate option for fighting various types of marina fires. In the early 20th century, a developing foam technology produced some of the first air foams used to fight fires. By the 1970s, aqueous film forming foam (AFFF) was being produced for use in many fire fighting applications. Such foams are available in low, medium and high expansion formulations.

- Low expansion foam has an expansion rate up to 20:1, and is used for extinguishing liquid and solid material fires. Being a fairly heavy foam, it can be projected from safe fire fighting distances, and is very effective in creating an air-tight film over the fire, cutting off the oxygen supply.

- Medium expansion foam has expansion rates ranging from 35:1 up to 200:1, and is used on a variety of fires including plastics, rubber products (tires) and liquids. It is also useful to extinguish glowing fires as it produces a gas-tight covering over the fire. Mobile foam generators are capable of projecting medium expansion foam up to 100 feet.

- High expansion foam has high expansion rates up to 500:1, and is particularly useful in fighting fires in enclosed situations in buildings and semi-enclosed structures. With its high expansion rate, light weight and low water content, it is highly effective in suppressing flammable gasses and in protecting property and objects from flame and heat damage. It has possible applications in covered berthing structures in which a volume of air space can quickly be “filled up” to starve out the fire, resulting in little or no water damage to boats compared to conventional sprinkler and water suppression systems.

. . . .

E5.1 Electrical Codes

Commentary:

Marina electrical systems typically conform to the requirements of:

☛ Article E555 Title 24
California State Building Standards

☛ NEC Article 555 - Marinas and Boatyards, NFPA 70
National Electrical Code (NEC)
National Fire Prevention Association (NFPA)

☛ NFPA 303 - Fire Protection Standard for Marinas and Boatyards

☛ Local city, county and district codes as applicable

The NFPA codes have been developed and maintained by the National Fire Protection Association, a private association that serves local, state and federal entities. The intent of the codes the association sponsors is clearly conveyed in the last paragraph on page one of the 2002 Edition of NFPA 70, which reads as follows:

> “This Code is purely advisory as far as the NFPA and ANSI are concerned, but is offered for use in law and for regulatory purposes in the interest of life and property protection.”

Therefore, local government agencies typically adopt NFPA codes for application in their respective jurisdictions. However, there may be instances where local codes are more restrictive in some regards to address special conditions. In such cases, the more conservative code requirements should be complied with at a given site.

. . . .

E5.5 Electrical Outlets at Berths

Commentary:

During the 1970s, 80s and 90s, marina electrical guidelines generally recommended one (1) 120 volt 30 amp electrical outlet for all berths under 50 feet, and two (2) 120 volt 50 amp electrical outlets for all berths 50 feet and over. However, with the growing cost and demand for electrical power throughout California, it is now prudent to emphasize the recommended minimum level of electrical service, and encourage marina electrical designers to determine the actual power needs for the types and sizes of boats to be berthed in a marina. The costs of more electrical power are not limited to just the power consumed by the boaters. It also includes larger wire sizes, greater equipment capacity, more transformers, larger wire/cable chase ways in the dock systems and increased installation and maintenance costs.

In some larger marinas that provide berths for larger boats, much higher levels of electrical power are being provided. Large yacht manufacturers have indicated the need for shore power at the following levels:

50-70 foot berths	two 50 amp outlets
70-80 foot berths	one 50 amp outlet, and one 100 amp outlet
80+ foot berths	two 100 amp outlets

These larger berths and their reasonable levels of electrical power demand are beyond the scope of these guidelines. In such cases, check with local building officials, power companies and recognized marina electrical experts who can advise and assist in the determination of actual needed service levels. Keep in mind that such elevated levels of electrical power service greatly increase the construction cost of each such berth as well as the consumption of power. Such berths should be sub-metered to identify the actual power consumption and cost.

