PIER INFRASTRUCTURE ASSESSMENT STUDY

Phase 3 - MAINTENANCE GUIDELINES

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City of Santa Monica

Santa Monica Pier Maintenance Guidelines

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INTRODUCTION

This document is intended to provide guidance for routine periodic inspection and maintenance of the Santa Monica Pier infrastructure. It is assumed that routine visual inspections will be carried out by Pier Maintenance Staff. Where specialized training or certification is required for specific inspections or testing that requirement is stated. The frequencies of inspection given are always stated as the maximum time interval recommended. Where local experience indicated more frequent inspections are warranted, then the local experience should be followed.

PIER STRUCTURE

<u>Timber Sub-structure</u> (See Figure 1)

The timber sub-structure consists of timber piles, timber pile caps, and timber pile to pile bracing. Within the Municipal Pier the bracing is a combination of horizontal and diagonal bracing. Within the Newcomb Pier the bracing is primarily horizontal. The vast majority of the timber substructure is on the sand and not subject to daily tidal inundation. However, some of the timber sub-structure is offshore and subject to tidal and wave action. It was the recommendation of the upgrade studies to replace all of the off shore timber sub-structure with concrete sub-structure. Until the replacement with concrete, the recommendations in the sub-section titled "Offshore Timber Piles" are applicable.

Onshore Timber Piles:

Deterioration of timber piles is generally caused by attack of insects or fungi or by physical damage. Pressure treatment is applied to piles to resist the insect and fungal attack; however, splits can breach the treatment layer, and years of exposure can dissipate the effectiveness.

For the onshore piles, marine organisms are not a concern, however, there are other insects such as termites and beetles that will eat wood if the treatment is breached or has become ineffective. Insect damage can be identified by holes in the surface of the wood or hollow sounds when striking the wood with a hammer.

Three categories of wood-decay fungi are: white rot, which tends to bleach the affected wood; brown rot, often termed "dry rot," which produces a brown, crumbling type of decay; and soft rot, which softens the wood. Slight strength reduction of infected wood can be caused by stain fungi, which produce bluish black to steel gray or brownish discoloration of the wood. Molds also produce a discoloration of the wood surface and are regarded as merely a blemish, but their presence indicates that conditions may be favorable for decay organisms. Most wood-destroying fungi require damp conditions for growth. A form of fungi observed at Santa Monica Pier is characterized by a fuzzy like fibrous surface.

Physical damage is usually in the form of cuts, gouges or abrasion. These types of damages, unless they are very deep, generally do not significantly affect the strength of the pile. The primary problem with physical damage is the breaching of the pressure treatment layer which allows insects or fungi access to the interior of the pile. Physical damage may also be in the form of bolt holes or cut ends.

A listing of piles with a specific rating can be obtained by accessing the GIS database.

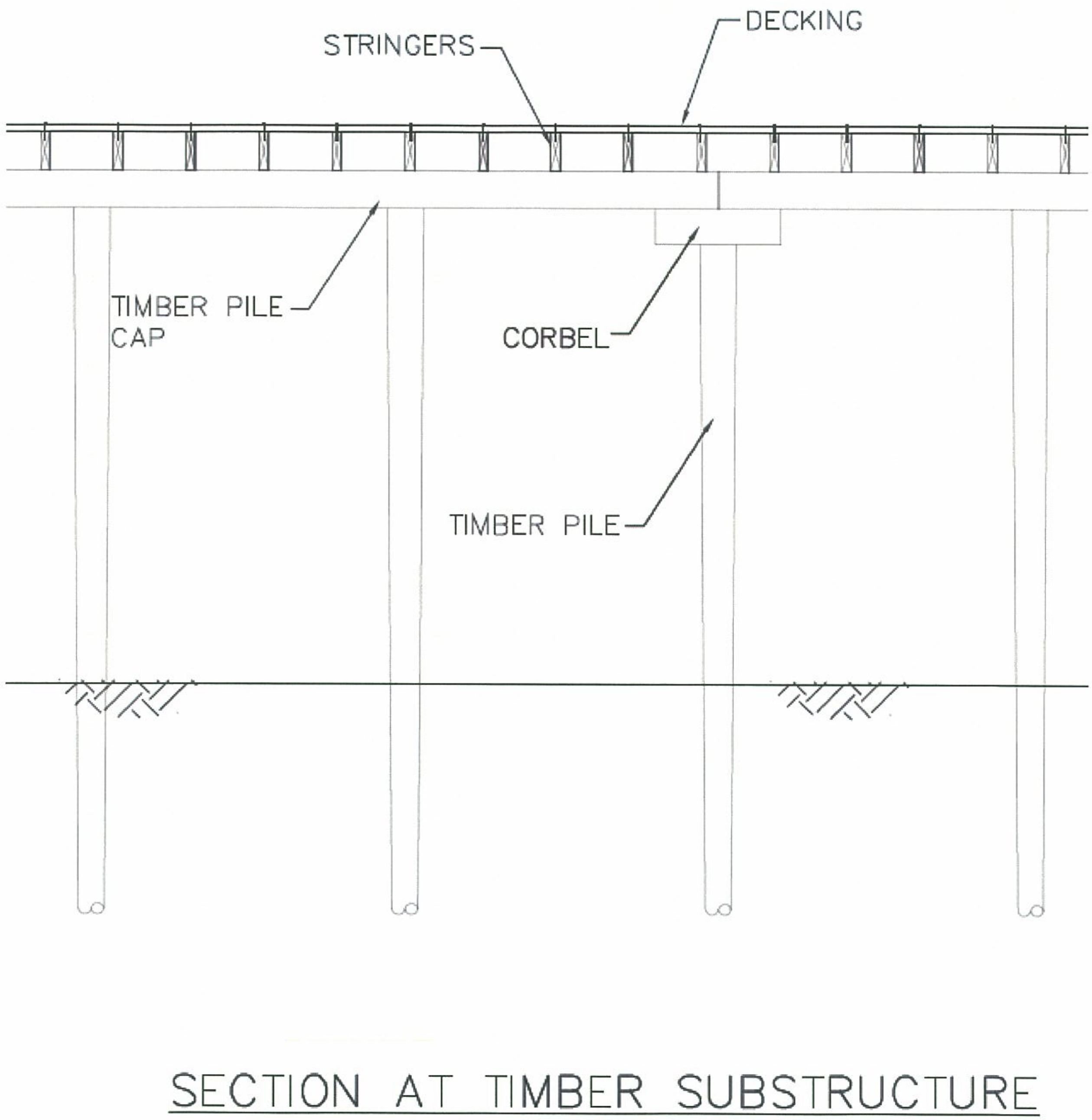

FIGURE 1

Inspection Recommendations

Piles rated Good –	Visually inspect at least once every five years and note any changes in condition.
Piles rated Fair –	Visually inspect at least once every five years and note any changes in condition.
Piles rated Poor -	Visually inspect, probe with a sharp instrument such as an ice pick or awl, sound with a hammer on all sides up and down the exposed pile length at least once each year. Note changes in condition, soft areas, and hollow sounds. Estimate the amount of the pile affected by soft or hollow areas and the width and length of splits.
Piles rated Bad -	These piles need to be repaired or replaced as soon as possible.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

The best maintenance practice to reduce fungal attack is to control sources of moisture. If wet areas are observed during inspection, the source of water should be investigated and either eliminated or diverted so it no longer wets the timber. If the source of moisture is ocean spay, then diversion is not practical and protective treatment of the timber is necessary.

Physical Damage: Field treat physical damage that is observed during inspection with an appropriate compound to restore the surface resistance to fungi and insects in accordance with American Wood Preservers' Association, Standard M4, *Standard for the Care of Preservative- Treated Wood Products.*

Fungal Damage: Treat surface damage from fungal attack with a fungicide such as Borate. Borates are available in many forms including fumigants, liquids, and solids. See *Dry Rot and Its Control* in the appendix. Significant dry rot that has more than surface depth should be cut out and the hole filled with an epoxy filler, and then the area around the hole treated.

Record all repairs and field treatments of specific elements in the GIS database.

Offshore Timber Piles:

In addition to the deterioration agents described for onshore piles, off shore piles are vulnerable to marine organisms (marine borers) that borrow into and destroy timber piles. In fact, these are the most aggressive predators of timber piles.

Offshore piles are also more susceptible to physical damage from objects carried by the water and thrown by waves.

There are two general types of marine borers that attack marine timbers: crustaceans and mollusks. The major wood-boring crustaceans are the Limnorians; the principle wood-destroying mollusks are the Teredines (Teredo and Bankia) and the Pholads (Martesia).

Crustaceans - Of the three common crustacean wood borers -Limnoria, Sphaeroma, and Chelura - Limnoria is considered to be the most economically important. These borers burrow just below the wood surface forming a network of interlacing tunnels. The weakened wood is easily eroded by wave action often resulting in a characteristic "hourglass" shape. Limnoria tripunctata is of particular importance because it can attack creosoted wood.

Teredines - The Teredines are commonly referred to as "shipworms" because of their wormlike appearance. Penetration of the wood occurs during the microscopic larval stage. As the shipworms grow, their tunnels increase in diameter and length while the entrance holes remain about the same size. Attacked piles may appear sound on the surface, yet be completely riddled.

Pholads - Pholads bore into wood, soft rock, or concrete for protection. These clams have pear shaped shells that can reach 6 cm in length. Like teredines, Pholads can cause considerable structural damage to wood. Both of these molluska can be more effectively controlled by creosote preservative treatment than the Limnorians.

Example of Limnoria Damage

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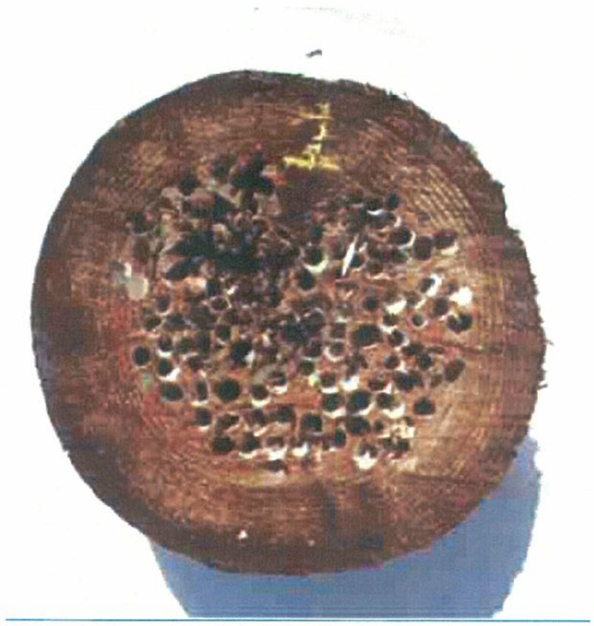

Example of Teredine Damage

In California, treated timber piles must be wrapped with a solid barrier to prevent leaching of the preservative chemicals into the water. While a well sealed barrier such as a polyethylene wrap can provide added protection, a poorly sealed barrier that allows exchange of water and oxygen can actually conceal damage from organisms that are able to get past the barrier.

Because offshore piles are subject to tidal and wave action, build up of marine growth, and must have a barrier; both the inspection and maintenance of these piles requires a much greater effort and task knowledge than onshore piles.

Inspection Recommendations

It is recommended that the inspection of offshore timber piles be performed by experience diver-engineers following the procedures given in *Underwater Investigations Standard Practice Manual* published by the American Society of Civil Engineers. Both the frequency and level of inspection are defined in the manual.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

It is recommended that the maintenance of offshore piles be performed by experienced and licensed marine contractors. Generally it is not economical to repair minor damages to individual offshore timber piles. However, missing or damaged barrier wraps should be replaced as soon as possible. Piles with major damages should be replaced.

Record all repairs and replacements of specific elements in the GIS database.

Timber Pile Caps & Corbels:

<u>Inspection Recommendations</u>

Visually inspect pile caps and corbels at the same time and interval as the associated piles. Particular attention should be made to the bearing surfaces and the connecting hardware.

At the bearing surfaces, where the cap or corbel rest on the pile or where stringers rest on the cap, look for indications that one element is crushing the other element, as this is a sign that rot is taking place, and normally would occur where there is excessive moisture. Look for sources of excessive moisture.

For the connecting hardware, look for signs of rust or missing elements such as nuts or entire bolts. If no connecting hardware is showing and there are no bolt holes, then the connecting hardware is a vertical drift pin completely embedded in the two pieces of timber.

Inspect caps for horizontal splits that are visible on both sides of the cap and for deflection (sagging) between piles. The location, width and the length of splits should be noted. Splitting and deflection of a cap may indicate a failure condition due to overloading.

Enter all changed conditions into the GIS database.

<u>Maintenance Recommendations</u>

Replace caps or corbels that have loss of bearing strength due to rot, and caps that have significant splitting and deflection with new pressure treated members of the same or greater size. Caps or corbels with surface fungal damage, but no loss of bearing capacity should be treated in the same manner as describe under onshore piles.

Clean and paint connecting hardware showing rust with no significant loss of material with a rust preventative paint. All missing components must be replaced with hot dipped galvanized elements.

Record all repairs and replacements of specific elements in the GIS database.

Timber Bracing:

<u>Inspection Recommendations</u>

It is recommended that timber bracing be inspected at least once every five years, and those subject to wave action after every major storm. The inspector should note overall brace condition, the specific condition at the connections, and the connecting bolts. Of all of the pier structural elements, the bracing is the most vulnerable to physical damage due to impact. Braces are relatively small members for the length of span and are easily broken if hit from the side.

Splitting at the bolt connection is common due to movement of the pier and shrinkage stresses in the brace itself.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

Replace with pressure treated timber all braces that are broken or are split at the connecting bolt hole. Also replace any brace that has over 30 percent of its cross-section lost due to physical damage, insect damage, or rot.

Treat braces with minor damage or surface fungi in the same manner as describe for onshore timber piles.

Record all repairs and replacements of specific elements in the GIS database.

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Timber Super-structure:

The timber superstructure consists of timber stringers spanning from pile cap to pile cap topped by timber decking planks. At the time this is being written, the stringers vary in size and spacing throughout the Newcomb Pier. It is not uncommon to see broken stringers within the area used for parking.

