

PRESERVATIVE TREATMENT OF GLUED LAMINATED TIMBER



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INTRODUCTION

Structural glued laminated timbers (glulam) bearing the APA EWS trademark are produced by members of *Engineered Wood Systems* (EWS), a division of APA – *The Engineered Wood Association*. These glulam timbers are manufactured to conform with ANSI Standard A190.1, American National Standard for Structural Glued Laminated Timber⁽¹⁾.

Although glulam does not require preservative treatment for most uses, certain applications may present environmental conditions conducive to decay, insect or marine borer attack, such as the long-term or frequent presence of moisture (generally 20 percent or greater moisture content of the wood) accompanied by temperatures ranging from 50 to 90°F. Decay slows at temperatures outside this range and virtually ceases at temperatures below 35°F or above 100°F.

These hazards are typically controlled through recognized design principles and construction techniques, such as use of overhangs, flashings, ventilation and proper joint connection details. When conditions conducive to decay or insect attack cannot be avoided, glulam must be pressure-preservative-treated or a naturally durable wood species must be used. Examples of construction where such hazards may exist include direct exposure to weather, ground contact (including direct contact with concrete foundations and footings), contact with fresh water or sea water and exposure to excessive condensation.

Outdoor uses of preservative-treated glulam include bridges, utility structures, marine applications, highway noise barriers and decks. Indoor uses that may require pressure treatment include environments subject to high humidity or condensation such as indoor swimming pools or greenhouses, where moisture content of the wood may exceed 20 percent. Indoor applications, such as post-and-beam construction in some farm buildings, may also involve ground contact, and thus require preservative treatment for those members in contact with the ground.

APPLICABLE STANDARDS

Applicable standards for preservative treatment of glulam include American Wood Preservers' Association (AWPA) Standards U1⁽²⁾ (and all other standards referenced therein) and M4⁽³⁾. Related specifications include American Forest and Paper Association National Design Specification⁽⁴⁾; American National Standards Institute, Inc. ANSI A190.1⁽¹⁾; and American Association of State Highway and Transportation Officials (AASHTO) (Standard Specification for Transportation Materials and Methods of Sampling and Testing)⁽⁵⁾.

INTENDED END-USE SERVICE CONDITIONS

The American Wood Preservers' Association (AWPA) has replaced the Commodity (C) Standards with the Use Category System (UCS). Service conditions are now designated into five basic use categories in AWPA Standard U1⁽²⁾. The use categories designations and service conditions that apply to glulam are summarized in Table 1.

TABLE 1

SUMMARY OF USE CATEGORIES FOR TREATED WOOD

Use Category	Service Conditions	Use Environment	Common Agents of Deterioration	Typical Applications
UC1	Interior construction, above ground, dry	Continuously protected from weather or other sources of moisture	Insects only	Interior construction and furnishings
UC2	Interior construction, above ground, damp	Protected from weather but may be subject to sources of moisture	Decay fungi and insects	Interior construction
UC3A	Exterior construction, above ground, coated and rapid water run-off	Exposed to all weather cycles, not exposed to prolonged wetting	Decay fungi and insects	Coated millwork, siding and trim
UC3B	Exterior construction, above ground, uncoated or poor water run-off	Exposed to all weather cycles, including prolonged wetting	Decay fungi and insects	Decking, deck joist, railings, fence pickets, uncoated millwork
UC4A	Ground contact or fresh water, non-critical components	Exposed to all weather cycles, normal exposure conditions	Decay fungi and insects	Fence, deck and guardrail posts, crossties and utility poles (low decay areas)
UC4B	Ground contact or fresh water, critical components or difficult replacement	Exposed to all weather cycles, high decay potential includes salt water splash	Decay fungi and insects with increased potential for biodeterioration	Permanent wood foundations, building poles, horticultural posts, crossties and utility poles (high decay areas)
UC4C	Ground contact or fresh water, critical structural components	Exposed to all weather cycles, severe environments extreme decay potential	Decay fungi and insects with extreme potential for biodeterioration	Land and fresh water piling, foundation piling, crossties and utility poles (severe decay areas)
UC5A	Salt or brackish water and adjacent mud zone, Northern waters	Continuous marine exposure (salt water)	Salt water organisms	Piling, bulkheads, bracing
UC5B	Salt or brackish water and adjacent mud zone, New Jersey to Georgia, south of San Francisco	Continuous marine exposure (salt water)	Salt water organisms, including creosote tolerant <i>Limnoria tripunctata</i>	Piling, bulkheads, bracing
UC5C	Salt or brackish water and adjacent mud zone, south of Georgia, Gulf Coast, Hawaii and Puerto Rico	Continuous marine exposure (salt water)	Salt water organisms, including creosote tolerant <i>Martesia</i> and <i>Sphaeroma</i>	Piling, bulkheads, bracing

