

APA

HDO/MDO Plywood

PRODUCT GUIDE



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WOOD

The Natural Choice



Engineered wood products are a good choice for the environment. They are manufactured for years of trouble-free, dependable use. They help reduce waste by decreasing disposal costs and product damage. Wood is a renewable resource that is easily manufactured into a variety of viable products.

A few facts about wood.

- **We're growing more wood every day.** Forests fully cover one-third of the United States' and one-half of Canada's land mass. American landowners plant more than two billion trees every year. In addition, millions of trees seed naturally. The forest products industry, which comprises about 15 percent of forestland ownership, is responsible for 41 percent of replanted forest acreage. That works out to more than one billion trees a year, or about three million trees planted every day. This high rate of replanting accounts for the fact that each year, 27 percent more timber is grown than is harvested. Canada's replanting record shows a fourfold increase in the number of trees planted between 1975 and 1990.



- **Life Cycle Assessment shows wood is the greenest building product.**

A 2004 Consortium for Research on Renewable Industrial Materials (CORRIM) study gave scientific validation to the strength of wood as a green building product. In examining building products' life cycles – from extraction of the raw material to demolition of the building at the end of its long lifespan – CORRIM found that wood was better for the environment than steel or concrete in terms of embodied energy, global warming potential, air emissions, water emissions and solid waste production. For the complete details of the report, visit www.CORRIM.org.

- **Manufacturing wood is energy efficient.**

Wood products made up 47 percent of all industrial raw materials manufactured in the United States, yet consumed only 4 percent of the energy needed to manufacture all industrial raw materials, according to a 1987 study.

Material	Percent of Production	Percent of Energy Use
Wood	47	4
Steel	23	48
Aluminum	2	8



- **Good news for a healthy planet.** For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood: It's the natural choice for the environment, for design and for strong, lasting construction.



NOTICE:
The recommendations in this guide apply only to products that bear the APA trademark. Only products bearing the APA trademark are subject to the Association's quality auditing program.

Demanding applications such as concrete forming, exterior siding, and industrial containers require tough building materials. APA trademarked High and Medium Density Overlay plywood (HDO and MDO) combine the toughness of Exterior-type plywood with the superior wear of an overlaid surface. These features place HDO and MDO among the most durable construction materials on the market today.

This publication from APA describes the properties of HDO and MDO plywood and the applications where these panels are used. It also includes finishing recommendations and sample specifications.

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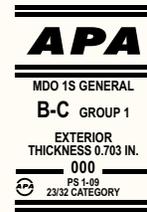
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PRODUCT DESCRIPTION

High Density Overlay (HDO) plywood is manufactured with a thermosetting resin-impregnated fiber surface bonded to both sides under heat and pressure. It's the more rugged of the overlaid panels and ideal for such punishing applications as concrete forming and industrial tanks. HDO brings to the job all the proven advantages of plywood's large size, high strength, light weight, dimensional stability and racking resistance. The tough resin overlay withstands severe exposure without further finishing. It also resists abrasion, moisture penetration and deterioration from many common chemicals and solvents.

TYPICAL TRADEMARKS

HDO • INDUSTRIAL • A-A • G2 • EXT • 0.734 IN. • APA • 000 • PS 1-09 • 3/4 CAT



As required by Voluntary Product Standard PS 1, the minimum HDO overlay thickness before pressing is 0.012 inch. The overlay weight is not less than 60 pounds per 1,000 square feet of panel surface. HDO plywood is bonded with 100 percent water-resistant glue and has inner ply construction of C- or C-Plugged grade veneer. Face veneers are B-grade or better. The HDO surface may be specified on the face only or on both the panel face and back.

HDO usually comes in a natural, opaque color. The overlay gives a soft wood tone appearance to the panel surface. Other colors, such as black, brown, or olive drab, are also available.

Medium Density Plywood (MDO) plywood is produced with a resin-impregnated fiber overlay with just the right tooth for rapid, even paint application. It's a preferred panel, therefore, for structural siding, exterior color accent panels, soffits and other applications where long-lasting paint or coating performance is required.

Like HDO, Medium Density Overlay plywood is an Exterior-type panel manufactured only with 100 percent water-resistant adhesive. Regular MDO is produced with B-grade face and back veneers and C-grade inner plies. Panels with B-grade veneers throughout or C-grade backs for siding can also be manufactured.