Inspection Recommendations

Until the timber stringers of the Newcomb Pier are upgraded as recommended in the Phase 2 Report, perform a visual inspection at least once per year and after any access by trucks in areas not already upgraded.

Note all damages or deterioration observed in stringers including the location and extent of the damage or deterioration. Typical damages include splits, dry rot at bearing points, and full breaks.

Carefully check stringer adjacent to broken stringers as they are more susceptible to overstress due to the lack of load distribution. Visually recheck stringers with splits at least once every two months and note all changes. Once the stringers are upgraded, visually inspect stringers at least once every five years.

Visually inspect the decking in areas not covered by permanent structures at least once each year. Note areas of uneven wear, gaps between planks greater that 3/4 inch, vertical changes in the top surface of adjacent planks greater than 1/4 inch, burn holes at joints, and any broken planks.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

Replace or supplement (install new stringer next to existing) broken stringers as soon as possible.

Replace stringers with loss of bearing strength due to dry rot. Eliminate sources of moisture where possible. Treat stringers showing surface fungi with an anti fungal compound as described in the section for onshore timber piles.

Replace decking when wear has reduced the thickness to less than 2-1/4 inch, or the where uneven surface wear creates a significant tripping hazard. Replace all broken planks.

Where the vertical difference between planks is caused by bowing of one plank and it is no longer bearing on the stringers, replace the spikes with lag screws with countersunk heads and washer to pull the plank down to bearing.

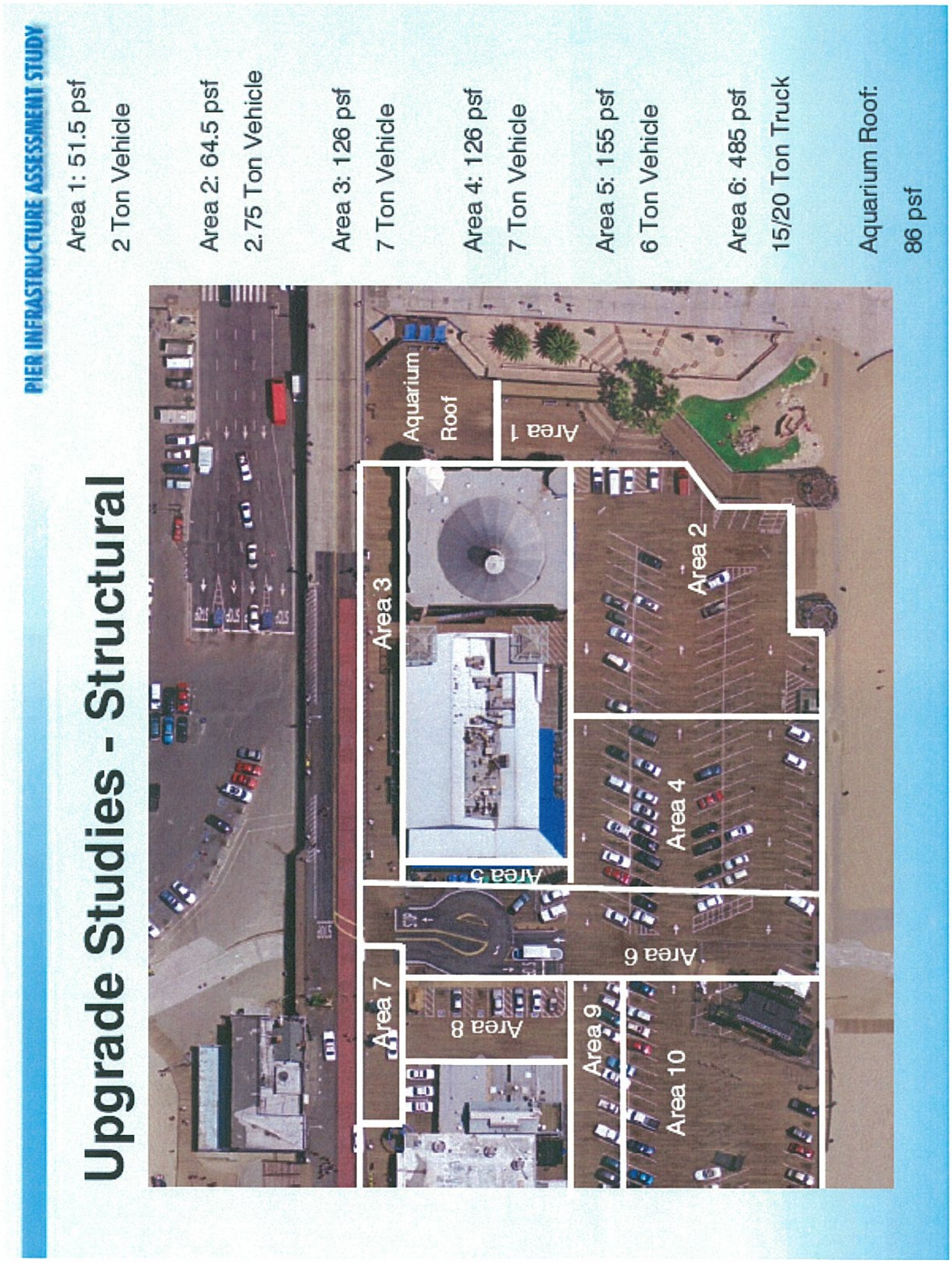
Where the vertical difference between planks is caused by a plank that is thicker than the adjacent plank and the adjacent plank is at least 2 3/8 inch thick, grind the thicker plank to match using a slope across the entire plank. Treat the ground surface of the plank with an appropriate compound to restore the surface resistance to fungi and insects in accordance with American Wood Preservers' Association, Standard M4, *Standard for the Care of Preservative- Treated Wood Products.*

Where the vertical difference between planks is caused by a plank that is thinner than the adjacent plank and the adjacent plank is at least 2 3/8 inch thick, replace the thinner plank with a new pressure treated 3 inch nominal (2 1/2 inch net) plank.

Record all repairs and replacements of specific elements in the GIS database.

Existing Pier Deck Load Limits

Limit the size of vehicles accessing the Newcomb Pier parking areas in accordance with the following diagrams until upgrades recommended in the Phase 2 Report are completed.



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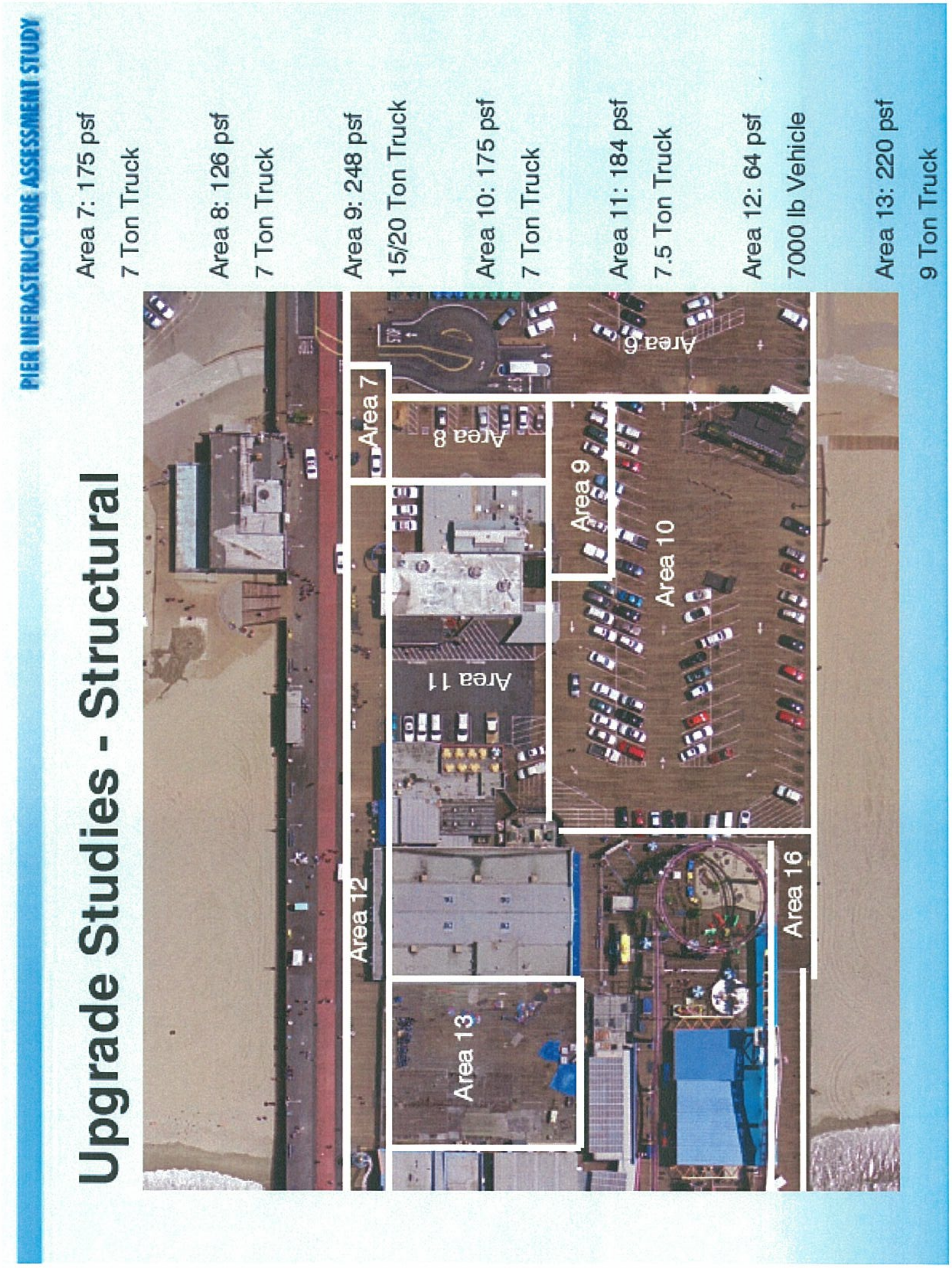


<u>Concrete Sub-structure</u> (See Figure 2)

The concrete sub-structure consists of prestressed concrete piles in the Waffle slab area beyond Bent 59 of the Municipal Pier and prestressed concrete piles with concrete pile caps and strut beams in the southern half of the Pacific Park area.

Deterioration of concrete in the marine environment is most commonly caused by corrosion of the reinforcing steel or physical damage from impact. Deterioration of concrete piles can also be caused by cracking during an earthquake. Sometimes, but rarely, deterioration is caused by excessive loads other than earthquake. Deterioration takes the form of concrete cracks, spalling (loss of surface concrete), and corrosion of the reinforcing steel evidenced by rust stains.

The most common location for corrosion damage in round concrete piles is at the top of the pile where the prestressing forces are reduced and possible overstress from driving is likely, and vertical cracks along the face of the pile. The most common location for corrosion damage in beams is at the lower corners where cracking from bending is likely and the infiltration of chlorides can approach from both the bottom and the side faces. In these corners the concentration of chloride ions increases twice as fast at the reinforcing steel as it does at steel with only one close face.

Example of Damage Near Top of Pile

Example of Cracking and Spalling Due to Corner Bar Corrosion
(Not Santa Monica Pier)

Onshore Concrete Piles:

Inspection Recommendations

Visually inspect onshore concrete piles at least once every five years. Note all surface damages, cracks, and rust stains on pile. Note the size and location of all observed defects. Especially note any exposed reinforcing steel.

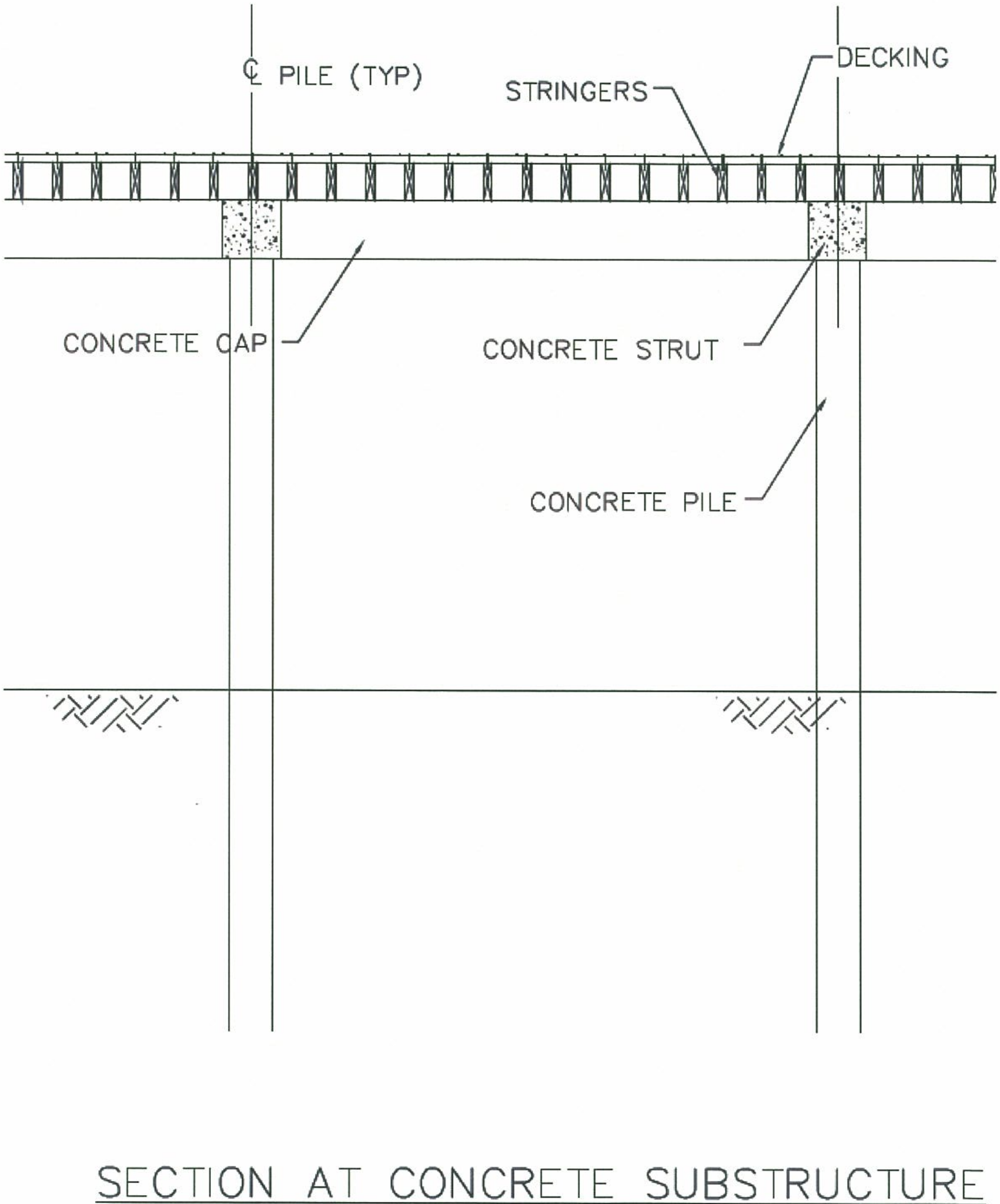
Enter all changed conditions into the GIS database.