Note that special attention should be paid when specifying preservative treatments for use in areas subject to Formosan subterranean termite activities. For a list of suitable preservatives, please refer to AWPA Standard U1⁽²⁾. When specifying the use of preservative-treated glulam in the state of Hawaii, confirm with city and county building codes that the specified preservative treatments meet the requirements for structural lumber, e.g., for the County of Honolulu, see <http://www.honolulu.gov/refs/roh/16a1.htm>.

PRESERVATIVES

Pressure-preservative treatments listed in AWPA Standard U1⁽²⁾ for glulam include creosote, pentachlorophenol, copper naphthenate, oxine copper and waterborne inorganics. Proprietary preservative treatments are permitted for use, having met the necessary AWPA requirements and approvals for use by local building departments, if required.

Organic Preservatives

Organic preservatives listed in AWPA Standard U1 include creosote, pentachlorophenol, copper naphthenate, and oxine copper. Creosote is a coal tar product with an oily appearance. It typically has an odor and is not paintable. It is often used when severe exposure to decay hazards, insect attack or marine borers may be encountered, such as in docks, wharfs, bridges and other marine structures.

Pentachlorophenol (penta) is most commonly dissolved in carriers, such as oils or light hydrocarbon solvents. Penta in oil may have an oily appearance and an odor. It is not recommended for painting, but is suitable for above-ground uses and ground contact when treated to the proper retention levels. Penta in light hydrocarbon solvents leaves a more natural appearance, and may be specified where a stain finish is desired.

Copper naphthenate (CuN) is suitable for above-ground uses and ground contact when treated to a proper retention level. CuN is often dissolved in heavy oil solvents or light hydrocarbon solvents for use as preservative carriers. CuN treated wood may have a light green coloration that may diminish during weathering. After thorough drying, it can be stained or painted, but a stain-blocking primer or second topcoat is recommended for finishing to minimize the CuN treatment's discoloration of the finish.

Oxine copper (Cu-8-Q) is suitable for above-ground use. Oxine copper solutions may leave a brown coloration that could weather to gray. Oxine copper is commonly dissolved in light hydrocarbon solvents that allow it to be stained or painted with an oil base finish after thorough drying.

Inorganic Preservatives

Waterborne treatments such as acid copper chromate (ACC), ammoniacal copper zinc arsenate (ACZA), alkaline copper quat-type-C (ACQ-C) and chromated copper arsenate (CCA) are not recommended for western species but may be used to treat glulam manufactured from southern pine. These types of treatments are usually used to treat the individual laminations prior to gluing. Check with the glulam manufacturer and treater to verify the availability of these treatments. CCA may only be used in applications where frequent human contact will not occur. Consult with local and state building codes prior to specifying the use of CCA-treated wood. When waterborne treatments are specified for glulam after gluing, the members must be redried after treating. This process may cause dimensional changes, such as warping and twisting, or may lead to excessive checking, splitting or raised grain, resulting in a finished product with an unacceptable appearance.

Other treatments and processes specified should be agreed to by purchaser, seller and the governing code body. Required retention and penetration levels depend on end use and exposure according to AWPA U1 or other applicable specifications. Table 2 provides a summary of these treatment characteristics and limitations.