In determining the projected electrical power demand for a marina, conservation of electrical power must be balanced with the actual power demands of boats that will occupy a marina. Larger boats are now being fitted with electrical equipment and features far beyond what is typically found in a residential home, including:

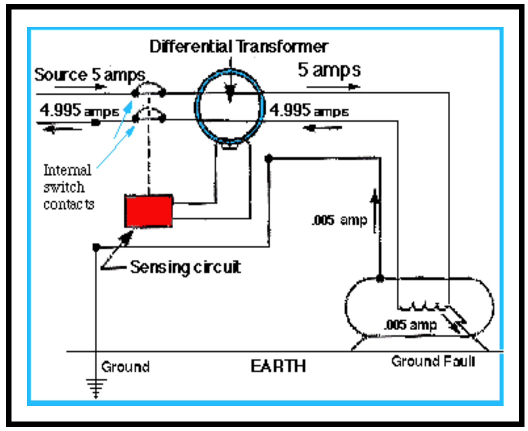
- 120 volt GFCI protected outlets
- televisions (each compartment)
- stereo systems
- DVD players
- digital satellite receivers
- hydro-jet bath tubs
- ventilation systems
- telephones
- microwave / convection ovens
- food processors
- pressurized water systems
- washers and dryers
- pumps (for fuel, water, sewage, etc.
- communication systems
- air compressors
- automatic shutters, doors, hatches, etc.
- lighting, internal and external
- telephones
- ice makers and chippers
- refrigerators
- freezers
- water heaters
- saunas and hot tubs
- stoves, ovens and ranges
- coffee makers
- trash compactors
- heating systems
- air conditioners
- vacuum systems (for cleaning)
- transformers
- dehumidifiers
- movie theaters

Marina electrical issues should be specifically addressed during the preliminary design phase of a marina project, and a competent marina electrical designer should be a member of the design team. In designing the electrical system, consideration must be given to the pro and con effects of the proposed marina layout, length of feeder lines, voltage drops, number of outlets per circuit, and the estimated power requirements of the types and sizes of boats that will occupy the marina. This is essential for both new and altered marina projects.

. . . .

E5.7 GFCIs Not Recommended For Berth Outlets

Commentary:



Laboratory tests by various agencies and industries over the years have shown that 5 milliamps (0.005 amp) is a safe and appropriate threshold for use in designing GFCIs to protect people. In a potentially wet environment around boats and boat docks, currents over 5 milliamps can cause injury or death to a person who is adequately grounded. Even small currents can cause a person's heart to stop, resulting in death from electrocution or electrical shock drowning if they are in the water. Therefore, GFCIs with tripping levels higher than 5 milliamps ***must not*** be used in a marina with the thought of protecting people.

However, the installation and maintenance of 5 milliamp GFCIs often results in nuisance tripping, a common problem that usually leads to frustration for boaters, maintenance staff and marina management. It can be caused by moisture problems in the devices themselves, "dirty boats" with sub-standard electrical systems, and electrolysis problems.

The primary goal of a marina owner/operator is to make a profit. However, satisfied berth renters is an important element in achieving that goal, and the installation of GFCIs that do not provide the results hoped for can lead to serious problems between marina staff and clients that are difficult to overcome. The resolution of such problems is usually expensive for both sides and can take lots of time to resolve to mutual satisfaction.

The presence of GFCIs in a marina can actually result in a false sense of security for not only the boat owners but for marina maintenance staff as well. There are far more maintenance workers who are harmed by marina electrical systems than boaters. The knowledge that a GFCI exists in a marina electrical outlet typically carries with it the assumption that it is working properly and will guard against both harm to persons and damage to equipment. A false sense of security can be dangerous for all concerned.

The installation of GFCIs carries with it the imperative necessity to test, calibrate, maintain, repair, and/or replace the devices on a regular basis. Such demands on a marina budget can become a low priority and the performance of these important safety practices gets delayed or omitted in lieu of other pressing matters. However, if GFCIs are used, marina management must commit to:

- planning, managing and supervising a program of regular and systematic testing of the devices;
- training staff to use approved testing equipment and procedures;
- procuring and using appropriate testing equipment that will actually create a ground fault to determine if the device is working properly, and trip at the design ground fault amperage of not more than 5.0 milliamp;
- using, maintaining and updating correct procedures;
- maintaining accurate inspection and maintenance records; and
- informing, encouraging and requiring boat owners to inspect, correct and maintain the electrical systems on their boats.

. . . .

E5.9 Sub-Metering of Marinas

Commentary:

The installation and use of kilowatt hour sub-meters in marinas has a dramatic impact on electrical power consumption. A documented field study funded by DBW, executed by *ADCO* Electric, Inc. of Santa Cruz, CA, and published in 1995, shows that sub-meters will reduce actual power consumption by nearly 50 percent. The field study is titled Report on Documented Field Study of Actual Electrical Power Use in California Small Craft Harbors, dated May 1995.