Maintenance Recommendations

Compare noted defects with those in the GIS database for the previous inspection. If minor defects are unchanged from the prior inspection, then immediate repair is not warranted. Major deterioration or deterioration that has significantly increased since the prior inspection should be scheduled for repair.

It is recommended that an experienced concrete repair specialist perform all concrete repairs.

Record all repairs and replacements of specific elements in the GIS database.



℄ PILE (TYP)
STRINGERS
DECKING
CONCRETE CAP
CONCRETE STRUT
CONCRETE PILE
SECTION AT CONCRETE SUBSTRUCTURE

FIGURE 2

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Offshore Concrete Piles:

Inspection Recommendations

It is recommended that both routine and post-event inspections of offshore concrete piles be performed by experience diver-engineers following the procedures given in *Underwater Investigations Standard Practice Manual* published by the American Society of Civil Engineers. Both the frequency and level of inspection are defined in the manual.

A post-event inspection is an inspection performed shortly after a potentially damaging event, such as a major storm or earthquake, to assess if the structure sustained any damages from the event.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

It is recommended that the maintenance of offshore piles be performed by experienced and licensed marine contractors. Generally it is not economical to repair minor damages to individual offshore piles. However, major damages should be repaired as soon as practical and all minor repairs included in the same project.

Record all repairs and replacements of specific elements in the GIS database.

Concrete Pile Caps & Struts:

Inspection Recommendations

Visually inspect concrete caps and struts at least once every five years. Pay close attention to the exposed corners. Note all defects observed including cracks, spalls, and rust stains. Note the location and approximates size of all defects observed especially note cracks that occur on both faces that form a corner. This can be an indication of corrosion in the corner reinforcing bar even without visible rust stains.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

Compare noted defects with those in the GIS data base for the previous inspection. If minor defects are unchanged from the prior inspection, then immediate repair is not warranted. Major deterioration or deterioration which has significantly increased since the prior inspection should be scheduled for repair. However, what looks like minor deterioration should be considered major if it occurs intermittently along the length of the member.

It is recommended that all concrete repairs be performed by an experienced concrete repair specialist.

Record all repairs and replacements of specific elements in the GIS database.

<u>Waffle Slab Super-structure</u> (See Figure 3)

The waffle slab super-structure consists of a sixteen inch thick horizontal grid of six inch wide by sixteen inch high concrete beams on two foot six inches on center both ways and two foot by two foot voids between the beams. Timber planking tops the grid. There is a solid area approximately eight feet by eight feet that serves as an integral pile cap at each pile and supports the horizontal grid. See the photo below. Each of the small beams of the grid has two reinforcing bars, one at the top and one at the bottom.

Waffle Slab & Integral Pile Cap

The most common location for corrosion damage in beams is at the lower corners where cracking from bending is likely and the infiltration of chlorides can occur from both the bottom and the side faces. In these corners the concentration of chloride ions increases twice as fast at the reinforcing steel as steel with only one close face. However, in the case of the small beams of the waffle slab, there are three close faces from which the chloride can migrate.

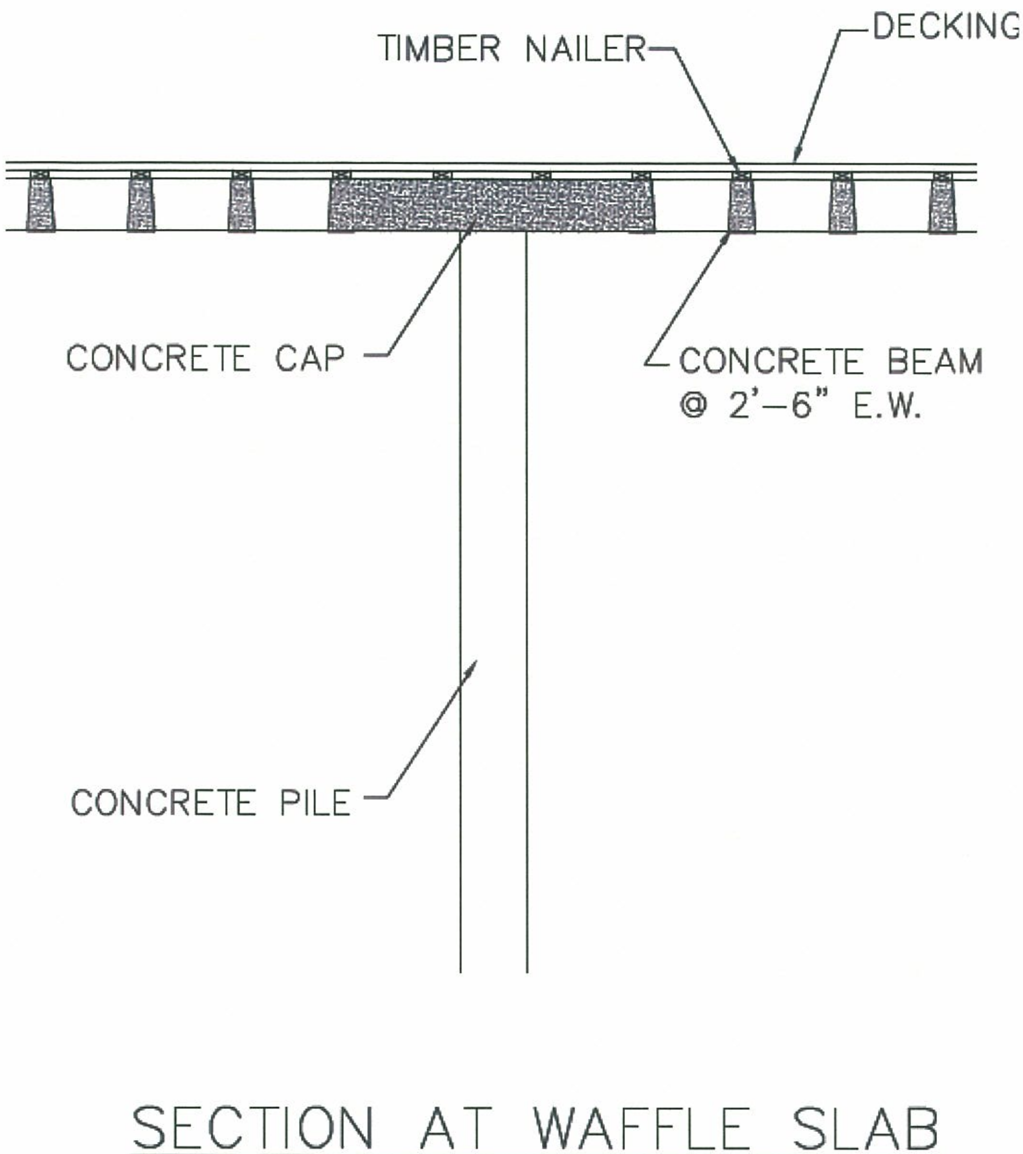
TIMBER NAILER
DECKING
CONCRETE CAP
CONCRETE BEAM @ 2'–6" E.W.
CONCRETE PILE
SECTION AT WAFFLE SLAB

FIGURE 3

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Inspection Recommendations

Because the waffle slab is wide and it is high above the water, visual inspection will need to be performed from a combination of locations including the existing utility catwalks, the lower fishing platforms, the lower catwalk along the southern edge and possibly by boat. The close spacing of the beams and the limited clearance between the utility catwalks and the bottom of the concrete will make the inspection of more than two or three beams beyond the catwalk difficult.

Visually inspect the waffle slab at least once every five years. Note any defects such as cracks, spalling, or rust stains. Pay special attention to possible longitudinal cracks approximately three inches above the bottom or in the middle of the bottom surface with or without rust stains.

If the exterior bonded carbon fiber reinforcing recommended in the upgrade study in installed, then inspect on the same schedule and look for delamination of the fiber wrap from the concrete, or bubbles in the surface of the wrap. Record location and size of all delaminations and/or bubbles.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

Since there is no redundancy in the reinforce steel of the waffle slab, any indication of corrosion in the bottom bar such as rust stains or longitudinal cracks in the bottom face or sides near the bottom, should trigger a repair project within the following five years.

Other surface defects without rust stains are not a trigger for repair, but need to be watched for continued deterioration or appearance of rust stains.

It is recommended that an experienced concrete repair specialty contractor perform all repairs to the waffle slab.

Because scaffolding will need to be constructed to provide access for the repair contractor, it is recommended that a detailed inspection, including sounding with a hammer or ultrasonic device be performed over all of the members, before repairs begin, and any additional damage repaired at the same time.

Record all repairs and replacements of specific elements in the GIS database.

TABLE OF PIER INSPECTION RECOMMENDATIONS

Timber Pier Members

Member Description	Frequency
Timber Piles rated Fair or Better	5 Years
Timber Piles rated Poor	1 Year
Timber Caps and Corbels	Same as Supporting Piles
Timber Bracing	5 Years or After Storm
Timber Stringers (Before upgrade)	1 Years or After Truck
Timber Stringers (After upgrade)	5 Years
Concrete Piles	5 Years
Concrete Caps and Struts	5 Years
Waffle Slab	5 Years
Timber Decking	1 Year

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Fire Protection System:

Santa Monica Pier Fire Systems Maintenance & Inspection Recommendations
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1. Introduction

This document outlines the recommendations for periodic maintenance and inspection of the existing fire systems on the Santa Monica Pier and was developed based on the recommendations and requirements as stated in NFPA-25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2008 Edition"

Inspection, testing, and maintenance should be implemented in accordance with procedures meeting the requirements in this document and in accordance with the manufacturer's instructions.

Personnel performing these tasks should have proper training and experience to carry out the procedures.

Prior to performing the procedures, the Fire Department and the alarm-receiving facility shall be notified before testing or shutting down a system or its supply. An additional notification shall be provided when the system, supply, or component is returned to service.

Deficiencies, damaged parts, or impairments found while performing the inspection, test, and/or maintenance shall be corrected promptly. Corrections and repairs shall be performed by qualified maintenance personnel or a qualified contractor.

2. General

2.1 Records

Records shall be made for all inspections, tests, and/or maintenance of the system and its components. Records shall indicate the procedure performed (e.g., inspection, test, or maintenance), the organization that performed the work, the results, and the date.

As-built system installation drawings, hydraulic calculations, original acceptance test records, and device manufacturer's data sheets shall be retained for the life of the system.

Subsequent records shall be retained for a period of 1 year after the next inspection, test, or maintenance.

2.2 Testing

All components and systems shall be tested to verify that they function as intended.

As an alternative means of compliance, subject to fire department approval, components and systems shall be permitted to be inspected, tested and maintained under a performance-based program.

Fire protection system components shall be restored to full operational condition following testing, including reinstallation of plugs and caps for auxiliary drains and test valves.

During testing and maintenance, water supplies shall remain in service unless under constant attendance by qualified personnel or impairment procedures are followed.

Test results shall be compared with those of the original acceptance test (if available) and with the most recent test results.

When a major component or subsystem is rebuilt or replaced, the subsystem shall be tested in accordance with the original acceptance test required for that subsystem.

3. Sprinkler Systems

3.1 The table below contains the minimum requirements for the routine inspection, testing, and maintenance of sprinkler systems.

Table 3.0 – Sprinkler System Maintenance/Inspection Schedule

Item	**Frequency**
Inspection	
Control valves	Weekly/monthly
Waterflow devices	Quarterly
Valve supervisory devices	Quarterly
Supervisory signal devices (except valve supervisory switches)	Quarterly
Gauges (wet pipe systems)	Monthly

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Hydraulic nameplate	Quarterly
Hanger/seismic bracing	Annually
Pipe and fittings	Annually
Sprinklers	Annually
Spare sprinklers	Annually
Fire department connections	Quarterly
Valves (all types)	
Obstruction	5 years
Test	
Waterflow devices	Quarterly/semiannually
Valves supervisory devices	Semiannually
Supervisory signal devices (except valve supervisory switches)	Semiannually
Main drain	Annually
Gauges	5 years
Sprinklers	At 50 years and every 10 years thereafter
Maintenance	
Valves (all types)	Annually or as needed
Obstruction investigation	5 years or as needed
Low-point drains (dry pipe system)	Annually and as needed
Investigation	
Obstruction	As needed

Valves and fire department connections shall be inspected, tested, and maintained in accordance with Section 5.

The procedures outlined in Section 7 shall be followed where impairment to protection occurs.

Hose connections shall be inspected, tested, and maintained in accordance with Sections 4 and 5.

3.2 Inspection Requirements

3.2.1 Sprinklers

Sprinklers shall not show signs of leakage; shall be free of corrosion, foreign materials, paint, and physical damage; and shall be installed in the proper orientation (e.g., upright, pendent, or sidewall).

Any sprinkler shall be replaced that has signs of leakage; is painted, other than by the sprinkler manufacturer, corroded, damaged, or loaded; or in the improper orientation.

Glass bulb sprinklers shall be replaced if the bulbs have emptied.

Sprinklers installed in concealed spaces such as above suspended ceilings shall not require inspection.

Sprinklers that are subject to recall shall be replaced per the manufacturer's requirements.

The minimum clearance required by the installation standard shall be maintained below all sprinklers. Stock, furnishings, or equipment closer to the sprinkler than the clearance rules allow shall be corrected.