The MDO overlay surface may be specified on the face only or on both the face and back. The overlay is smooth and generally opaque, although it may show some evidence of the underlying wood grain. Siding panels with a texture-embossed surface and grooved panels with either smooth or textured overlays are also available. Most manufacturers produce MDO with a wood-tone surface color, although some supply their own identifying brand colors. Some also offer factory-primed and textured MDO, particularly for painted signs and residential siding applications.

Both HDO and MDO are easy to work using ordinary shop and carpentry tools. The overlays provide high resistance to edge splitting and slivering. They are tightly bonded and overlay separation is not a problem – even at high machine speeds. Both panels can be produced with non-skid surfaces. Both can be pressure-treated with preservatives. And both are produced in all standard sizes and thicknesses. Extra-long panels, including 9- and 10-foot siding panels, can be special ordered from some member mills of APA.

While HDO is best suited for some applications and MDO for others, either panel may be used for a broad range of jobs. Truck and trailer linings, painted signs, highway signs, storage bins, factory work surfaces and farm buildings are just a few uses for which either HDO or MDO offers high performance and low maintenance. Other applications are outlined on the following pages.

COMMON USES OF APA OVERLAID PANELS

- Painted Signs
- Concrete Forming
- Siding
- Soffits and Fascias
- Cabinets and Built-ins
- Industrial Tanks and Vats
- Counter Tops
- Truck and Trailer Linings
- Highway Signs
- Agricultural Bins

APPLICATIONS

Construction

Easy to finish and maintain, Medium Density Overlay plywood lends itself to all kinds of residential and commercial construction applications, both interior and exterior. As siding it's durable, attractive and easy to maintain. And it provides the excellent natural insulation properties of wood. (See "Thermal Properties," page 9.) Other typical exterior applications include color accent panels, soffits and fascias, chimney enclosures, screens, gable ends, privacy fences and garage doors. Inside, MDO is often used for cabinets and built-ins, paneling (with decorative moldings), shelving and partitions. HDO plywood also has been used successfully for wainscoting, partitioning, and interior and exterior walls. MDO and HDO may also be pressure treated with preservative or fire-retardant chemicals when required.



MDO panels are applied to the interior of a cold storage building.

Industry

There's no limit to the industrial uses of HDO and MDO. Because HDO requires no painting and resists scuffs, mars and dirt penetration, it finds wide favor as a material for display shelves, storage racks and bins. The only care it needs is occasional cleaning with a damp cloth. The smooth, snag-free surface also makes the panel an ideal choice for assembly benches and work tables.

HDO tanks and vats are less expensive and easier to build than stainless steel or lead-lined equivalents and effectively resist many corrosive liquids. (See "Chemical Resistance," page 10.) Exhaust ducts constructed with HDO stand up to corrosive acid and water vapors, thus providing a longer-lasting and less expensive duct system than those fabricated from other products.

HDO also performs excellently when used for pallet decks, storage lockers and trunks, counter tops, drying racks, foundry pattern mounts, freezer lockers, humidity chambers and other controlled atmospheres. Although not as rugged as HDO, MDO plywood is widely used in industry as well. Common applications include factory work surfaces, storage bins, signage, freezer liners, patterns and shelving.

Concrete Forming

From giant gang forms and complex shapes to simple conventional form components, HDO PLYFORM® is the best concrete form material available for exceptionally smooth surfaces and maximum reuse. Some patent-form companies, specialists in handling HDO, expect up to 200 pours. Time and labor savings are greater, too. Form building, stripping and moving are fast and easy.

HDO performs well under the alkaline exposures common to concrete while the natural insulating quality of plywood helps provide more consistent curing conditions. Scraping of forms is minimized – wiping the surface is usually all that's required. A light application of a releasing agent before each use makes stripping easier. Due to the low permeability of HDO, the panels may be stacked on level supports immediately after stripping without time-consuming panel separation for drying.



HDO panels can be reused many times in concrete forming.

Although general-use MDO is not suitable for concrete forming, MDO plywood designed and recommended specifically for forming is also available. It imparts a matte finish to concrete which is often specified by architects.

Chemically reactive release agents are recommended by most MDO manufacturers because they cause a chemical reaction that resists bonding of the concrete to the overlay. These release agents should be tested and recommended by the manufacturer for use on overlaid plywood.

For complete concrete form design and treatment information, refer to APA's *Design/Construction Guide: Concrete Forming*, Form V345.