Utilization of sub-meters in a marina has a significant effect on high peak use as well. The field study revealed that the highest recorded peak amps, which reflect worst condition use, were also reduced by nearly 50% when sub-meters were in operation.

Another benefit of sub-metering is a significant conservation of energy, along with a reduction in monthly operation costs. It is typical for an existing non-sub-metered marina to realize a 60-70 percent reduction in annual electrical utility costs after sub-meters are installed.

Example: The public marina in Antioch, California installed sub-meters in the 1990s, and quickly realized a 66 percent reduction in power consumption. The marina’s electrical bill dropped from $36,000 per month to approximately $20,000, of which $14,000 is recoverable from the boaters under CPUC rules for sub-metering marina boat slips.

Prior to installation of the sub-meters, the cost of electrical power was included in the monthly berthing fees. If such monthly berthing fees are based solely on the length of the berth, inequities occur. For example, it is well known that larger boats use disproportionately more electrical power than smaller boats as they typically have more and bigger equipment. But does a ***typical 60 foot boat*** use twice as much power as a ***typical 30 foot boat***? Obviously, there are variables involved here. But what does not vary is the length of berths and the marina basin water surface areas required for berths of various lengths. A single berth for a 30 foot power boat requires a total area of 960 square feet, including the water area in the berth, the fairway in front of the berth, and the main walkway and fingerfloat deck areas that define the berth. However, a single berth for a 60 foot powerboat requires a total area of 2,628 square feet, more than 2.7 times the required area of the 30 foot berth (see Table B-7). The utilization of sub-meters removes the cost of electrical power from the inequitable berth length/area equation, identifies actual power consumption, allocates costs to the actual users, and encourages significant savings of electrical power and money for both marina operators and their customers.

Sub-metering will also result in a decrease in fire hazards by encouraging boaters to unplug or turn off unattended/unnecessary heaters, lights, air conditioners, refrigerators, freezers, trash compactors, battery chargers, radios, TVs, computers, and other power equipment and devices.

Another positive impact of sub-metering is the potential increase of the effective capacity of older electrical systems on existing marinas. Aging marinas experience the growing demand for more power as more electrically demanding boats occupy the berths. Marinas that allow liveaboards and overnight/weekend occupation of berthed boats experience increased power demands. This results in a growing frequency of circuit breaker tripping, maintenance, repair and/or replacement. The installation of sub-meters has an immediate impact on the boater’s perspective on the cost of power and its impact on their wallets. Typically, wasteful use of power is greatly reduced, making capacity available to meet legitimate increases in demand and extending the useful life of existing electrical systems.

In California, prior to 1993, only private marinas could install and operate sub-meters. However, Assembly Bill 2108, signed into law on October 11, 1993, specifically allowed public marinas to sub-meter as well. Along with this legal approval came the requirement to comply with rules and regulations dictated by the California Public Utilities Commission (CPUC). Strict adherence to the rules is mandatory, requiring marina operators to collect monthly fees, independent of the monthly berthing fees, to offset the costs of installing, maintaining, replacing, reading and billing related to the sub-meters and other related electrical equipment. The monthly fees are based on single-phase service, polyphase service, and energy charges per kWh during summer and winter periods. Check with your local electrical utility provider to obtain a copy of their rate schedule.

Authorization to sub-meter a marina is conveyed through a document known as Rule 18. All electrical power utility companies in California have a Rule 18, or variation thereof. As an example, the following excerpt is taken from the Pacific Gas and Electric Company Rule 18, page 3:

“C. FURNISHING AND METERING OF ELECTRICITY

3. MARINAS AND SMALL CRAFT HARBORS

Notwithstanding any other provision of this rule, PG&E will furnish electrical service to the master-meter customer at a privately or publicly owned marina or small craft harbor. The master-meter customer may sub-meter individual slips or berths at the marina or harbor but may not sub-meter any land-based facility or tenant.

If the master-meter customer sub-meters and furnishes electricity to individual slips or berths, the rates and charges to the user must not exceed those that would apply if the user were purchasing such electricity directly from PG&E."

To illustrate the actual benefits of utilizing marina electrical sub-meters, the field study included a marina that had two separate berthing areas: one sub-metered, the other not metered; one with recreational boats only, the other with commercial fishing boats only. Over a period of one year, the two berthing areas had nearly 100% occupancy, and were monitored using separate utility company meters. Over the study period, ***the unmetered 144 recreational boat berths used 246% more electrical power than the sub-metered 228 commercial fishing boat berths***. Even considering that there may be different patterns of electrical power consumption between recreational boats and commercial fishing boats, the fact that 37 % fewer recreational boats used 246 % more power than 228 commercial fishing boats is still a very significant indication of the impact and positive benefits of sub-meters in a marina.