The supply of spare sprinklers shall be inspected annually for the following:

(1) The proper number and type of sprinklers
(2) A sprinkler wrench for each type of sprinkler

3.2.2 Pipe and Fittings

Sprinkler pipe and fittings shall be inspected annually from the floor level.

Pipe and fittings shall be in good condition and free of mechanical damage, leakage, and corrosion.

Sprinkler piping shall not be subjected to external loads by materials either resting on the pipe or hung from the pipe.

Pipe and fittings installed in concealed spaces such as above suspended ceilings shall not require inspection.

3.2.3 Hangers and Seismic Braces

Sprinkler pipe hangers and seismic braces shall be inspected annually from the floor level.

Hangers and seismic braces shall not be damaged or loose.

Hangers and seismic braces that are damaged or loose shall be replaced or refastened.

Hangers and seismic braces installed in concealed spaces such as above suspended ceilings shall not require inspection.

3.2.4 Gauges

Gauges on wet pipe sprinkler systems shall be inspected monthly to ensure that they are in good condition and that normal water supply pressure is being maintained.

3.2.5 Alarm Devices

Alarm devices shall be inspected quarterly to verify that they are free of physical damage.

3.2.6 Hydraulic Nameplate

The hydraulic nameplate for hydraulically designed systems shall be inspected quarterly to verify that it is attached securely to the sprinkler riser and is legible.

3.3 Testing Requirements

3.3.1 Sprinklers

Where sprinklers have been in service for 50 years, they shall be replaced or representative samples from one or more sample areas shall be tested. Test procedures shall be repeated at 10-year intervals.

Where sprinklers have been in service for 75 years, they shall be replaced or representative samples from one or more sample areas shall be submitted to a recognized testing laboratory acceptable to the Fire Department for field service testing. Test procedures shall be repeated at 5-year intervals.

Where sprinklers are subjected to harsh environments, including corrosive atmospheres and corrosive water supplies, on a 5-year basis, sprinklers shall either be replaced or representative sprinkler samples shall be tested.

A representative sample of sprinklers for testing shall consist of a minimum of not less than four sprinklers or 1 percent of the number of sprinklers per individual sprinkler sample, whichever is greater.

Where one sprinkler within a representative sample fails to meet the test requirement, all sprinklers within the area represented by that sample shall be replaced.

3.3.2 Gauges

Gauges shall be replaced every 5 years or tested every 5 years by comparison with a calibrated gauge. Gauges not accurate to within 3 percent of the full scale shall be recalibrated or replaced.

3.3.3 Alarm Devices

Mechanical waterflow devices including, but not limited to, water motor gongs, shall be tested quarterly.

Vane-type and pressure switch–type waterflow devices shall be tested semiannually.

Testing the waterflow alarms on wet pipe systems shall be accomplished by opening the inspector's test connection.

3.4 Maintenance Requirements

3.4.1 Sprinklers

Replacement sprinklers shall have the proper characteristics for the application intended. These shall include the following:

(1) Style
(2) Orifice size and K-factor
(3) Temperature rating
(4) Coating, if any
(5) Deflector type (e.g., upright, pendent, sidewall)
(6) Design requirements

Replacement sprinklers for the pier and wharf area shall comply with NFPA 307, "Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves".

Only new, listed sprinklers shall be used to replace existing sprinklers.

A supply of spare sprinklers (never fewer than six) shall be maintained on the premises so that any sprinklers that have operated or been damaged in any way can be promptly replaced.

The sprinklers shall correspond to the types and temperature ratings of the sprinklers in the system.

The sprinklers shall be kept in a cabinet located where the temperature in which they are subjected will at no time exceed 100°F.

The stock of spare sprinklers shall include all types and ratings installed and shall be a minimum of 12 sprinklers.

A special sprinkler wrench shall be provided and kept in the cabinet to be used in the removal and installation of sprinklers. One sprinkler wrench shall be provided for each type of sprinkler installed.

3.4.2 Installation and Acceptance Testing

Where maintenance or repair requires the replacement of sprinkler system components affecting more than 20 sprinklers, those components shall be installed and tested in accordance with NFPA 13, "Standard for the Installation of Sprinkler Systems".

3.4.3 Component Action Requirements

Whenever a component in a sprinkler system is adjusted, repaired, reconditioned, or replaced, the actions required in following table shall be performed.

Table 3.4.3 Summary of Component Replacement Action Requirements				
Component	**Adjust**	**Repair/ Recondition**	**Replace**	**Required Action**
Water Delivery Components				
Pipe and fittings affecting less than 20 sprinklers	X	X	X	Check for leaks at system working pressure
Pipe and fittings affecting more than 20 sprinklers	X	X	X	Hydrostatic test in conformance with NFPA 13, Standard for the Installation of Sprinkler Systems
Sprinklers, less than 20	X		X	Check for leaks at system working pressure
Sprinklers, more than 20	X		X	Hydrostatic test in conformance with NFPA 13
Fire department connections	X	X	X	Refer to Section 5
Antifreeze solution	X		X	Check freezing point of solution Check for leaks at system working pressure
Valves				Refer to Section 5
Alarm and Supervisory Components				
Vane-type waterflow	X	X	X	Operational test using inspector's test connection
Pressure switch–type waterflow	X	X	X	Operational test using inspector's test connection
Water motor gong	X	X	X	Operational test using inspector's test connection
Valve supervisory device	X	X	X	Test for conformance with NFPA 13 and/or NFPA 72, National Fire Alarm Code
Status-Indicating Components				

Gauges			X	Verify at 0 psi and system working pressure
Testing and Maintenance Components				
Main drain	X	X	X	Main drain test
Auxiliary drains	X	X	X	Check for leaks at system working pressure Main drain test
Inspector's test connection	X	X	X	Check for leaks at system working pressure Main drain test
Structural Components				
Hanger/seismic bracing	X	X	X	Check for conformance with NFPA 13
Pipe stands	X	X	X	Check for conformance with NFPA 13
Informational Components				
Identification Signs	X	X	X	Check for conformance with NFPA 13
Hydraulic Placards	X	X	X	Check for conformance with NFPA 13

Where the original installation standard is different from the cited standard, the use of the appropriate installing standard shall be permitted.

A main drain test shall be required if the system control or other upstream valve was operated in accordance with Section 5.1.1.

4. Standpipe Systems

This section shall provide the minimum requirements for the routine inspection, testing, and maintenance of standpipe systems. The table below shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.

Table 4.0 Summary of Standpipe and Hose Systems Inspection, Testing, and Maintenance		
Item	**Frequency**	**Reference**
Inspection		

Control valves	Weekly/monthly	Table 4.4
Piping	Annually	Section 3.2.2
Hose connections	Annually	Table 4.4
Hose	Annually	NFPA 1962
Hose storage device	Annually	NFPA 1962
Hose nozzle	Annually and after each use	NFPA 1962
Test		
Waterflow devices	Quarterly/semiannually	Table 4.4
Valve supervisory devices	Semiannually	Table 4.4
Supervisory signal devices (except valve supervisory switches)	Semiannually	Table 4.4
Pressure reducing valve	5 years	Table 4.4
Hydrostatic test	5 years	Section 4.5
Flow test	5 years	Section 4.3
Main drain test	Annually	Table 4.4
Maintenance		
Hose connections	Annually	Table 4.1
Valves (all types)	Annually/as needed	Table 4.4

Valves and fire department connections shall be inspected, tested, and maintained in accordance with Section 5.

Where the inspection, testing, and maintenance of standpipe and hose systems results or involves a system that is out of service, the procedures outlined in Section 7 shall be followed.

4.1 Inspection

Components of standpipe and hose systems shall be visually inspected annually or as specified in the above table.

The table below shall be used for the inspection, testing, and maintenance of all classes of standpipe and hose systems.

Table 4.1 Standpipe and Hose Systems

Component/Checkpoint	**Corrective Action**
Hose Connections	
Cap missing	Replace
Fire hose connection damaged	Repair
Valve handles missing	Replace
Cap gaskets missing or deteriorated	Replace
Valve leaking	Close or repair
Visible obstructions	Remove
Restricting device missing	Replace
Valve does not operate smoothly	Lubricate or repair
Piping	
Damaged piping	Repair
Control valves damaged	Repair or replace
Missing or damaged pipe support device	Repair or replace
Damaged supervisory devices	Repair or replace

Checkpoints and corrective actions outlined in the table above shall be followed to determine that components are free of corrosion, foreign material, physical damage, tampering, or other conditions that adversely affect system operation.

4.2 Testing

Where water damage is a possibility, an air test shall be conducted on the system at 25 psi prior to introducing water to the system.

4.3 Flow Tests

A flow test shall be conducted every 5 years at the hydraulically most remote hose connections of each zone of an automatic standpipe system to verify the water supply still provides the design pressure at the required flow.

Where a flow test of the hydraulically most remote outlet(s) is not practical, the Fire Department shall be consulted for the appropriate location for the test.

All systems shall be flow tested and pressure tested at the requirements for the design criteria in effect at the time of the installation.

The actual test method(s) and performance criteria shall be discussed in advance with the Fire Department.

4.4 Component Action Requirements

Whenever a component in a standpipe system is adjusted, repaired, reconditioned or replaced, the action required in the following table shall be performed.

Table 4.4 Summary of Component Replacement Action Requirements				
Component	**Adjust**	**Repair**	**Replace**	**Required Action**
Water Delivery Components				
Control valves	X	X	X	Refer to Section 5
Piping	X	X	X	Hydrostatic test in conformance with NFPA 14, Standard for the Installation of Standpipe and Hose Systems
Hose valve	X	X	X	Refer to Section 5
Fire department connections	X	X	X	Refer to Section 5
Backflow prevention device	X	X	X	Refer to Section 5
Valves				Refer to Section 5
Alarm and Supervisory Components				
Vane-type waterflow	X	X		Operational test using inspector's test connection
Vane-type waterflow			X	Operational test using inspector's test connection
Pressure switch–type waterflow	X	X	X	Operational test using inspector's test connection
Water motor gong	X	X	X	Operational test using inspector's test connection
Valve supervisory device	X	X	X	Operational test for receipt of alarms and verification of conformance with NFPA 14 and/or NFPA 72, National Fire Alarm Code
Status-Indicating Components				
Gauges			X	Verify at 0 psi and system working pressure

Testing and Maintenance Components				
Drain riser	X	X	X	Check for leaks while flowing from connection above the repair
Auxiliary drains	X	X	X	Check for leaks at system working pressure
Main drain	X	X	X	Check for leaks and residual pressure during main drain test
Structural Components				
Hanger/seismic bracing	X	X	X	Verify conformance with NFPA 14
Pipe stands	X	X	X	Verify conformance with NFPA 14
Informational Components				
Identification signs	X	X	X	Verify conformance with NFPA 14
Hydraulic placards	X	X	X	Verify conformance with NFPA 14

A main drain test shall be performed on all standpipe systems with automatic water supplies in accordance with the requirements of Section 5.1.1.

The test shall be performed at the low point drain for each standpipe or the main drain test connection where the supply main enters the building (when provided).

Pressure gauges shall be provided for the test and shall be maintained in accordance with Section 3.3.2.

4.5 Hydrostatic Tests

Hydrostatic tests of not less than 200 psi pressure for 2 hours, or at 50 psi in excess of the maximum pressure, where maximum pressure is in excess of 150 psi shall be conducted every 5 years on manual standpipe systems and automatic-dry standpipe systems, including piping in the fire department connection.

Hydrostatic tests shall be conducted on any system that has been modified or repaired.

The hydrostatic test pressure shall be measured at the low elevation point of the individual system or zone being tested. The inside standpipe piping shall show no leakage.

4.6 Alarm Devices

Where provided, waterflow alarm and supervisory devices shall be tested in accordance with Section 5.1.2.

4.7 Maintenance

Equipment that does not pass the inspection or testing requirements shall be repaired and tested again or replaced.

4.8 Component Action Requirements

Whenever a component in a standpipe and hose system is adjusted, repaired, reconditioned or replaced, the action required in Table 4.4, Summary of Component Replacement Action Requirements, shall be performed.

Where the original installation standard is different from the cited standard, the use of the appropriate installing standard shall be permitted.

A main drain test shall be required if the control valve or other upstream valve was operated in accordance with Section 5.1.1.

5. Valves and Valve Components

This Section provides the minimum requirements for the routine inspection, testing, and maintenance of valves, valve components, and trim. Table 5 shall be used to determine the minimum required frequencies for inspection, testing, and maintenance.

Table 5 Summary of Valves, Valve Components, and Trim Inspection, Testing, and Maintenance

Item	Frequency	Reference
Inspection		
Control Valves		
Sealed	Weekly	Section 5.3
Locked	Monthly	Section 5.3
Tamper switches	Monthly	Section 5.3
Alarm Valves		
Exterior	Monthly	Section 5.4
Interior	5 years	Section 5.4
Strainers, filters, orifices	5 years	Section 5.4

Check Valves		
Interior	5 years	Section 5.5
Backflow Prevention Assemblies		
Reduced pressure	Weekly/monthly	Section 5.6
Reduced pressure detectors	Weekly/monthly	Section 5.6
Fire Department Connections	Quarterly	Section 5.7
Test		
Main Drains	Annually/quarterly	Section 5.1.1
Waterflow Alarms	Quarterly/semiannually	Section 5.1.2
Control Valves		
Position	Annually	Section 5.3.3
Operation	Annually	Section 5.3.3
Supervisory	Semiannually	Section 5.3.3
Backflow Prevention Assemblies	Annually	Section 5.6.2
Maintenance		
Control Valves	Annually	Section 5.3.5

5.1 General

Manufacturers' literature shall be available to provide specific instructions for inspecting, testing, and maintaining the valves and associated equipment. All pertinent personnel, departments, and the Fire Department shall be notified that testing or maintenance of the valve and associated alarms is to be conducted.

Before opening a test or drain valve, it shall be verified that adequate provisions have been made for drainage.

5.1.1 Main Drain Test

A main drain test shall be conducted annually at each water-based fire protection system riser to determine whether there has been a change in the condition of the water supply piping and control valves.

Systems where the sole water supply is through a backflow preventer and/or pressure reducing valves, the main drain test of at least one system downstream of the device shall be conducted on a quarterly basis.

When there is a 10 percent reduction in full flow pressure when compared to the original acceptance test or previously performed tests, the cause of the reduction shall be identified and corrected if necessary.