Transportation

Plywood's excellent strength-to-weight ratio and the armor-like durability of an overlaid surface make both HDO and MDO ideal for truck and trailer linings. The panels hold up better, reducing damage and maintenance costs. And they're good looking. HDO-lined railroad cars can help keep freight clean as well as reduce refrigeration costs. Some companies produce a grid-textured HDO panel that produces a slip-resistant floor surface. And because of its light weight, abrasion resistance and durability, MDO plywood is also specified by recreational vehicle manufacturers for built-in furniture and cabinetry.

Signs

HDO and MDO panels are frequently used for signs and large displays. Highway departments and commercial sign shops across the nation specify HDO and MDO for signs because they carry the message clearly, deliver the structural properties required of large sign installations, and are highly resistant to weathering and vandalism.

While both MDO and HDO panels can be painted or reflectorized, MDO provides an excellent base for painted signs and HDO is a superior substrate for reflective films. MDO panels should be finished with a quality primer and topcoat before applying reflective backgrounds and legends. HDO should be cleaned before finishing or applying reflective material as described in the finishing section on page 12. Rounding the corners of MDO and HDO panels and applying a quality sealer to the edges will extend the life of reflectorized signs. As life expectancy of a sign is usually dependent on the message material, the HDO or MDO sign can often be stripped and refinished with no apparent degradation of the overlaid panel base.

HDO and MDO also may be used to upgrade metal signs that have served beyond their time. A like-new appearance is produced inexpensively by applying an HDO or MDO sign directly over the worn, original version. For further information, refer to APA's *Industrial Use Guide: Overlaid Plywood for Signs*, Form X240.



HDO is frequently used in highway signs.

Agriculture

Minimum maintenance and maximum durability are the key reasons HDO and MDO are specified for many kinds of farm buildings and equipment applications. The panels provide good-looking, easy-to-clean walls – both interior and exterior – on animal shelters and other farm buildings.

The acid-resistance of HDO makes it an excellent structural lining for chemical fertilizer bins. HDO linings in controlled-atmosphere storage chambers help preserve freshness in fruits and vegetables. HDO linings will not pick up odors and, when properly joined and sealed, the virtually impervious surface reduces gas loss. And overlaid plywood forage wagons and fertilizer spreader bodies last longer and won't rust.

Marine

Top-quality performance in marine applications requires premium quality materials. That's why it pays to include HDO and MDO as an integral part of any boat's structural and appearance makeup. These two panels provide the kind of protection and durability that is especially needed in areas of demanding wear – bulkheads, marina decks, hulls, transoms, cabin construction and hatch covers. Specially constructed Marine grades of plywood, in addition to regular Exterior grades, are also available with HDO or MDO faces.



Overlaid panels provide a smooth surface in boat construction.

PROPERTIES AND CHARACTERISTICS

Bending

Simple curves are easy to form with plywood. A continuous rounded bracing produces the best results. When the application calls for abrupt curvatures, fasten the panel end to the shorter radius first.

The radii in Table 1 have been found through experience to be appropriate minimums for mill-run panels of the Performance Categories shown, bent dry. An occasional panel may develop localized fractures at these radii. Values shown are based on the physical properties of non-overlaid Douglas-fir.

Flame Spread Rating

The flame spread classification of materials used for wall and ceiling finish (and occasionally for other applications) is usually limited by building codes for certain occupancies. Tests have shown that untreated HDO and MDO plywood manufactured in accordance with PS 1 will develop flame spread values between 76 and 200, which puts it in a Class III (or C) category. Smoke will also develop a value of less than 200.

HDO and MDO plywood is therefore suitable as finish for most interior applications. Certain more restrictive locations, such as exitways, require a Class I or Class II rating which can be achieved by the use of fire-retardant treatment.

Vapor Permeance

Values shown in Table 2 represent the average water vapor transmitted through plywood in grains per square foot per hour per inch of mercury pressure (perms). Materials with vapor permeance of one perm or less are considered effective vapor barriers. Values shown are based on the physical properties of Douglas-fir. The use of overlaid plywood can reduce the water vapor permeance of unfinished plywood.