If sub-meters are installed in a marina, they must meet the requirements of CCR Title 4, Division 9, Chapter 1, Article 2.2. Two of the more important requirements address the location and height ranges of the sub-meters with regard to personnel who read, calibrate, maintain, repair and replace sub-meters. For details, see the above cited code or contact staff at the Division of Measurement Standards, California Department of Food and Agriculture.

. . . .

E5.11 Electrical Power Centers (boxes, pedestals and towers)

Commentary:

Individual power centers are usually low in profile, 12" to 16" high, have two electrical outlets, two breakers, one low voltage (7-watt) fluorescent deck/outlet light with a photo-electric cell, fuses if required, and perhaps telephone and cable TV jacks. The power centers can be mounted on posts or power pedestals to raise the outlets to more convenient heights for boater use and staff maintenance. They are often mounted in the front face of a dock storage box used to store supplies, materials and equipment for operating and maintaining a boat.

Power Center and Separate Water Supply

When potable water lines and hose bibbs are also provided in the face or sides of dock storage boxes, safety problems can develop if a water line leaks or breaks, creating a wet environment. It is not recommended that electrical power outlets and water supply lines and hose bibbs be installed in the same storage box. The boxes are tall enough to easily be struck by the bow of a boat entering the boat slip. Such an impact can punch holes in the back of the box, rip it free of its attachments to the decking, and/or break the water line within the box or below the deck. It is advisable to keep the water service completely independent of and separated from the electrical service for safety, and ease of repair and maintenance.

Storage Box with Power & Water Supply

Electrical power pedestals are usually taller than storage boxes, and can be up to 60 inches high, have greater utility capacity, and can provide a full service package including electrical power, telephone, cable TV, low-voltage lights, potable water lines and hose bibbs. Care should be taken to locate such pedestals so as to avoid the storage box utility problems described in the paragraph above. Power pedestals can usually house up to four electrical outlets, breakers for each outlet, two TV jacks, two telephone jacks, two hose bibbs, larger low-voltage fluorescent lights, and two kilowatt hour electrical submeters. Power pedestals should probably be used on all accessible boat slips because of height and reach-range requirements that apply to all dock features and components except cleats and other boat securement devices.

Full Service Utility Tower

An operational problem may occur if boaters “lasso” and tie up their boats to tall power pedestals. This can impart lateral boat line loads that the pedestals are not designed to carry. When waves are generated within a marina basin, whether from wind or boat traffic, a line secured high up on a pedestal can cause a large bending moment in the pedestal resulting in damage to the utility systems, pedestal, anchor bolts, and decking under the pedestal. Here again the location of power pedestals and their orientation to the berths is important to safe and convenient operation and trouble-free service.

NOTES

F1.1 Piers

Commentary:

There may be instances where piers are multi-use and a higher ULL would be necessary. Where trucks, maintenance vehicles, rescue vehicles and other heavy loads will be on a pier, a ULL of 100#/ft^2 may be required.

F2.1 Minimum Number of Gangways

Commentary:

The minimum number of gangways for a specific marina is a complex matter that is influenced by the number of berths, the inventory of berth sizes, the shape and size of the marina basin, the characteristics of the marina basin shoreline, the location of shoreside facilities, and the requirements of the local fire chief and regulatory permitting agencies.

From a fire safety perspective, it is always desirable to have a minimum of two emergency avenues of exit, i.e. two gangways serving each separate section of berthing in a marina. However, it is often impractical, economically infeasible, and environmentally undesirable to do so. Additional gangways will often reduce the number of berths in order to provide space for another gangway, will double the cost of providing and maintaining the gangways, and will cause problems in obtaining environmental permits. In California coastal waters, permitting agencies such as the Bay Conservation and Development Commission (BCDC) consider a gangway over water to be “bay fill” that diminishes the water surface area which in turn is considered to be a negative impact. Therefore, the decision as to the minimum number of gangways in a specific marina is subject to the parameters of the particular site and the collective wisdom and influence of the parties involved.