5.1.2 Alarm Devices.

Mechanical waterflow devices, including but not limited to water motor gongs, shall be tested quarterly.

Vane-type and pressure switch–type waterflow devices shall be tested semiannually.

5.1.3 Gauges

Gauges shall be inspected monthly to verify that they are in good condition and that normal pressure is being maintained.

Where other sections of this standard have different frequency requirements for specific gauges, those requirements shall be used.

Gauges shall be replaced every 5 years or tested every 5 years by comparison with a calibrated gauge.

Gauges not accurate to within 3 percent of the full scale shall be recalibrated or replaced.

5.1.4 Records

Records shall be maintained in accordance with Section 2.1.

5.3 Control Valves

5.3.1 General

Each control valve shall be identified and have a sign indicating the system or portion of the system it controls.

Systems that have more than one control valve that must be closed to work on a system shall have a sign on each affected valve referring to the existence and location of other valves.

When a normally open valve is closed, the impairment procedures shall be followed.

When the valve is returned to service, a drain test (either main or sectional drain, as appropriate) shall be conducted to determine that the valve is open.

Each normally open valve shall be secured by means of a seal or a lock or shall be electrically supervised in accordance with the applicable NFPA standards.

Normally closed valves shall be secured by means of a seal or shall be electrically supervised in accordance with the applicable NFPA standard.

Sealing or electrical supervision shall not be required for hose valves.

5.3.2 Inspection

All valves shall be inspected weekly.

Valves secured with locks or supervised in accordance with applicable NFPA standards shall be permitted to be inspected monthly.

After any alterations or repairs, an inspection shall be made by the property owner to ensure that the system is in service and all valves are in the normal position and properly sealed, locked, or electrically supervised.

The valve inspection shall verify that the valves are in the following condition:

(1) In the normal open or closed position
(2) Properly sealed, locked, or supervised
(3) Accessible
(4) Provided with appropriate wrenches
(5) Free from external leaks
(6) Provided with appropriate identification

5.3.3 Testing

Each control valve shall be operated annually through its full range and returned to its normal position.

This test shall be conducted every time the valve is closed.

Outside screw and yoke valves shall be backed a one-quarter turn from the fully open position to prevent jamming.

A main drain test shall be conducted any time the control valve is closed and reopened at system riser.

5.3.4 Supervisory Switches

Valve supervisory switches shall be tested semiannually.

A distinctive signal shall indicate movement from the valve's normal position during either the first two revolutions of a hand wheel or when the stem of the valve has moved one-fifth of the distance from its normal position.

The signal shall not be restored at any valve position except the normal position.

5.3.5 Maintenance

The operating stems of outside screw and yoke valves shall be lubricated annually.

The valve then shall be completely closed and reopened to test its operation and distribute the lubricant.

5.4 Alarm Valves

5.4.1 General

Alarm valves and system riser check valves shall be externally inspected monthly and shall verify the following:

(1) The gauges indicate normal supply water pressure is being maintained.
(2) The valve is free of physical damage.
(3) All valves are in the appropriate open or closed position.
(4) The retarding chamber or alarm drains are not leaking.

Alarm valves and their associated strainers, filters, and restriction orifices shall be inspected internally every 5 years unless tests indicate a greater frequency is necessary.

5.4.2 Maintenance

Internal components shall be cleaned/repaired as necessary in accordance with the manufacturer's instructions.

The system shall be returned to service in accordance with the manufacturer's instructions.

5.5 Check Valves

5.5.1 Inspection

Valves shall be inspected internally every 5 years to verify that all components operate correctly, move freely, and are in good condition.

5.5.2 Maintenance

Internal components shall be cleaned, repaired, or replaced as necessary in accordance with the manufacturer's instructions.

5.6 Backflow Prevention Assemblies

5.6.1 Inspection

The double check assembly (DCA) valves and double check detector assembly (DCDA) valves shall be inspected weekly to ensure that the OS&Y isolation valves are in the normal open position.

Valves secured with locks or electrically supervised in accordance with applicable NFPA standards shall be inspected monthly.

Reduced pressure assemblies (RPA) and reduced pressure detector assemblies (RPDA) shall be inspected weekly to ensure that the differential-sensing valve relief port is not continuously discharging and the OS&Y isolation valves are in the normal open position.

Valves secured with locks or electrically supervised in accordance with applicable NFPA standards shall be inspected monthly.

After any testing or repair, an inspection by the property owner shall be made to ensure that the system is in service and all isolation valves are in the normal open position and properly locked or electrically supervised.

5.6.2 Testing

All backflow preventers installed in fire protection system piping shall be tested annually in accordance with the following:

(1) A forward flow test shall be conducted at the designed flow rate, including hose stream demand, of the system, where hydrants or

inside hose stations are located downstream of the backflow preventer.

(2) A backflow performance test, as required by the authority having jurisdiction, shall be conducted at the completion of the forward flow test.

For backflow preventers sized 2 in. (50 mm) and under, the forward flow test shall be acceptable to conduct without measuring flow, where the test outlet is of a size to flow the system demand.

Where water rationing is enforced during shortages lasting more than 1 year, an internal inspection of the backflow preventer to ensure the check valves will fully open shall be acceptable in lieu of conducting the annual forward flow test.

Where connections do not permit a full flow test, tests shall be completed at the maximum flow rate possible.

The forward flow test shall not be required where annual fire pump testing causes the system demand to flow through the backflow preventer device.

Where connections do not permit a full flow test, tests shall be conducted at the maximum flow rate possible.

5.6.3 Maintenance

Maintenance of all backflow prevention assemblies shall be conducted by a trained individual following the manufacturer's instructions in accordance with the procedure and policies of the authority having jurisdiction.

Rubber parts shall be replaced in accordance with the frequency required by the authority having jurisdiction and the manufacturer's instructions.

5.7 Fire Department Connections

Fire department connections shall be inspected quarterly. The inspection shall verify the following:

(1) The fire department connections are visible and accessible.
(2) Couplings or swivels are not damaged and rotate smoothly.
(3) Plugs or caps are in place and undamaged.
(4) Gaskets are in place and in good condition.
(5) Identification signs are in place.
(6) The check valve is not leaking.
(7) The automatic drain valve is in place and operating properly.

(8) The fire department connection clapper(s) is in place and operating properly.

If fire department connection plugs or caps are not in place, the interior of the connection shall be inspected for obstructions, and it shall be verified that the fire department connection clapper is operational over its full range.

Components shall be repaired or replaced as necessary in accordance with the manufacturer's instructions. Any obstructions that are present shall be removed

6. Obstruction Investigation and Prevention

This section provides the minimum requirements for conducting investigations of fire protection system piping for possible sources of materials that could cause pipe blockage.

An inspection of piping and branch line conditions shall be conducted every 5 years by opening a flushing connection at the end of one main and by removing a sprinkler toward the end of one branch line for the purpose of inspecting for the presence of foreign organic and inorganic material.

Alternative nondestructive examination methods shall be permitted.

Tubercules or slime, if found, shall be tested for indications of microbiologically influenced corrosion (MIC).

An obstruction investigation shall be conducted for system piping wherever any of the following conditions exist:

(1) The discharge of obstructive material during routine water tests
(2) Foreign material in water during drain tests or plugging of inspector's test connection(s)
(3) Plugged sprinklers
(4) Plugged piping in sprinkler systems dismantled during building alterations
(5) Failure to flush piping or surrounding public mains following new installations or repairs
(6) A record of broken public mains in the vicinity
(7) Abnormally frequent false tripping of a dry pipe valve(s)
(8) A system that is returned to service after an extended shutdown (greater than 1 year)
(9) A system has been supplied with raw water via the fire department connection Pinhole leaks
(10) A 50 percent increase in the time it takes water to travel to the inspector's test connection from the time the valve trips during a full flow trip test of a dry pipe sprinkler system when compared to the original system acceptance test

Systems shall be examined for internal obstructions where conditions exist that could cause obstructed piping.

If the condition has not been corrected or the condition is one that could result in obstruction of the piping despite any previous flushing procedures that have been performed, the system shall be examined for internal obstructions every 5 years.

Internal inspections shall be accomplished by examining the interior of the following four points:

(1) System valve
(2) Riser
(3) Cross main
(4) Branch line

Alternative nondestructive examination methods shall be permitted.

If an obstruction investigation carried out in accordance with the above indicates the presence of sufficient material to obstruct sprinklers, a complete flushing program shall be conducted by qualified personnel.

7. Impairment Program

This Section provides the minimum requirements for a water-based fire protection system impairment program. Measures shall be taken during the impairment to ensure that increased risks are minimized and the duration of the impairment is limited.

7.1 Impairment Coordinator

The City shall assign an impairment coordinator to insure that the proper steps are followed.

7.2 Tag Impairment System

A tag shall be used to indicate that a system, or part thereof, has been removed from service.

The tag shall be posted at each fire department connection and system control valve, indicating which system, or part thereof, has been removed from service.

The Fire Department shall specify where the tag is to be placed.

7.3 Impaired Equipment

The impaired equipment shall be considered to be the water-based fire protection system, or part thereof, that is removed from service.

The impaired equipment shall include, but shall not be limited to, the following:

(1) Sprinkler systems
(2) Standpipe systems
(3) Underground fire service mains
(4) Fire service control valves

7.4 Preplanned Impairment Programs

All preplanned impairments shall be authorized by the impairment coordinator.

Before authorization is given, the impairment coordinator shall be responsible for verifying that the following procedures have been implemented:

(1) The extent and expected duration of the impairment have been determined.
(2) The areas or buildings involved have been inspected and the increased risks determined.
(3) Recommendations have been submitted the City or the Tenant. Where a required fire protection system is out of service for more than 10 hours in a 24-hour period, the impairment coordinator shall arrange for one of the following:
    a. Evacuation of the building or portion of the building affected by the system out of service
    b. An approved fire watch
    c. Establishment of a temporary water supply
    d. Establishment and implementation of an approved program to eliminate potential ignition sources and limit the amount of fuel available to the fire
(4) The fire department has been notified.
(5) The alarm company, tenant, and other authorities having jurisdiction have been notified.
(6) The supervisors in the areas to be affected have been notified.
(7) A tag impairment system has been implemented.
(8) All necessary tools and materials have been assembled on the impairment site.

7.5 Emergency Impairments

Emergency impairments include but are not limited to system leakage, interruption of water supply, frozen or ruptured piping, and equipment failure.

When emergency impairments occur, emergency action shall be taken to minimize potential injury and damage.

7.6 Restoring Systems to Service

When all impaired equipment is restored to normal working order, the impairment coordinator shall verify that the following procedures have been implemented:

a. Any necessary inspections and tests have been conducted to verify that affected systems are operational. The appropriate chapter of this standard shall be consulted for guidance on the type of inspection and test required.
b. Supervisors have been advised that protection is restored.
c. The fire department has been advised that protection is restored.
d. The impairment tag has been removed.

Utility Systems

It is recommended that all future utility repairs, relocations, and new installation, whether for the benefit of the City or tenants, be performed by licensed contractors, specializing in the type of utility, approved by the City; and that all materials be appropriate for the marine environment.

Potable Water System:

Inspection Recommendations

An inspection of the potable water system should be made every six months. Inspections should be conducted on the piping for visible leaks, corrosion, and hanger/support integrity. Notify the City of Santa Monica Office of Sustainability and the Environment if any leaks are found.

Tag and schedule for replacement or refurbishment valves that have already frozen open or closed.

One area of note is the potable water piping in the catwalk areas at the ocean end of the pier. Some of it was heavily scaled and/or pitted during the condition assessment (Phase 1) and was recommended to be replaced.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

All observed leaks should be repaired as soon as possible to avoid water wastage and damage to adjacent utilities or structures.

The water heater and circulating pump serving the restrooms under the entrance ramp should be maintained per manufacturer's recommendations.

All isolation valves and branch valves should be operated (closed and reopened, or opened and closed) to prevent them from freezing in whatever position they are intended to perform.

Record all repairs and replacements of specific elements in the GIS database.

Sanitary Sewer, Drain and Vent System:

During the utility condition assessment, leakage was observed that originated above the pier decking. Based on usage noises, it is likely that drainage piping was the source of the leakage, even though it was not observed directly.

There are numerous original wooden supports still in use. Some are serviceable, but some are inadequate and in violation of code.

Inspection Recommendations

An inspection of the sanitary sewer, drainage, and vent systems should be made every six months. It could be accomplished at the same time as an inspection of the potable water system since much of the piping for both systems is in the same areas.

Inspections should be conducted on the piping for visible leaks, corrosion, and hanger/support integrity. Note all defects including type and specific location. Notify the City of Santa Monica Office of Sustainability and the Environment if any leaks are found.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

All observed leaks should be repaired as soon as possible to avoid damage to adjacent utilities or structures. Some areas where leakage is occurring may be hard to verify.

Phase out and replace wooden supports with stainless steel hangers and supports.

Record all repairs and replacements of specific elements in the GIS database.

Natural Gas System:

Inspection/Maintenance Schedule

An inspection of the natural gas system should be made every six months. Inspections should be conducted on the piping for corrosion and hanger/support integrity.

Any sign of a leak, such as the smell of natural gas, must be reported immediately.
Tag and schedule for replacement or refurbishment all valves that have already frozen open or closed.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

All isolation valves and branch valves should be operated (closed and reopened, or opened and closed) to prevent them from freezing in whatever position they are intended to perform. Replace valves that are already frozen either open or closed.

Record all repairs and replacements of specific elements in the GIS database.

Electrical Systems:

Inspection Recommendations

Visually inspect the electrical systems at least once every year. Note broken conduits, open joints between conduit sections or between conduits and junction boxes, damaged or missing supports, missing box covers, and exposed wiring.

Visually inspect the electrical systems supported by the offshore portions of the pier after every major storm event.

Perform continuity test and circuit tests annually.

It is recommended that all electrical system testing be performed by a licensed electrical engineer or contractor.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

It is recommended that all electrical system repairs be carried out by licensed electrical contractors.

Repair broken conduits and open joints as soon as practical.

Replace missing covers and gaskets for junction boxes.

It is recommended that all conduit systems, boxes, and enclosures have NEMA rating for exposed marine environment.

Record all repairs and replacements of specific elements in the GIS database.