TABLE 2*

TREATMENT TYPE CHARACTERISTICS

	Creosote	Penta in Oils	Penta in Light Solvents	Copper Naphthenate	Oxine Copper (Cu-8-Q)	Waterborne Preservatives
Suitable Applications	Saltwater or fresh water applications, wood block floors, bridges, towers and ground contact.	Fresh water, ground contact, above-ground uses, including docks, bridges, towers and beams.		Ground contact and above-ground uses. Should not be used in direct contact with water.	Above-ground use only.	Fresh water applications and ground contact. May be used indoors provided sawdust and construction debris are cleaned up and disposed by ordinary trash collection.
Appearance	Dark, oily odor.	Oily, may be blotchy, may have odor.	Varies from natural appearance of wood to some darkening of wood.	Light green coloration that may diminish during weathering.	Varies from natural appearance of wood to some darkening of wood.	Green to brown depending on chemicals used and exposure to light.
Paintability	Not paintable.	Not practical.	Can be finished with water repellent or oil-based semitransparent stain.	Can be stained or painted after thorough drying.	Can be finished with an oil based stain or paint.	Can be stained or painted when surface is dry and prepared in accordance with coating manufacturer's recommendations.
Comments	Should not be used in residential interiors. May be used in industrial interiors when two coats of effective sealer are applied.	May be used in residential, industrial or commercial interiors as laminated beams or building components that are in ground contact and where two coats of effective sealer are applied.		May develop greenish discoloration of light-colored finishes. Stain-blocking primer or second topcoat is recommended for finishing to minimize potential discoloration by the treatment. Check with supplier for use in high decay hazard applications.	Stain-blocking primer will help to minimize discoloration. May be used in residential interiors where frequent human contact will not occur.	May develop greenish discoloration of finish. Stain-blocking primer will help to minimize discoloration. Surfaces may have raised grain and extensive checking may occur.

*For treatments suitable for human contact, see Table 8.

TREATMENT RECOMMENDATIONS

Glulam timbers are available in custom and stock sizes. Stock sizes are typically cut to length at a distribution center or on the job site. Most glulam to be pressure-treated will be in custom sizes and should be ordered to exact dimensions when possible to avoid field cuts, which must be retreated. In addition, all fabrication, cutting and predrilling of holes for fasteners is recommended prior to pressure treating.

Glulam may be treated after gluing or the individual laminations may be treated prior to gluing, depending on the wood species and treatment specified. Treatments such as creosote or pentachlorophenol (penta) in oil are typically only specified for treatment of the finished member. Penta in light hydrocarbon solvents may be specified for the laminations prior to gluing or for the finished member. Copper naphthenate and oxine copper may also be specified for softwood glulam prior to gluing and for the finished glulam, depending on the species and the use category. Waterborne inorganic treatments may be specified for southern pine laminations prior to gluing, using ACC, ACZA, ACQ-C and CCA. Glulam manufactured using pre-treated laminations is not available from all manufacturers, however, so availability should be verified prior to specifying.

The use of waterborne preservatives for the treatment of finished glulam members is generally not recommended. One waterborne preservative, ACZA, is listed in AWPAs Standard U1 for use with coastal region Douglas-fir after gluing. Waterborne types of treatments, however, can lead to potential discoloration of the wood, possible raised grain and excessive checking or warping of the member, and their use will void the manufacturer's warranty for western species. Although not specifically listed in AWPAs Standard U1, specifiers may choose to treat glulam with CCA after gluing. This treatment process also requires special attention to re-drying to minimize raised grain, checking and warping.

Glulam that is to be preservative-treated should be trademarked with the APA EWS stamp and must be bonded with wet-use adhesives conforming to ANSI A190.1.

Table 3 provides a summary of treatment recommendations.

TABLE 3

RECOMMENDED PRESERVATIVE TREATMENTS FOR GLULAM

Treatment Type	Western Species		Southern Pine		Hardwoods	
	Glulam Treated Prior to Gluing	Glulam Treated After Gluing	Glulam Treated Prior to Gluing	Glulam Treated After Gluing	Glulam Treated Prior to Gluing	Glulam Treated After Gluing
Creosote	No ²	Yes	No ²	Yes	No	Yes
Oil-borne Penta	No ³	Yes	No ³	Yes	No	No
Copper Naphthenate	No ²	Yes	No ²	Yes	No	No
Cu-8-Q ¹	No ²	No ⁴	Yes	Yes	No	No
CCA	No ²	No	Yes	No	No	No
ACZA	No ²	No ²	Yes	No	No	No
ACC	No	No	Yes	No	No	No
ACQ-C	No ²	No	Yes	No	No	No

1. For above ground use only, AWPAs Use Category UC1, UC2 and UC3B.
2. Although not recommended, AWPAs Standard U1 permits this treatment.
3. Except when penta with hydrocarbon solvents is used.
4. Except when treating western hemlock and hem-fir.