F2.3 Loadings Transferred from Gangways to Docks

Commentary:

The live load (LL) transferred from a gangway to a floating dock may be calculated on the basis of 20#/ft^2 applied to the total surface area of the gangway deck, the same ULL applied to low traffic area floating docks. This will result in the LL being transferred from the gangway to the dock as a moving point load via an axle and two wheels on the lower end of the gangway, including both gangway DL and ULL. The two gangway wheels roll back and forth on the surface of the dock as water levels rise and fall. If a gangway serves a high traffic dock area with a higher required ULL, that ULL should be used to calculate the LL transferred from the gangway to the floating dock.

The more critical situation typically occurs during low water periods (i.e. low tide) when the relative position of the lower end of a gangway is closer to the edge of a floating dock. If it is necessary to have a gangway “land” near the edge of a floating dock, supplementary flotation may be necessary under the edge of the dock below where the gangway rests. This extra flotation might be necessary to maintain safe and required freeboard levels and cross slopes under various loading conditions.

Full LL on a gangway probably will not occur very often. Therefore, to transfer the full gangway structural design ULL of 50#/ft^2 to the gangway-supporting docks would result in “unloaded” docks that ride unnecessarily high in the water for long periods of time, causing excess dock freeboard. This causes localized differences in freeboard and problems with cross-slopes, especially along those areas that are part of an accessible route.

The above reduction provides a reasonable consideration of both typical and extreme conditions without compromising safety. In the event that a gangway was loaded with the full design ULL of 50#/ft^2, this short-term load would spread within the dock system. Freeboard would diminish, pontoons would be forced deeper into the water, and the dock’s structural frame would cause the load to spread to other nearby pontoons that would pick up portions of the gangway load. Any well-designed and constructed dock system should be capable of supporting additional short-term loads that temporarily reduce the design freeboard. Once the higher than normal loads are removed, the dock recovers and freeboard returns to normal levels. This dynamic action described above can only be tolerated if the minimum freeboard requirements for floating docks are still complied with.

. . . .

F2.5 Minimum Clear Width of Gangways

Commentary:

Nominal widths of gangways typically vary from 36 to 60 inches, depending on location, expected traffic loads, gangway lengths and special needs.

If gangways are too narrow, they can be awkward to use, and people moving up and down a gangway at the same time cannot pass safely and comfortably, particularly during low water periods when gangway slopes are greatest. Conversely, if gangways are too wide, the handrails on each side cannot be used at the same time if desired and needed. This is important to people with small children, senior citizens, persons with disabilities, etc.

Considering the requirements for 1¼ to 1½ inch handrail diameters, 1½ inch clearance between the handrail and the gangway railing posts or other supporting elements, the 36 inch minimum clear width, and the width of the railing structure, the total overall minimum width of an accessible gangway will be about 48 inches.

. . . .

F2.6.2.2 Maximum Gangway Handrail Height

Commentary:

It is recommended that gangway handrail heights not exceed 35¼ inches on gangways that exceed a maximum slope of 3:1, measured perpendicular from a gangway deck surface to the top of the handrails. As a gangway (and the attached handrails) rotates vertically with changing water levels, the perpendicular height of the handrails remains constant. However, as seen in the table below, the vertical height from any point on the top of the handrail to the gangway deck progressively increases as the gangway slope increases. At zero slope, a 35¼ inch handrail height is both perpendicular to the deck and vertical. But at a slope of 3:1 the vertical dimension increases from 35.25 to 37.2 inches, and at 2½:1 it increases to 38.0 inches. So at maximum allowable slopes, the vertical dimension is still at or below the 38 inch maximum allowable height.

If, however, the top of the handrail is 38 inches high measured perpendicular to the gangway deck, the vertical dimension increases to 40.1 inches at a 3:1 slope, and 40.9 inches at a 2½:1 slope, both well above the 38 inch maximum allowable. Therefore, it is recommended that handrails not exceed a maximum height of 35.25 inches on gangways that exceed a 3:1 slope.

Table App-2 Gangway Handrail Heights

Slope ▼	**Perpendicular Height to Top of Handrail from Gangway Deck** (inches)									
	34	34.5	35	35.25	35.5	36	36.5	37	37.5	38
	Vertical Height to Top of Handrail from Gangway Deck									
3:1	35.8	36.4	36.9	37.2	37.4	37.9	38.5	39	39.5	40.1
2½ :1	36.6	37.2	37.7	38	38.2	38.8	39.3	39.9	40.4	40.9

. . . .