Lighting Fixtures

Inspection Recommendations

Visually inspect all pier lighting poles and fixtures at least once every month. Note all physical damage and deterioration of the components due to environmental exposure.

At least once per year open the lighting fixture and inspect interior elements for deterioration and check ballast and lamp. Test light intensity at deck surface 10 feet from fixture.

Test timer switches and circuit breakers at least once every six months.

It is recommended that only City's lighting maintenance personnel or licensed electrical contractors perform the interior inspection and breaker testing.

Enter all changed conditions into the GIS database.

Maintenance Recommendations

At the time of fixture inspection, clean the lens inside and outside and clean the photocell if one exists on the fixture.

Replace failed photocells (light on during daylight).

Replace timers or circuit breakers that fail testing.

Replace lamps in all fixtures at least once every four years, and sooner if the light intensity at deck surface 10 feet from fixture falls below 50% of the initial output when installed. Test light intensity at deck surface 10 feet from fixture after new lamps are installed and record value.

Replace fixture gaskets that are damaged or have become brittle.

Record all repairs and replacements of specific elements in the GIS database.

TABLE OF UTILITY & LIGHTING INSPECTION RECOMMENDATIONS

Element Description	Frequency
Potable Water System	6 Months
Sewer, Drain & Vent Systems	6 Months
Natural Gas System	6 Months
Electrical System	1 Year
Lighting System	
Poles & Fixture Exteriors	1 Month
Fixture Interiors	1 Year
Timer Switches and Breakers	6 Months

APPENDIX

On-Shore Pile Inspection Report
Santa Monica Pier

Date Inspected: Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

Bent	Row	Pile ID	Pile Type	Classification	Condition	Material	COMMENTS	PIER	TYPE OF INSPECTION

Off-Shore Pile Inspection Report
Santa Monica Pier

Date Inspected: Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

Bent	Row	Pile ID	Pile Type	Inspection Level(1,2,3)	Time	Gauge Depth @ Dmg/Note	Classification	Condition	Type Of Damage	Height Of Damage	Width Of Damage	Penetration From Surface	Material	Comments	Pier	Type Of Inspection (Offshore)

Pile Cap Inspection Report

Santa Monica Pier

Date Inspected:

Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

BENT	ROW	Cap_ID	PILE_ID	MEMBER	CONDITION	COMMENTS	MATERIAL	PIER

Corbel Inspection Report
Santa Monica Pier

Date Inspected:

Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

Bent	Row	Pile ID	Member	CONDITION	Material	COMMENTS	Pier

Sub-Cap Inspection Report
Santa Monica Pier

Date Inspected:

Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

BENT	ROW	Cap ID	PILE ID	MEMBER	CONDITION	COMMENTS	MATERIAL	PIER

Block Inspection Report
Santa Monica Pier

Date Inspected: Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

Bent	Row	Pile ID	Member	CONDITION	Material	COMMENTS	Pier

Transverse Bracing Inspection Report
Santa Monica Pier

Date Inspected: Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

Pile ID	TransB_ID	Orientation	CONDITION	Material	COMMENTS	Pier

Longitudinal Bracing Inspection Report
Santa Monica Pier

Date Inspected:

Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

PILE_ID	LONGB_ID	ORIENTATION	CONDITION	MATERIAL	COMMENTS	PIER

Pile Cap Inspection Report
Santa Monica Pier

Date Inspected: Inspectors:

Note: Bents numbered from East to West and piles lettered from North to South

PILE ID	UTILITY	CONDITION	COMMENTS	PHOTO

SAFEGUARD Chemicals

DRY ROT
AND
ITS CONTROL

A Guide to the Biology, and
the Control of Dry Rot
using
Safeguard ProBor Boron
Preservatives

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Whilst every care has been taken to ensure the accuracy of the contents and data contained within this publication, no guarantee or liability is assumed for the information given.

CONTENTS

DRY ROT AND ITS CONTROL

PREFACE.

The dry rot fungus, *Serpula lacrymans,* is often regarded as the 'cancer' of a building. Many myths have built up concerning what this fungal decay is capable of doing, occasionally leading to the belief that the fungus is indestructible and that the whole of the building will have to be pulled down.

However, dry rot is vulnerable to certain environmental effects and, like *all* wood destroying fungi, it has essential needs, and it is those needs that limit the extent of spread and damage that this organism can inflict. Unfortunately dry rot is a very secretive organism, favouring dark, damp stagnant conditions to develop. This is frequently why it is able to spread extensively before the damage is first noticed

'Dry Rot and its Control' sets out to describe the fungus its biology, what it can and can't do, the conditions it must have, and most importantly how it can be readily controlled with the proper combination of environmental and building considerations coupled with the *proper* use of timber and masonry preservatives.

Many people expect large volumes of chemicals to be used and that they will have to put up with the risk of any toxic effects and unpleasant odours and fumes which may be a part of the treatment.

'Dry Rot and its Control' describes the use of Safeguard ProBor 50, ProBor 20 and ProBor 10, a new series of fungicides based on boron, a naturally occurring mineral. These new products are virtually odourless and have a mammalian toxicity generally in the order as that of common household salt! Furthermore, 'ProBor' formulations are 'environmentally friendly' and have a very significant advantage over the traditional dry rot preservatives in that they are water diffusible and therefore diffuse into those areas that are particularly susceptible to dry rot and other decays, i.e., where the wood is wet; the traditional preservative will not diffuse into wet timber therefore leaving such wood at great risk of decaying.

The correct use of Safeguard 'ProBor' products as described in 'Dry Rot and its Control', coupled with good building practice, will ensure that a building will be at very little risk from further dry rot activity and yet not put the occupants or the environment at risk from the problems which can arise from the use of traditional timber and masonry preservatives.

DRY ROT AND ITS CONTROL

The wood destroying fungus, *Serpula lacrymans*, is commonly known as dry rot. However, the name 'dry rot' might be considered rather inappropriate since like all wood destroying fungi it requires water for germination, growth and survival. Indeed, water/dampness is the fundamental need of all wood destroying fungi plus, of course, a food source (wood); without either the fungus ceases to grow and dies.

WOOD AS A FOOD SOURCE:

FORMATION OF WOOD

Wood is a natural material being the end product of a complex chemical process, photosynthesis, which occurs in green plants (Fig. 1). Wood basically consists of boxes and tubes made of sugars which are linked together to form *cellulose*, the basic building material of plants. Chains of cellulose are laid down in different orientations and bonded by another material, *hemicellulose*. A further material, *lignin*, adds rigidity and strength. It is the arrangement of cellulose with the two other materials which give wood its characteristic properties and its 'cellular' structure.

Figure 1: The formation of wood:

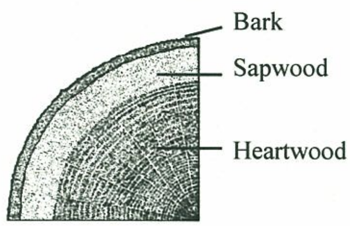
CARBON DIOXIDE + WATER —photosynthesis→ SUGARS

↓

CELLULOSE
HEMICELLULOSES
LIGNIN

The wood forming the outer part of the tree is known as the *sapwood* and transports sap and stores food (Fig. 2). This is the most vulnerable part of wood to fungal decay and attack by wood-boring insects. The inner wood is the *heartwood* and forms the older wood in the centre of the tree; it does not conduct sap or store food but it does contain some excretory products and is more resistant to decay than the sapwood. It is also more resistant to the movement of water and preservatives in general. The heartwood of different timbers varies in its resistance to fungal decay and it is this heartwood resistance to decay by which timbers can be classified, i.e., non-durable, durable, etc.

Figure 2: Structure of wood



WOOD DECAY

Wood decay is basically the reverse of wood formation. Dry rot attacks the cellulose and hemicellulose of the wood to break it back down into its sugar components (Fig. 3). The sugars are respired with air to produce carbon dioxide, water and the energy for growth. However, the lignin is not metabolised and this gives rise to the darkening in colour of the wood

Figure 3: Wood decay:

CELLULOSE —Enzymes from fungus→ SUGARS + WATER

↓

SUGARS + OXYGEN

↓

WATER + CARBON DIOXIDE + ENERGY

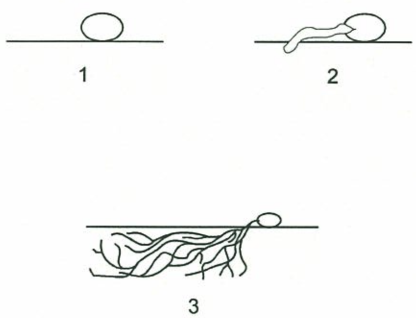
A number of wood destroying fungi other than dry rot also decay the wood in the same manner, leaving the lignin untouched. The characteristic darkening of the wood by these fungi give them the loose title of 'brown rots'; dry rot is one of the brown rots.

When the wood is broken down and utilised for food, shrinkage, loss of weight, loss of strength and cracking occur. It is the shrinkage which causes the typical 'cuboidal' cracking (cracks to form small cubes) of dry rot and the other brown rots. Indeed, it is this shrinkage and cracking which is often the first signs of a problem.

THE INITIATION OF FUNGAL DECAY.

The essential requirements for any fungal decay to take place are both food and water, especially the latter at a sufficient level. Fungal decay is generally initiated in several stages.

Figure 4: Initial colonisation of wood.

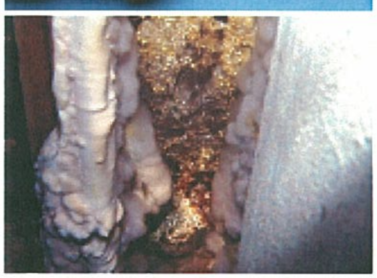


First the water penetrates the wood and this allows bacteria and micro fungi to colonise. These break down part of the cell structure but do not cause weakening of the wood. Instead, the wood becomes more porous which allows it to become even wetter. Provided that the wood is now sufficiently wet and remains wet and that other conditions are suitable the wood rotting fungi such as dry rot can colonise.

DRY ROT -- *SERPULA LACRYMANS*

COLONISATION

A minute spore of dry rot lands on wet wood and germinates (Fig. 4, 1 - 2). The first growth that emerges from the spore is known as the *germ tube*. This grows and divides to produce fine filaments, *hyphae*, which invade the timber and secrete enzymes to break down the wood (Fig. 4, 3).



Mycelium

As the wood is broken down by the enzymes secreted by the growing fine filamentous *hyphae* the wood becomes even more porous so allowing further water to penetrate into the timber. Furthermore, the by-product of the decay process is water which can also contribute to the moisture within the wood (Fig. 2).

VEGETATIVE GROWTH

The fine filaments of fungal growth, the hyphae, develop into a larger mass, the *mycelium*, which grows into and across the damp wood. Under humid conditions the mycelium is white and cotton-wool like, and in a very humid and stagnant environment droplets of water will form on the mycelium rather like tear drops; hence the name 'lacrymans'. These droplets are probably caused by the fungus removing excess water from the wood.

Developing strands

Under less humid conditions the mycelium forms a silky grey coloured skin which is often tinged with yellow and lilac patches. This form of the mycelium can be peeled rather like the skin on the cap of a mushroom.

Strands: Within the mycelium special thick walled hyphae develop — these are known as *strands*. They are resistant to desiccation and assume their real importance when the fungus spreads over and into 'inert' materials such as mortar and brick. In these situations they conduct water and nutrients to the growing hyphal tips so allowing the fungus to continue to spread over non-nutrient substrates. It is this ability to travel away from the food source, over and through inert materials allowing the fungus to reach more timber, which makes dry rot so potentially destructive.

FRUITING BODY (SPOROPHORE)

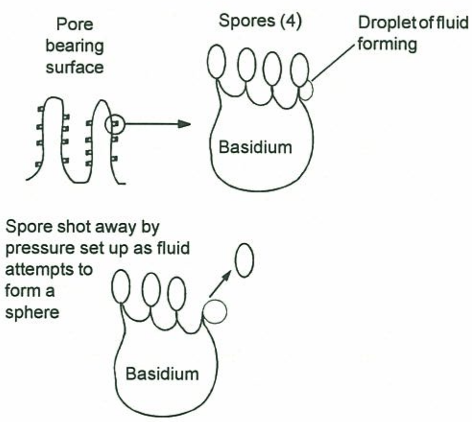
Fruiting body

When growth is usually advanced a *fruiting body* (*sporophore*) may develop. This can occur as the result of two different mycelia meeting, or the onset of 'stress' conditions such as drying out of the wood/environment. Light is also thought to be the cause of fruiting body formation in some situations.

The fruiting body takes the form of a 'fleshy pancake' or a bracket, the surface of which is covered with wide pores or corrugations. The surface is orange/ochre coloured. The corrugations form the spore bearing surface.

The spores themselves are very small (about 0.01mm), ovoid in shape and orange in colour. They develop on a structure known as the basidium, four spores to each basidium (Fig. 5). When fully developed a small droplet of fluid forms at the junction between the spore and the fine stalk on which it developed. The pressure exerted by the droplet of fluid trying to form a true sphere is sufficient to eject the spore some 20mm away from the fruiting body into the surrounding air currents for dispersal.

Figure 5: Spore formation and dispersal:



Large numbers of spores frequently collect around the fruiting body under still conditions and form the red 'dust' often visible where there is a significant attack of dry rot.

GROWTH AND SURVIVAL

It is essential to understand that water is absolutely fundamental to the growth and survival of not only dry rot but all wood destroying fungi; wood decay cannot occur, exist or survive without it!

Spore germination: To *initiate* growth from a spore the wood must be physically wet; in other words it must be subject to a source of water ingress, e.g., leaking gutters, wood in contact with damp masonry, etc. In practical terms the wood must have a moisture content in excess of 28-30%. Spores will not germinate on dry surfaces or surfaces which are not suitably wet. In other words, unless the wood is wet dry rot cannot become initiated.

Growth: Whilst timber needs to be wet for growth to be initiated, at moisture contents of around 22% existing mycelial growth ceases and the fungus will eventually die; decay just above 22% is likely to be *very* minimal. However, for practical purposes when dealing with fungal decay as a whole moisture contents of 20-22% should be taken as the threshold figure and assume moisture contents in excess of this level put the timber at risk.