SPECIES

Softwood species listed in AWPAs Standard U1 for preservative treatment include coastal Douglas-fir, western hemlock, hem-fir and southern pine. Listed hardwood species include red oak, red maple and yellow poplar when treated after gluing. The most commonly available west coast species are Douglas-fir and hem-fir. Other species of glulam may also be available for pressure treatment, subject to agreement by the seller and purchaser and to approval by the governing code body.

Incising is required for Douglas-fir, western hemlock, hem-fir, red maple and yellow poplar. Such incising is normally performed after gluing of the finished glulam. If laminating lumber is to be treated prior to gluing, the mating faces to be glued should not be incised. Incising is not considered to have a detrimental effect on the strength of glulam. The effects of incising on appearance, however, should be considered when ordering glulam where aesthetics are important. If incising is not specified, difficulties in meeting the specified treatment retention and penetration levels may result. This option should only be considered with caution. If the specifier waives the incising requirement, penetration and retention requirements may still apply.

RETENTION AND PENETRATION LEVELS

Retention and penetration levels are specified in AWPA Standards in pounds of retained preservative per cubic foot of wood and depth of penetration in inches. Specified retention and penetration levels vary according to the type of preservative, species of wood and the level of exposure. AWPA Standard U1 lists specified retention levels according to the intended end use, and is summarized in Tables 4, 5, 6 and 7.

TABLE 4

PRESERVATIVE RETENTIONS (pcf): GLUE-LAMINATED MEMBERS (Laminations treated prior to gluing)

USE CATEGORY Species	Preservative System									
	Creosote			PCP-A						
	CR	CR-S	CR-PS	PCP-C	Cu-8-Q	CuN	ACQ-C	ACC	ACZA	CCA
UC1, UC2, UC3B										
Southern Pine	8.0 ²	8.0 ²	— ^{1,2}	0.3 ²	0.02	0.04	0.25	0.25	0.25	0.25
Coastal Douglas-fir	8.0 ²	— ^{1,2}	8.0 ²	0.3 ²	0.02 ²	0.04 ²	0.25 ²	0.25 ²	0.25 ²	0.25 ²
Western Hemlock	8.0 ²	— ^{1,2}	8.0 ²	0.3 ²	0.02 ²	0.04 ²	0.25 ²	0.25 ²	0.25 ²	0.25 ²
Hem-fir	8.0 ²	— ^{1,2}	8.0 ²	0.3 ²	0.02 ²	0.04 ²	0.25 ²	0.25 ²	0.25 ²	0.25 ²
UC4A										
Southern Pine	10.0 ²	10.0 ²	— ^{1,2}	0.6 ²	— ¹	0.06	0.4	0.5	0.4	0.4
Coastal Douglas-fir	10.0 ²	— ^{1,2}	10.0 ²	0.6 ²	— ^{1,2}	0.06 ²	0.4 ²	0.5 ²	0.4 ²	0.4 ²
Western Hemlock	10.0 ²	— ^{1,2}	10.0 ²	0.6 ²	— ^{1,2}	0.06 ²	0.4 ²	0.5 ²	0.4 ²	0.4 ²
Hem-fir	10.0 ²	— ^{1,2}	10.0 ²	0.6 ²	— ^{1,2}	0.06 ²	0.4 ²	0.5 ²	0.4 ²	0.4 ²

1. Not recommended by AWPA

2. Not recommended by the glulam industry, see Table 3.

TABLE 5

PRESERVATIVE RETENTIONS (pcf): GLULAM MEMBERS (Treated after gluing)

USE CATEGORY Species	Preservative System						
	Creosote			PCP-A			
	CR	CR-S	CR-PS	PCP-C	Cu-8-Q	CuN	ACZA
UC1, UC2, UC3B							
Southern Pine	8.0	8.0	8.0	0.3	0.02	0.4	— ^{1,2}
Coastal Douglas-fir	8.0	8.0	8.0	0.3	— ^{1,2}	0.4	0.3 ²
Western Hemlock, Hem-fir	8.0	8.0	8.0	0.3	0.02	0.4	— ^{1,2}
Red Oak	7.0	7.0	7.0	— ^{1,2}	— ^{1,2}	— ^{1,2}	— ^{1,2}
Red Maple, Yellow Poplar	8.0	8.0	8.0	— ^{1,2}	— ^{1,2}	— ^{1,2}	— ^{1,2}
UC4A							
Southern Pine	10.0	10.0	10.0	0.6	— ¹	0.06	— ^{1,2}
Coastal Douglas-fir	10.0	10.0	10.0	0.6	— ^{1,2}	0.06	0.6 ²
Western Hemlock, Hem-fir	10.0	10.0	10.0	0.6	— ¹	0.06	— ^{1,2}
Red Oak	8.5	8.5	8.5	— ^{1,2}	— ^{1,2}	— ^{1,2}	— ^{1,2}
Red Maple, Yellow Poplar	10.0	10.0	10.0	— ^{1,2}	— ^{1,2}	— ^{1,2}	— ^{1,2}