F2.7 Gangway Non-Skid Deck Surfaces

Commentary:

Traction can be a characteristic of the decking material itself. For example, extruded aluminum decking frequently used for gangway decks typically has patterns of small continuous raised ridges that provide good traction. Such decking can be enhanced by running the decking material through a knurling roller that imparts small v-grooves across the ridges at close intervals. This interrupts the continuous ridges, resulting in a multiple-row tooth-like surface that provides excellent traction. Such serrated metal decking provides good service, but if manufactured from relatively "soft" aluminum alloys, the aluminum serrations will probably wear smooth in high traffic areas within a few years. This can result in loss of traction and slick conditions when wet and when at steeper slopes.

Various deck coatings can provide excellent traction on both new and altered gangways. However, attention to detail during application of the coatings is critical. Consideration must be given to temperature, humidity, surface preparation, porosity of the decking, product selection and adherence to manufacturer's recommendations. Also, coated gangways must be touched up or re-coated periodically in order to maintain safe and suitable traction and appearance. Gangway coatings usually consist of binder base materials such as acrylic resin or latex that contain fine aggregate materials such as silica sand, Carborundum, ground walnut shells or other hard durable materials that provide a long-wearing non-slip surface. Keep in mind that as the binder material wears, the incorporated aggregate material will progressively come into view, sometimes resulting in gradual changes in surface texture and color.

Characteristics of a suitable deck coating should include flexibility, good bonding, and resistance to deterioration from UV and minerals in local water. Darker colors are probably more resistant to UV damage, but also absorb the most heat from sunlight during the spring, summer and fall boating season. The presence of salt, alkali and other mineral components may be detrimental to the integrity and service life of the coating, and ultimately to the gangway structure. Flexibility is critical to enable the coating to bend and flex in accordance with the dynamic nature of a gangway, and to properly respond to thermal expansion and contraction of the gangway during daily and seasonal temperature cycles.

On new construction, gangway coatings typically are applied in fabrication shops under controlled conditions. However, field application of gangway coatings should be performed either (1) on shore after temporary removal of a gangway, or (2) in place over water using approved procedures to repair and/or remove existing coatings and apply new materials. Containment methods must be employed to catch, contain and remove any coating materials, new or removed, that could enter the water as chips, dust, vapor, spray, drips or spills.

How aggressive a surface texture to provide on a gangway is a local judgment call that must be tempered by local conditions and consideration of the users. If a surface is too smooth, it will not provide adequate traction on steep slopes when wet. If too aggressive and rough, it may be suitable to boot-wearing persons engaged in commercial fishing, but be totally unsatisfactory for young children wearing shorts who are prone to falling down and scuffing their hands and knees. Also, some senior citizens who are only able to slightly lift their feet when walking will sometimes have problems with their shoes catching on surfaces that are too aggressive. Additionally, the rougher the surface, the faster the high points wear, and the more difficult it is to keep clean and serviceable.

The color of a gangway decking is important. Metal decking should be lightly blasted to remove the shine that can be overly bright on sunny days. Such light blasting removes oil and fabrication residue, and is excellent preparation for application of deck coatings. Dark colors are to be avoided as they become hot during summer days, and can actually burn bare feet. The absorbed heat from dark surface colors also can have a negative impact on adhesives that bond coatings to the gangway decking material.

The use of truck bed sprayed-on coatings is a possible solution for gangway coatings that can be applied either in a shop or in the field. These durable polyurethane based coatings have become very popular for use in pickup trucks. They are available in a number of colors and when applied to a gangway, can provide traction for pedestrian traffic as well as protection against corrosion. If a more aggressive surface texture is required, mineral aggregates can be mixed into the polyurethane to provide various degrees of surface traction.

F2.8 Cleats on Gangway Decks

Commentary:

In cases where cleats are considered necessary on a gangway deck, the cleats should not extend across the full width of the gangway, but be confined to a strip down the center of the gangway. The length of such cleats should be determined on the basis of the axle lengths of the carts and dollies expected to be used on specific gangways. In general, a rule of thumb for cleat lengths on narrow gangways (not over 48 inches wide) is about 40% of the clear width of the gangway. On a gangway that has a clear width of 48 inches, the maximum length of the cleats would be about 19-20 inches. This will provide a “cleatless lane” down each side of the gangway deck for the unobstructed passage of equipment, carts and dollies that roll on wheels, but still provide cleats for specified needs.