The fungus flourishes under humid, stagnant conditions; hence growth tends to be secretive and hidden and is therefore often extensive before it becomes evident.

Identification of dry rot

- The wood shrinks, darkens and cracks in a 'cuboidal manner (typical 'brown' rot damage)

- A silky grey to mushroom coloured skin frequently tinged with patches of lilac and yellow colouration develops under less humid conditions. This 'skin' can be peeled like a mushroom.

- White fluffy cotton wool-like mycelium develops under humid conditions: 'teardrops' may develop on the growth.

- Strands develop in the mycelium; these are brittle when dry, and crack on bending.

- Fruiting bodies are a soft fleshy pancake or bracket with an orange.ochre surface: the surface has wide pores.

- Rust red coloured spore dust frequently seen around fruiting bodies.

- Active decay produces a musty, damp odour.

Dry rot:

Unlike other wood destroying fungi dry rot can grow significantly on and through damp masonry; under special conditions very limited growth might occur over and through dry materials. Distances in excess of 2 metres away from its food source have been recorded, and it is this ability to grow over and through inert material that can lead to significant problems of spread.

Like all wood destroying fungi dry rot flourishes in the slightly acidic conditions found in wood. But unlike the others it also flourishes under slightly alkaline conditions which explains the frequently encountered rapid growth behind and through old mortars and renders.

Growth rates of up to 4 metres per annum have been recorded; in other cases the organism may only have spread a few millimetres in the same period of time. However, Building Research Establishment give a figure of about 0.8 meters per year as a general purpose maximum growth rate (BRE Digest 299) and Coggins (1980) gives a general figure of about 1 metre per annum. Because there are large variations in growth rates, the age of an outbreak cannot be positively determined. The problem is further complicated since it is not always possible to tell if an outbreak is the result of a single outbreak or the coalescing of numerous outbreaks.

Without a source of food (wood) growth will quickly cease and the fungus eventually die. But research has shown that in the laboratory the food reserves in the mycelium may allow up to 20% growth before spread ceases. This might have important implications in control measures since it could theoretically allow the infection to pass to immediately adjacent non-infected wood even though the original food source had been removed but leaving the mycelium on, say, damp brickwork.

Survival: The spores are reported to remain viable for up to 3 years. They could therefore lay dormant until such times when conditions become suitable for their germination, that is, when any exposed wood surface on which they have landed becomes wet. The mycelium can remain viable in damp masonry at around 18-20°C without a food source for up to 10-12 months. But under the damp, humid conditions such as found in a cellar with temperatures of 7-8°C, the mycelium may remain viable for up to 9-10 years! If untreated wood is put in contact with damp infected masonry there is always the potential for the new wood to become infected.

THE PRINCIPLES FOR THE CONTROL OF DRY ROT

The *principals* for the control and eradication of dry rot are outlined as follows:

PRIMARY MEASURES

The most vulnerable feature of the fungus is its requirement for water, and it is the control and elimination of this essential requirement that forms the *fundamental* measure for the control and elimination of dry rot.

- Locate and rectify the source of water causing and maintaining the rot.
- Promote and maintain rapid drying conditions.

The removal of the source of water is the first point of attack. It is therefore absolutely essential to stop further water ingress. This action alone will eventually control and eliminate the activity. Indeed, it is the fundamental measure in eradicating the organism. Included in this action is the promotion and maintaining of rapid and good drying conditions.

SECONDARY AND SUPPORT MEASURES:

- Remove infected wood: the removal of the food source will relatively quickly stop the spread of growth.
- Reinstate using pre-treated timber (double vacuum/pressure impregnated as appropriate), or use inert materials such as concrete, steel, etc. Consideration should also be given to the use of preservatives for steeping joist ends prior to reinstatement.
- Spacial and physical isolation: for example reinstate timbers using joist hangers, joinery wrap. These deny the fungus a potential food source and they also prevent timbers from becoming wet.
- Contain the fungus within the masonry away from potential food sources as follows:

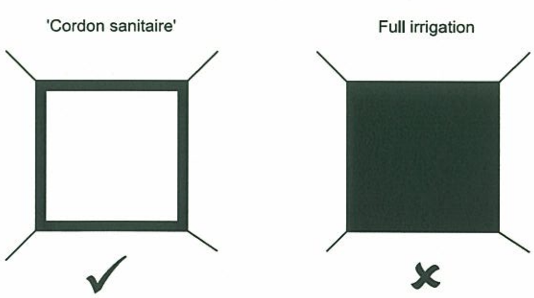
  a. Physical containment: joinery lining around adjacent timbers.

  b. Fungicidal renderings and paints: these effectively form chemical barriers. They are based on the use of zinc oxychloride (ZOC).

  c. Masonry sterilisation: This involves the application of a special water based fungicide to the masonry in the following manner:-

A surface spray with a masonry biocide is usually all that is required. However, in more severe situations a 'cordon sanitaire'

Figure 6: Masonry treatment.



SAFEGUARD Chemicals

('toxic box') could be used (Fig. 6) This involves drilling perimeter of the infected area and injecting masonry sterilant into the masonry under pressure; the work is finished with a liberal surface spray or brush treatment with the sterilant

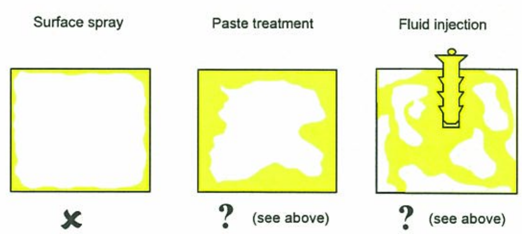
The traditional full wall irrigation using standard water based fungicides injected under pressure where the whole of the wall is drilled and injected usually introduces too many problems and is basically unnecessary. It introduces excess water into the masonry which frequently causes more damage than the dry rot. It is also unlikely that full saturation will be achieved, and it is also unnecessary use of a biocide.

- Insitu chemical treatment of timber:

a. Surface spray: These are likely to be relatively ineffective since they afford very little protection of the wood. Only the outer surface of the wood receives fungicide, the greater proportion of the timber remaining untreated (Fig. 7).

b. Conventional fungicidal pastes: Conventional pastes consist of an oil/water emulsion with the consistency of a thick 'mayonnaise'. Because of their high oil content which carries the fungicide there is the *potential* for deep penetration provided that sufficient is applied and that the wood is not too wet.

Figure 7: Insitu chemical treatments of timber:



In most situations, however, the wood is already damp and therefore at risk from decay. In such situations conventional paste preservatives are unlikely to penetrate to any great extent because of the resident moisture in the wood. Furthermore, any surface applied paste relies on diffusion to reach deep within the wood, and even with a paste preservative the levels of fungicide necessary to prevent rot are unlikely to be achieved since the highest loading remain towards the surface therefore affording little protection towards the interior (Fig. 7).

c. Fluid injection: This involves the injection of fungicides carried in organic solvents via special plastic valves driven into the wood (Fig. 7). The fluid is injected under pressure and can potentially give good distribution of the fungicide *provided* the wood isn't too wet.

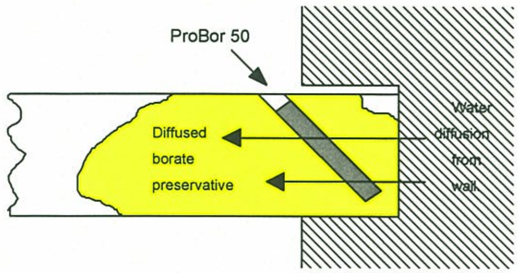
Unlike conventional paste preservatives the fluid is injected within the wood and doesn't depend on penetration from the surface. But it is likely that insitu timbers are damp/wet and when such a treatment is applied it can lead to very poor distribution of the preservative due to the presence of resident moisture.

d. Borate rods: This preservative is supplied as glass-like rods which consist of a special fusion of boron compounds; these are inserted into holes drilled into the wood. The rods are soluble in water and should timber become damp then the rod slowly dissolves and distributes the preservative by diffusion into the wet areas. Because the rod is embedded *in* the wood the preservative distributes precisely into those areas which become at risk to decay. Their use is ideal in those areas which are at risk to decay but not yet affected, e.g., embedded joist ends, window joinery, etc.

However, it must be appreciated that diffusion of the borate preservative from the rod does not take place at any significant speed at moisture contents below 26-27%. Thus, it is possible to have a situation which will propagate the spread of dry rot yet the preservative is not diffusing.

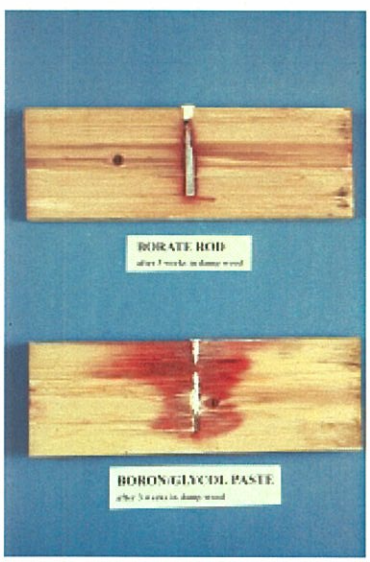
e. Safeguard 'ProBor' 20 and 50 boron preservatives: These consist of an inorganic boron preservative dissolved in a glycol. ProBor 20 Gel is a thickened liquid and is usually surface applied and ProBor 50 is a paste which can be either surface applied or preferably injected into holes in timber or into masonry by means of a caulking gun (Fig. 8)

Figure 8: The action of ProBor 50 boron paste



Like the borate rod Safeguard ProBor preservatives are water soluble and will readily diffuse into damp wood, even from the surface. But unlike the rods diffusion is significantly more rapid and efficient because the material is supplied as a water miscible liquid/paste. The glycol in which the borate is dissolved and suspended is hygroscopic thereby causing rapid mixing of the soluble borate with any resident moisture.

The nature of the Safeguard ProBor formulations also ensures that diffusion will occur in wood with a moisture content considerably lower than 20% because of the hygroscopic liquid base. This adds to the initial protective value of the treatment should the wood eventually become wetted because the preservative would have already diffused and distributed. In this respect ProBor 50 paste has the added advantage of leaving a reservoir of solid preservative after the initial rapid diffusion which will slowly dissolve and diffuse for a long period should the conditions remain damp. Indeed, a recent research paper by Holland and Orsler reporting the evaluation of *traditional paste* treatments was of the opinion that, " — treatment against wood destroying fungi — may be insufficiently effective for more severe risk situations in the longer term."



ProBor -v- Borate rod diffusion

The overall advantages of boron based preservatives, especially Safeguard ProBor formulations, are that they are designed to distribute effectively *within* timbers at risk thereby affording good protection, unlike the more conventional formulations which suffer from a distinct limitations where they are required to penetrate damp, susceptible wood.

Note: Whatever the strategy employed to control fungal decays it is essential that the primary measures are instigated immediately before deciding on the secondary and supportive chemical treatments.

All risks should be thoroughly evaluated where wood is like to remain embedded or in damp conditions, even where treated, and it is essential that in such cases the centre of the wood receives full treatment. The limitations of traditional preservatives and their application in conditions of sustained dampness must be fully understood.

CONCLUSIONS.

In considering the requirements for the growth and survival of dry rot and methods and practices for its control, *the emphasis is on attacking the essential requirements for growth and survival.*

Where chemical control is used as a support measure or to reduce the risk of decay to damp timbers it is essential that the *whole* of the area of wood at risk is treated, i.e., deep within the timber. This is unlikely to be achieved with 'conventional' preservatives. Indeed, Holland and Orsler (1992) reported in a paper to The International Research Group on Wood Preservation (Preservatives and methods of treatment) that, *"--- treatment against wood destroying fungi by this means [conventional preservative pastes] may be insufficiently effective for more severe risk situations in the longer term."*

Unlike conventional preservative pastes the boron based materials, especially Safeguard ProBor formulations, are designed to work under high risk situations, i.e., when the timbers are damp and at risk to decay. The ProBor formulations have the added advantage in that they will distribute more rapidly than the solid borate rods thereby ensuring greater potential protection and lowering more rapidly the risk of rot. This is especially important where the moisture contents for dry rot are marginal for survival -- the solid borate rods will not distribute so effectively under these marginal conditions. Furthermore, ProBor 50 also leaves a 'reservoir' of solid borate for long term diffusion and effectiveness.

The control of dry rot should be the *total* responsibility of specialist treatment companies; this includes all the attendant building works as well as any chemical treatment where deemed necessary. Fundamentally, the specialist contractor will fully understand the factors involved with the outbreak of dry rot and the significance of the control measures and associated risks. Furthermore, the use of the single specialist contractor will eliminate the problem of *'split responsibility'* where part of the required and essential work is undertaken by a third party and part by the specialist contractor. The elimination of this split responsibility certainly serves to eliminate the cause of many continued outbreaks following failure of third parties to comply fully with the instructions issued. It certainly can eliminate some potentially very expensive disputes!

A PRACTICAL GUIDE TO THE CONTROL AND ERADICATION OF DRY ROT

A guide to the eradication of dry rot using Safeguard ProBor soluble boron preservatives is outlined below. However, it must be remembered that the following details will need to be modified to suit site conditions and level of risk.

Before undertaking any work/treatment a full risk/hazard assessment must made as required under the Control of Substances Hazardous to Health (COSHH) Regulations 1988.

INSPECTION:

1) Carefully inspect all timbers, removing skirtings, floorboards, masonry, etc., to determine the extent of the infection. Test for fungal decay by prodding timbers with a screwdriver or similar instrument and carefully examine to assess depth of decay in any large dimension timbers.

2) Inspect plasterwork adjacent to decay for signs of fungal strands/mycelium. The extent of growth can be determined by removal of plaster samples. Strip off any plaster containing or suspected to contain the fungus; also examine the mortar courses for fungal growths. Flaking, bulging and damp patches an plaster should also be investigated.

3) Inspect cavity wall for spread of fungus by removal of random bricks to provide access.

4) Check ventilation to timber suspended floors and improve if necessary.

CONTROL MEASURES:

i Primary:

i) Locate and rectify the source of dampness causing the decay and identify other vulnerable areas within the property. Promote and maintain drying conditions.