UC4B, UC4C: See Table 7 (Glulam Poles).

1. Not recommended by AWPA

2. Not recommended by the glulam industry, see Table 3.

TABLE 6

**PRESERVATIVE RETENTIONS (pcf):
GLULAM MEMBERS (Treated after gluing)¹**

USE CATEGORY Species	Preservative System	
	Creosote	
	CR	CR-S
UC5A, UC5B, UC5C		
Southern Pine	25.0	25.0
Coastal Douglas-fir	25.0	25.0
Western Hemlock, Hem-fir	25.0	25.0

1. Retention levels are based on published values for sawn products.

TABLE 7

PRESERVATIVE RETENTIONS (pcf): GLULAM POLES (Treated after gluing)

USE CATEGORY Species	Preservative System		
	CR as solution	PCP-A PCP-C	CuN
UC4A, UC4B			
Southern Pine	7.5	0.38	0.08
Coastal Douglas-fir			
Outer zone	9.0	0.45	0.095
Inner zone	4.5	0.23	0.048
UC4C			
Southern Pine	9.0	0.45	0.13
Coastal Douglas-fir			
Outer zone	12.0	0.60	0.15
Inner zone	6.0	0.30	0.075

FIELD CUTS

It is strongly recommended that all fabrication, trimming and boring of glulam be performed prior to pressure treating. If there is any field fabrication or surface damage to the glulam, all cuts, holes or damaged areas must be field treated to protect the exposed wood material. Copper naphthenate may be used to reseal exposed areas of glulam treated with creosote or pentachlorophenol. It may leave a greenish coloration. Field treatments should be applied to saturation by dipping, brushing, spraying, soaking or coating in accordance with AWWPA Standard M4⁽³⁾.

FASTENERS

Fasteners used to connect preservative-treated glulam should be corrosion resistant to withstand the effects of the high-moisture environment to which these members are typically exposed.

Corrosion of fasteners is influenced by the amount of moisture present, temperature, wood pH, extractives, chemicals in the treatment and environmental factors, such as chlorine, salt and pollutants. Oil-borne treatments are generally not corrosive whereas the waterborne treatments can be highly corrosive depending upon environmental conditions. Hot-dip galvanized connectors are typically adequate but other materials, such as stainless steel, may be required in certain applications. Aluminum should not be used in direct contact with wood treated with copper based solutions. Follow preservative treater's guidelines for recommended fasteners.

STRUCTURAL PROPERTIES

The International Building Code (IBC) and International Residential Code (IRC) recognize glulam design values as specified in the latest edition of the National Design Specification for Wood Construction (NDS)⁽⁴⁾. Although the NDS does not specify reductions in the dry design values for preservative-treated glulam according to AWWPA Standards, it does specify that wet-use design values shall be used whenever the moisture content of the member in service is 16 percent or more. It is important to note that the application of a wet-use design factor is based on the judgment of the designer of record considering the end-use environment to which the member is subjected and is not related to any preservative treatment that may be specified.

USE AND HANDLING PRECAUTIONS

The U.S. Environmental Protection Agency (EPA) requires registration of pesticides used in preservative treatments. They have approved use and handling precautions for treated wood as published in Consumer Information Sheets. These sheets also list recommended sealers for treated wood used in certain indoor applications. These sheets are available from treaters and should accompany each shipment of treated wood. They can also be obtained from the Western Wood Preservers Institute (WWPI) at their web site, <http://www.wwpinstitute.org>, under the heading, "Safe Use Information." Use precautions are summarized in Table 8. Appropriate sealers are listed in Table 9.