TABLE 1

MINIMUM BENDING RADIUS

Panel Performance Category	Across Grain (ft.)	Parallel to Grain (ft.)
1/4	2	5
5/16	2	6
3/8	3	8
1/2	6	12
5/8	8	16
3/4	12	20

TABLE 2

WATER VAPOR PERMEANCE

Product	Surface Finish	Perms
Exterior-type Plywood (3/8 Performance Category)	None	0.8
Exterior-type Plywood (3/8 Performance Category)	One coat exterior primer plus two coats exterior house paint (oil system)	0.2
Exterior Medium Density Overlay Plywood One Side (3/8 Performance Category)	None	0.3
Exterior High Density Overlay Plywood Both Sides (1/2 and 5/8 Performance Categories)	None	0.1

Water Absorption

Water absorption of High Density Overlay plywood, edge-sealed and soaked in room temperature water, averages 10 grams or less per square foot per single panel surface in 48 hours. Water absorption of Medium Density Overlay plywood averages 50 grams or less per square foot per single panel surface in 48 hours.

Thermal Properties

Plywood is a good insulating material. Used for concrete forming, HDO plywood helps to assure more consistent curing conditions. And MDO plywood siding contributes to the thermal resistance of walls.

Although actual thermal conductivity of wood varies with specific gravity and moisture content, differences are sufficiently small to be ignored in practice. Table 3 lists values for the common thicknesses of Medium Density Overlay plywood. These values are derived from data published by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). The use of this information is illustrated on the drawing below the table.

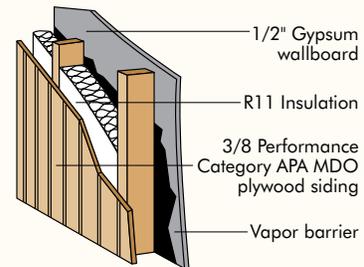
TABLE 3

APPROXIMATE THERMAL RESISTANCE OF PLYWOOD

Panel Performance Category	"R Value" (Degrees F-hr-sq ft/Btu)
11/32	0.43
3/8	0.47
15/32	0.59
1/2	0.62
19/32	0.74
5/8	0.78
23/32	0.90
3/4	0.94

APA Sturd-I-Wall	Resistance
Outside air	= 0.17
3/8 Performance Category MDO plywood	= 0.47
R11 insulation	= 11.00
1/2" gypsum wallboard	= 0.45
Inside air	= 0.68
	R = 12.77
	U = 1/R = 0.08*
	Btu/Degrees F-hr-sq ft

*U = 0.07 when R13 insulation is substituted.



Chemical Resistance

HDO and MDO are highly resistant to chemicals and are used effectively in many industrial applications requiring continuous contact with dilute acids, alkalis, organic chemicals and many neutral and acid salts. MDO plywood is not as resistant as HDO but is suitable for applications where a liner or coating is added to the surface.

Table 4 gives the effects – no effect (N), softened (S), roughened (R), or discolored (D) – of various chemicals to the overlaid surface of HDO after 24 hours of contact.

TABLE 4

CHEMICAL RESISTANCE OF OVERLAYS

Reagent	Effect on HDO	Effect on MDO
Amyl Acetate	N	N
Acetic Acid 10% and 99.5%	N	N
Acetone	N	N
Amyl Alcohol	N	N
Benzene	N	N
Calcium Hypochlorite 30%	N	D-red-brown
Carbon Tetrachloride	N	N
Chloroform	N	N
Cresol	N	N
Formalin 37%	N	N
Formic Acid 88-90%	S, D-grey	R, S, D-yellow-red
Hydrochloric Acid 10%	N	S, D-yellow-brown
Hydrochloric Acid 37%	S, R, D-pink	S, R, D-red-brown
Hydrogen Peroxide 30%	N	D, yellow
Methyl Alcohol	N	N
Monochlorobenzene	N	N
Nitric Acid 1%	D-brown	D-yellow
Nitric Acid 5%	S, R, D-brown	S, D-yellow-brown
Nitric Acid 30%	S, R, D-brown	R, S, D-yellow-brown
Nitric Acid 70%	S-to plywood, R, D-brown (surface gone)	R, S, D-orange-yellow
Phosphoric Acid 85%	S, R	R, S, D-yellow-red-brown
Soapless Detergent (Dreft)	N	N
Sodium Carbonate 25%	D-brown	D-red-brown
Sodium Chloride 10%	N	D-yellow-brown
Sodium Chloride 25%	N	N
Sodium Hydroxide 1%	D-red-brown	R, S, D-red-brown
Sodium Hydroxide 30%	S, R, D-brown	R, S, D-red-orange
Sulfuric Acid 10%	N	R, S, D-yellow-purple
Sulfuric Acid 35%	N	R, S, D-yellow-purple
Sulfuric Acid 50%	D-pink-orange	R, S, D-yellow-purple
Sulfuric Acid 70%	S, R, D-brown	R, S, D-yellow-purple
Sulfuric Acid 97%	S, R, D-black	R, S, D-yellow-purple
Zinc Chloride 50%	N	D-brown