The primary measures for control as described above are extremely important and form the basis for eradicating the fungal infection.

ii Secondary

Cut out and remove from site all decayed timbers together with a margin of up to 600mm beyond the last evidence of fungal decay; the actual amount removed will depend upon the extent of decay and the site conditions.

Remove all built in timbers e.g. lintels, bonding timbers etc., within the affected areas and replace with steel or concrete according to the local building regulations.

However, in many cases this might be unwarranted or too expensive. There fore the use of Safeguard ProBor 20 Gel and ProBor 50 preservatives should be used. Application details and rates are given below.

Ensure that all timber debris is removed from any damp subsite. Where dry rot is present in the subsite soil remove the top 75mm and dispose. Where this cannot be acheived, rake to a depth of 100mm after removing any debris and apply Safeguard ProBor

10 to sufficient quantity.

Replacement of timber suspended floors with solid floor should be considered if appropriate ensuring hardcore is NOT dry rot or wood contaminated.

Thoroughly clean down all exposed masonry using a wire brush to remove surface fungal growth. Thoroughly clean up and remove all dirt and debris which may contain fungal growth.

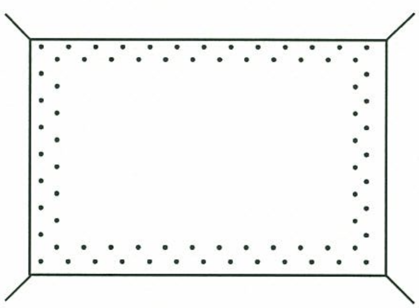
Full masonry treatment with conventional liquid sterilants is not recommended due to the attendant problems of injecting large quantities of water into masonry. It is also unnecessary and will also introduce excess biocide into the environment. Where masonry sterilisation is deemed necessary then:

(a) First rake out all mortar joints to a depth of 10-15mm; this will facilitate penetration of sterilant into the mortar and a key for subsequent replastering.

(b) Thoroughly sterilize the *surfaces* of walls using Safeguard ProBor 10 Masonry Biocide, using a coarse spray (not atomised); two to three liberal applications should be applied.

(c) Irrigation by injecting into masonry should only be undertaken to isolate an outbreak or dry rot by imposing a 'cordon sanitaire' (peripheral irrigation - Fig. 9); this may be undertaken in the following circumstances:

Figure 9: 'Cordon sanitaire' (peripheral irrigation)



(i) between the outbreak and any timbers in close proximity not yet affected.

(ii) to isolate some built in timbers which have decayed and are not readily removable. Such timbers should also be thoroughly treated with a combination of Safeguard ProBor 20 Gel and 50 boron based preservatives.

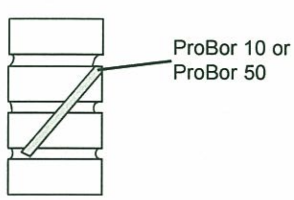
(iii) to masonry where dry rot has become firmly established in timbers/masonry from an adjacent property.

(iv) to the base of a wall where dry rot is firmly established in infected wood beneath a solid floor.

Peripheral irrigation should only be carried out where deemed necessary to walls in excess of 130mm in thickness.

In most cases use Safeguard ProBor 10. Two to four rows of holes 10 - 14mm diameter should be drilled around the perimeter of the walls with a spacing between rows of 115 - 225mm (Fig. 9). Drill holes down through the brickwork at an angle to terminate in a mortar bed and with a spacing of approximately 230mm. Fill each hole with ProBor 10 (Fig. 10); top up holes if necessary after it has percolated into masonry. One litre of ProBor 10 should fill around 30-40 holes in a 225mm wall with a single application; double this figure for a 'top up' application. Finish with a liberal surface spray of ProBor 10 using low flooding technique using 2 - 3 passes to apply around 1 litre per 1 - 2 square metres.

Figure 10: Drilling masonry for Deepflow/ Deepwood



Alternatively, where masonry is likely to remain damp the perimeter may be drilled and Safeguard ProBor 50 injected into

SAFEGUARD Chemicals

the holes; one cartridge should fill 10-12 holes in a 225mm wall. The surface must be treated with ProBor 10 as above.

Please note that the above figures are only a guide and may vary considerably according to the condition, nature and porosity of the substrate.

REINSTATEMENT

1) When considering reinstatement of timbers into previously infected damp walls careful consideration to the use of membranes, sleeper walls and joist hangers, in accordance with local Building Regulations, should be made. This will physically and spacially isolate the wood from damp infected masonry

2) Replaster exposed walls before replacement of woodwork. Consideration should be given to use of chemical barriers, including the use of zinc oxychloride based materials, in situations where a severe infection of dry rot has been identified; with particular reference to areas where access for treatment to both sides of masonry is not possible e.g. terrace property.

3) Replacement timbers should be pre-treated by industrially pressure impregnation, eg, tanalised timber, or similar approved method; following working any cut ends should be retreated with ProBor 20 Gel or ProBor 50 paste.

As an alternative new timbers may be first fully worked and the ends drilled using 8 - 190mm diameter holes. The ends are then steeped to a depth of at least 400mm in ProBor 20 Gel for 3 hours. ProBor 50 paste should then be applied into the holes. Joist ends should then be wrapped in suitable damp-proof membrane around their bearing ends or paint the cut ends where they are to be embedded with at least 3 liberal coats of a suitable bituminous compound and allow it to dry thoroughly. The remainder of the wood should be given liberal coats of ProBor 20 Gel.

4) All sound timber in the vicinity of the outbreak should be cleaned and thoroughly treated with ProBor 20 Gel and 50 preservatives. The extent of treatment should be assessed depending on site conditions. This treatment is especially important should the wood be sound but damp. Any embedded timbers will need to be drilled with holes of 8-10mm diameter and ProBor 50 applied in the holes and also around the periphery if possible.

In the case of embedded large dimensioned timbers or lintels it is recommended that masonry is removed to gain access to the embedded parts and these are treated with ProBor 50 paste before reinstatement of the disturbed masonry.

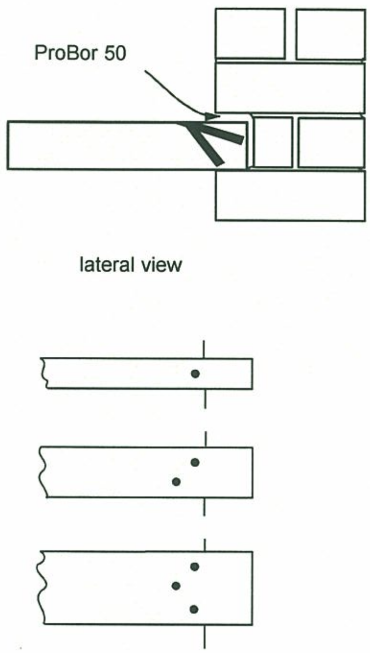
PLEASE NOTE:

Where timbers are to be left in situ in a damp environment they will be at risk from fungal decay. To treat these timbers it is essential that the whole of their area *and* volume receives treatment. Safeguard ProBor boron preservatives are designed to distribute well into the timbers under such conditions.

Any insitu damp timber will be at risk --whether treated or not! However, Safeguard ProBor preservatives, when applied as directed, will significantly minimise that risk.

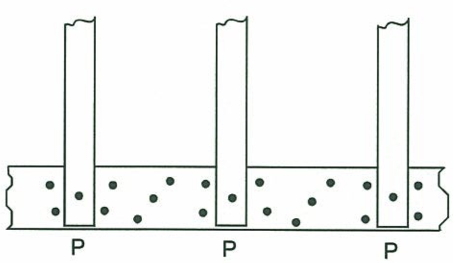
Following works it is *essential* that the property is kept in good order and is maintained in a dry state.

Figure 11: Embedded joist ends



= ProBor 20 Gel

Figure 12: Joists and wallplates



= ProBor 20 Gel

P = apply ProBor 50 to exposed end grain

APPLICATION OF PROBOR 20 AND 50 TO INSITU TIMBERS

In many cases it may be necessary, because of costs or other considerations, to leave wood in infected damp areas. Any timbers remaining in such a condition will be at risk from fungal decay. However, the correct use of Safeguard Deepwood boron preservatives will keep any risk to a minimum. It might also be considered prudent to treat those areas where dampness could appear, e.g., subfloor timbers.

ProBor 20 Gel is supplied in 5 litre containers. It is a moderately viscous liquid which can be applied by brush and by dipping.

ProBor 50 is supplied as a viscous paste in plastic cartridges which fit readily in to caulking guns. An extension nozzle is also supplied to allow full application deep into holes drilled into timber and masonry.

SURFACE APPLICATION OF PROBOR 20:

Apply by brush or dipping.

Brush: Apply to wood surfaces at a rate of 1 - 2 litres per square metre; if necessary use more than one application to obtain this level of preservative application.

Dipping: Fully work timber before dipping. Bearing ends should be dipped at least to 400mm from their bearing ends for a minimum of 2 hours. 8 - 10mm holes may be drilled in the bearing ends to facilitate the uptake of ProBor 20 Gel within the wood during the dipping process (See ProBor 50 below). The holes may then be further filled with ProBor 20 Gel or preferably ProBor 50 before reinstatement. Dipping is considered to be more thorough than brushing, and should be used where possible.

APPLICATION OF PROBOR 50:

ProBor 50 boron paste has been cleared for use under the Control of Pesticide Regulations for both timber and masonry.

Timber:

Joists and wallplates.

Warning! Always ensure that the structural integrity of the joist ends/wallplates is not compromised by drilling!

Ideally, if possible, lift the wallplate/joist and insert damp-proof membrane beneath to isolate wood from any dampness in the substrate.

If this is not possible and to give added protection then drill two holes each between 8 - 10mm diameter in the end of an embedded joist/wallplate (See Figs. 11 and 13). Where more than pair of holes is to be inserted the holes must be staggered as in Figure 11.

Figure 13: Joists on sleeper walls

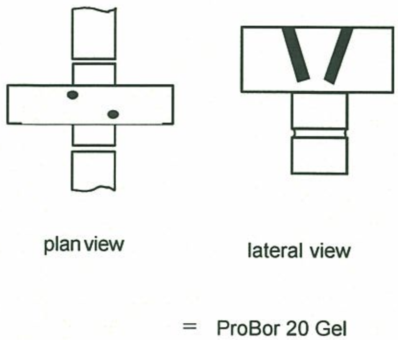


Figure 14: Lintels and embedded timbers

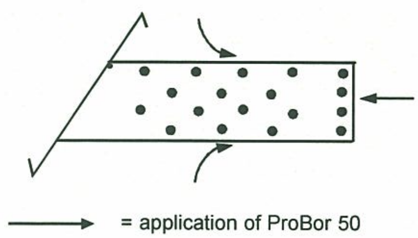


Figure 15: Window frames

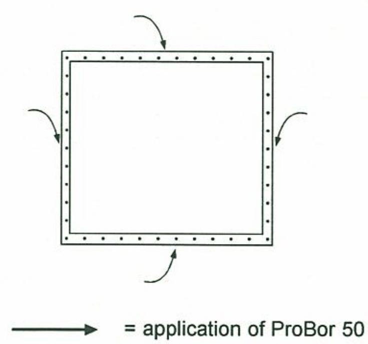
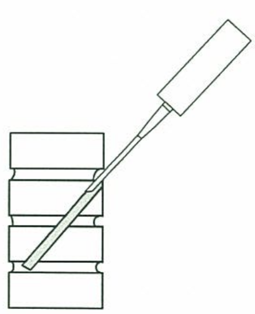


Figure 16: ProBor 50 applied to masonry



Where the whole length of a wallplate is embedded then drill a staggered pattern of 8 - 10mm diameter holes broadly as shown in Figure 12.

ProBor 50 is applied via a caulking gun into the holes by pushing down the extension nozzle to the bottom of the prepared holes and gradually withdrawing as the paste is extruded; this action ensures that the holes are fully filled.

ProBor 50 may also be applied to a surface by trowel or palette knife 3 -5mm in thickness and should cover all surfaces. This technique is especially useful following the above treatment of exposed insitu joist ends (Fig. 12) and in gaps and cracks around embedded timbers.

It is also possible to apply ProBor 50 in 'strips' of 8mm diameter from a caulking gun; these should be placed at 15 to 20mm intervals across the full width of the surface to be treated.

Lintels/embedded timbers

Drill holes 8 - 10mm diameter around the perimeter to within 10mm of the furthest face. The holes should be drilled within 25mm of the end of the lintel and follow a staggered pattern of 100mm intervals along the grain and 70mm intervals across the grain (Fig. 14). Ensure that 'end grain' is fully treated. Where possible remove masonry around the lintel/embedded wood and apply ProBor 50 paste to all exposed surfaces. The exposed face should be treated with ProBor 20 Gel.

Door frames/window frames

Warning! Always ensure that the structural integrity of timbers is not compromised by drilling.

Ideally these should be removed and the recess lined before reinstatement to prevent long term contact with damp/infected masonry. However, where this is not possible then drill holes 8 - 10mm diameter at 100mm intervals to within 15mm of far face and apply ProBor 50 by caulking gun. Plug holes following injection with short lengths of timber dowel. Where possible use ProBor 50 paste around the edges of the frames (Fig. 15)

Please Note: ProBor 50 may leave an 'icing sugar' like residue when applied to timber surfaces.

Masonry

ProBor 50 can be applied into pre-drilled holes in masonry for the control of dry rot (Fig. 16); this is recommended where walls are likely to remain damp for very long periods. The injection is undertaken by means of the caulking gun. The extension nozzle is placed down the drilled hole and the paste extruded whilst slowly withdrawing the nozzle.

GUIDE TO APPLICATION RATES OF PROBOR BORON PRESERVATIVES

The following figures should be taken as a guide only. They may vary with the condition and type of substrate.

Before use please read carefully the Health and Safety Data Sheets for ProBor preservatives.

ProBor 10

Masonry:-

Surface application:	1 litre per 1 - 2 m^2
Irrigation:	30 - 40 holes per litre in a 225mm wall

ProBor 20 Gel

Wood:-

Surface application (brush/spray):	1 litre per 1 - 2 m^2

ProBor 50

Wood:-

Surface application (trowel)	3 - 5 kilo per m^2
Holes in wood	around 25 holes of 150mm long by 8mm diameter per cartridge.

Masonry:-

Irrigation	10 - 12 holes per cartridge in a 225mm wall.

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