EPA handling precautions are summarized below. See Consumer Information Sheets for complete information.

TABLE 8

USE PRECAUTIONS FOR PRESSURE-TREATED WOOD¹

Application	Organic Preservatives		Inorganic Preservatives
	Creosote	Pentachlorophenol	
Skin contact applications.	OK ²	OK ²	OK
Residential interiors.	NO	OK ²	OK
For industrial and farm buildings, interior components that are in ground contact and subject to decay or insect attack. Also see Application 5.	OK ²	OK ²	OK
Laminated beams for commercial or industrial buildings.	NO	OK ²	OK
Interiors of farm buildings when animals can crib (bite) or lick the treated wood.	NO	NO	NO
Agricultural farrowing or brooding facilities.	NO	NO	OK
Applications where preservative may become a component of food or animal feed, such as structures or containers for storing silage or food.	NO	NO	NO
Cutting boards or countertops for preparing food.	NO	NO	NO
Decks, patios and walkways if surface is visibly clean and free from residues.	OK	OK	OK
Portions of beehives that may come into contact with honey.	NO	NO	NO
Applications where treated wood can come into direct or indirect contact with drinking water for public or animal consumption.	NO ³	NO ³	NO ³

1. Based on EPA-approved Consumer Information Sheets.
2. Must be painted with recommended sealer (two coats).
3. OK for incidental contact, such as bridges or docks.

Use and Handling Tips

- Treated wood, in some forms, is considered to be a hazardous waste and as such can only be disposed of in an approved hazardous waste disposal site. Contact your local agency for further information.
- Treated wood from commercial or industrial uses (e.g., construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and federal regulations.
- Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask.
- Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.
- When power sawing and machining, wear goggles to protect eyes from flying particles.
- Avoid frequent or prolonged skin contact with any form of preservative-treated wood. When handling wood treated with these chemicals, wear long-sleeved shirts and long pants, and use gloves.
- After working with treated wood, and before eating, drinking or using tobacco products, wash hands and exposed skin areas thoroughly.
- If preservatives or sawdust accumulate on clothes, launder before reuse. Wash work clothes separately from other clothing.

FINISHING

Creosote or pentachlorophenol in oil are not paintable on a practical basis. Pentachlorophenol in light solvents can be finished with natural finishes, such as a clear water repellent or an oil-based semitransparent stain. Clear film-forming finishes such as lacquers, varnishes or urethanes are not recommended for glulam used outdoors because they have a short service life and require extensive surface preparation prior to refinishing.

Glulam that has been treated with waterborne preservatives, such as CCA, can be finished with clear water repellents, oil-based semitransparent stains or film-forming finishes, such as solid-color stains or paint systems. The treatment, however, may leave a green or brown color on the glulam surface that can affect the color and appearance of the finish.

If an opaque coating is desired, the most durable finish is a top-quality paint system, such as a stain-blocking acrylic latex primer followed by two all-acrylic latex topcoats, preferably from the same manufacturer. A stain-blocking primer may also be required under light-colored acrylic latex or solid-color stains to help minimize discoloration of the finish. Always follow the coating manufacturer's recommendations.

If treated wood is to be used indoors, follow the EPA recommendations for appropriate sealing of the wood. See Table 9.

TABLE 9

EPA RECOMMENDED SEALERS FOR TREATED GLULAM

Creosote	Urethane, epoxy, shellac. Coal tar pitch or coal tar pitch emulsions suitable for wood block flooring.
Pentachlorophenol	Urethane, shellac, latex epoxy enamel, varnish.

LIST OF REFERENCES

- (1) American National Standards Institute, Inc. 2002. *American National Standard for Wood Products – Structural Glued Laminated Timber*, ANSI A190.1. New York, NY.
- (2) American Wood Preservers' Association. 2006. *U1 – Use Category System: User Specification for Treated Wood*. Birmingham, AL.
- (3) American Wood Preservers' Association. 2006. *M4 – Standard for the Care of Preservative-Treated Wood Products*. Birmingham, AL.
- (4) American Forest and Paper Association. 2005. *National Design Specification for Wood Construction*. Washington, DC.
- (5) American Association of State Highway and Transportation Officials. 2006. *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*. Washington, DC.

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA and APA EWS trademarked products. For additional assistance in specifying engineered wood products, contact us:

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