Cleats @ 12" Centers Across Gangway Deck

F2.9.1 Maximum Gangway Slopes — On Coastal Waterways
F2.9.2 Maximum Gangway Slopes — On Inland Waterways

Commentary:

Gangways steeper than 2½:1 are difficult for many persons to use, including children, senior citizens and persons who are carrying supplies and equipment to and from their boats. Steep gangway slopes are particularly troublesome if a gangway remains at a steep slope for long periods. Such could be the case at an inland lake, reservoir or river where late summer, fall and winter water levels can remain seasonally low for several months, or even for years during prolonged droughts.

Maximum gangway slopes are influenced by water level fluctuations, size of marina basins, number of berths, shoreline topography, marina berthing layouts and gangway lengths. At some sites, constraints on shore and on the docks can dictate rather short gangways that are steep at low water levels. The 2½:1 maximum slope guideline acts as an umpire in the best interests of both landside and dockside constraints, and the safe long-term usability of a gangway.

. . . .

F2.13 Gangway Utility Connections

Commentary:

The utility connections at the top and bottom end of a gangway must flex with the changing gangway slope as water levels rise and fall, and must be highly reliable to provide public safety and insure against leaks, breaks and failures that would result in contamination of the water in a marina basin. The materials used for these critically important utility components must be highly resistant to corrosion, non-hardening from years of bending cycles, UV resistant and suitable for the utility service they provide.

A typical design for gangway utility lines includes loops at both the top and bottom of a gangway to provide the slack necessary to avoid developing tension in the lines that could result in damage and/or failure. The dead weight of the lines and any fluids they may be carrying, causes additional forces to be transferred to the actual connections. Therefore, the use of “line slings” or “locking nets” made of fine stainless steel cable material will relieve the connections from supporting the weight of the lines as it is transferred to the slings or nets and on to the pier, gangway or dock.

. . . .

F2.14 ADA and ADA-ABA Reference Numbers

Commentary:

Reference numbers in the following sections refer to specific requirements in ADAAG which was edited and re-published by the Access Board in 2004 under the new title ADA-ABA, a document that combines the accessibility guidelines from the Americans With Disabilities Act (ADA) with the accessibility guidelines from the Architectural Barriers Act (ABA). At the time of publication of this 2005 Layout & Design GUIDELINES for Marina Berthing Facilities, the ADA-ABA is being reviewed by the federal Department of Justice, the enforcement agency for these federal accessibility guidelines. Until ADA-ABA is officially approved by DOJ, ADAAG is still in effect and must be complied with.

See Appendix B for a side-by-side comparison table of the complete text of both ADAAG 15.2 and ADA-ABA 1003 and 235. The cited sections in both documents address particular accessibility guidelines for recreational boating facilities.

. . . .

F2.14.6 Alteration or Replacement of Gangways

Commentary:

An example of such a case would be the provision of additional marina berths of a different size or with different utility services. The addition of a completely new marina component such as a fuel dock or other new service would constitute a change in a primary function and could possibly require a change in the length of a replaced or altered gangway.

F2.14.7 Disproportionate Cost to Lengthen Gangways

Commentary:

Department of Justice regulations for Title III of the ADA deem the cost of lengthening a gangway to be disproportionate when the cost exceeds 20 percent of the cost of the overall marina alteration.

NOTES

NOTES CONTINUED

G1.2 Minimum Number of Parking Spaces

Commentary:

The minimum parking requirement is to be utilized where self-parking is provided for marina patrons, including persons with disabilities. This level of parking is specifically for support of the users of the boat berths, and is not intended to address the parking needs of visitors, offices, restaurants, concessionaire operations, retail businesses, chandleries, fishing piers, boat launching ramps, park and picnic areas, government agencies and other entities and activities that require vehicle parking at a marina.

. . . .

G1.2.2 Parking Spaces for Commercial Fishing Boats

Commentary:

Where mixtures of recreational and commercial fishing boat berths are provided in marinas, the minimum parking capacity requirement for commercial fishing boat berths is higher because of additional parking demand for crew members, support vehicles (supplies and equipment) and others typically involved in commercial fishing operations.

. . . .

G1.2.3.3 Types of Accessible Parking Spaces

Commentary:

Designated barrier-free spaces are to be provided for each type of parking that is provided. It is not intended that this will increase the number of required accessible parking spaces. For example, at a marina with 365 parking spaces, the required minimum number of accessible parking spaces is eight (8), as per Table G -1. Where there is little demand for van and recreational vehicle parking, a reasonable parking plan would include six (6) accessible single parking spaces, one (1) van space, and one (1) recreational vehicle space, for a total of eight (8).

. . . .

G1.3.1.1 Option for Reduced Width of Van Accessible Parking Space Access Aisles

Commentary:

The normal overall width of a van accessible space is 16 ft; 8 ft for the van parking space and 8 ft for the adjacent access aisle. This option will maintain the overall 16 ft width, but permits the parking space to be widened to 11 ft, and the access aisle to be reduced to 5 ft, the normal access aisle width for other accessible parking spaces. This option has two advantages:

1. It eliminates the problem of people mistaking an 8 ft wide access aisle for an 8 ft wide parking space, particularly in the rain at night when pavement markings, stripes, etc. are difficult to see. The fine for parking in an access aisle is the same as for parking in an accessible parking space without a legal handicap placard or license plate sticker.

2. The lift provided on vans is typically located on the passenger side of the van. Depending on the circumstances, the access aisle may be on either the right or left side of the parking space. An example situation is where two accessible parking spaces share a common access aisle between them. The access aisle will be on the right side of one space and on the left side of the other. If one or both of the parking spaces is designated "van accessible" and made 11 ft wide, the extra width provides "wiggle room" allowing a driver to park a little more to the left or right in order to enhance exiting or entering the parked vehicle and utilizing the access aisle.

Van accessible parking spaces are not reserved, and may be used by anyone with a proper placard or license plate sticker. The intent of the designation is to inform van drivers that the spaces are particularly suited for parking vans.

. . . .

G1.4.3 Special Local Requirements for Parking Areas

Commentary:

For example, one major California city has a "shade requirement" that 25 years after completion of a new paved parking area, 50 percent of the parking area must be in shade at noon on July 1st. This requirement cannot be met without the provision of landscaped islands provided throughout the parking areas.

. . . .

G2.2 Unisex Restroom Facilities

Commentary:

Unisex facilities are particularly helpful for families with small children. Also, adults who are injured, disabled, elderly or otherwise in need of assistance from a spouse or partner of the opposite sex, will greatly benefit from the provision of unisex toilet facilities. Such facilities help solve various cultural and social issues that would otherwise be problems for certain users and marina operators.

. . . .

G2.4 Minimum Number of Restroom Toilet Fixtures

Commentary:

Common sense and practicality must prevail in determining how many restroom buildings are necessary at a given marina, the spacing distances between restroom buildings, how many toilet fixtures to provide in each restroom building, how many toilet stools in combinations with urinals to provide in men's restrooms, the number of berths to be served by each restroom facility, and how to provide unisex restroom facilities in place of, or in combo with, conventional men / women toilet compartments.

. . . .

G2.5 Ultra-Low Flush Toilets (ULF)

Commentary:

Following the passage of the 1992 Energy Act, California is one of about 40 states that has developed regulations that require ULF toilets be used in all new buildings, as well as in remodels and expansions.

. . . .

G2.6 Sanitary Public Restrooms

Commentary:

The architectural design of public restrooms in marinas should take advantage of the array of new and innovative building materials that provide safe, sanitary, durable, attractive and cost effective service to the boating public. The architectural motif of such facilities should be appropriate for the site and compatible with existing structures and buildings. Material selections should address the wet environment typical in public restrooms which are often washed out with water hoses. Porous materials such as concrete floors should be avoided to guard against cultivating molds and bacteria that thrives in a wet environment. Ceramic tiles on the floors and walls are durable, easy to seal and keep clean, are vandal resistant to painting and marking, and are fairly easy to chip out and replace when damaged. Maintenance of tile floors may be a little more expensive than bare concrete floors, but they are more user friendly, have a better appearance, can brighten the interior of a restroom and are probably more sanitary.

. . . .

G3.2 Boat Launching Facilities

Commentary:

A boat launching facility located deep inside a marina fairway in which live-aboard boats are berthed is a potential social problem. People on the live-aboard boats may not be thrilled with the Saturday or Sunday 5:00 AM launching crowd during salmon season!

Also, boat wakes from boats leaving and returning to a boat ramp located deep within a marina causes additional wear on docks, piles, pile rollers, and disturbs boaters who are occupying their boats.

NOTES