WOODWORKING TECHNIQUES

Proven plywood woodworking techniques are followed in working HDO and MDO plywood. Panels can be sawn, nailed, drilled, routed, shaped and edge-planed. HDO plywood also can be glued. (See details below). Always take care to avoid marring the premium quality overlay surface and use sharp, high-speed power tools.

Cutting

For best results, use a power saw with little or no set and as much lead as possible. Adjust the blade to extend through the panel at least 1/2 inch. Cutting teeth should enter the face of MDO plywood. Backing the panel with scrap material and feeding it through slowly helps avoid chipping.



Overlaid siding is available with grooved or smooth surfaces.

Drilling

A high speed drill is recommended. If appearance of the back is important, panels should be backed with scrap material to avoid chipping as the drill breaks through. Drill at least 1/4 inch in from the panel edge.

Fastening

Nailing procedures for HDO and MDO are the same as for other grades of plywood. Spiral or ring-shank nails provide the best holding power. Care should be taken to avoid overdriving fasteners which could provide a path for moisture to penetrate the overlay. Screws, bolts, staples and other fasteners may also be used. Pre-drill screw holes and countersink carefully. Use washers for a better bearing surface. If fasteners are overdriven or countersunk, fill the holes with caulk or exterior wood filler to protect the underlying surface from moisture which could cause localized swelling. If overlay surface is to be painted, be sure to use a paintable caulk.

Gluing

HDO plywood develops strong joints if proper gluing techniques are used. The overlay surface should be roughened by light sanding and cleaned before glue is applied. A resorcinol or phenolic-type glue is recommended for exterior applications. Follow the glue manufacturer's recommendations. Nails, screws or clamps can be used to maintain pressure while the glue hardens.

Finishing

MDO is an ideal base for paint and is designed to be exposed to the weather when finished. Although it performs perfectly well without further finishing in applications where it is not exposed to the weather, MDO should always be face-primed and top-coated with a compatible solid-color stain or house paint if used outdoors or subjected to wet, humid conditions. If solid-color stain is desired, some panel manufacturers recommend only acrylic-latex formulations. Check panel manufacturer's recommendations. Some producers of MDO offer panels with a pre-primed surface. HDO is designed to be used without further finishing, although it too is an excellent base for conventional paints after a light surface roughening.



MDO panels create a smooth, easy-to-finish surface in fascias.

Like any finish material, HDO and MDO should be stored in a cool, dry place out of the sun and protected from heaters or highly humid conditions which frequently exist at construction sites. Be sure panels are dry when finish is applied and that the specific application recommendations of the paint manufacturer are followed.

Panels intended for exterior exposure should be edge-sealed as soon as possible. Edge sealing is not permanent, nor does it necessarily make the edges moisture proof. It does, however, minimize sudden changes in moisture content due to weather cycles. Panel edges may be sealed with one or two heavy coats of top-quality exterior house paint primer formulated for wood. Edges are most easily sealed while panels are in a stack.

To insure a good paint or reflective sheeting bond, HDO is prepared by one of the following simple surface conditioning treatments. One method is scuff-sanding with fine grit sandpaper which slightly roughens the surface and provides better tooth for the paint. Scuff-sanding also helps remove any surface contaminants. Panel surfaces should then be wiped clean to remove all dust.

The surface of HDO can also be conditioned for painting by thoroughly scrubbing with a nylon abrasive pad saturated in VM&P naphtha or similar solvent. The liquid solvent should then be wiped off with a dry cloth to completely remove any surface contaminants. Panels should be exposed to good air circulation at least overnight to insure complete evaporation of all solvent from the overlay. If stacked, panels should be separated with stickers. The time required to permit complete evaporation will depend upon the temperature and air movement through the stack.

Only paint products formulated for wood should be used to finish overlaid plywood. Primer and finish materials produced by the same manufacturer and formulated as companion products should be specified to insure good adhesion between successive paint coats. Allow each coat to dry before applying the next, but complete as soon as practical to obtain good adhesion between coats. Follow the manufacturer's instructions carefully for best results. Conventional, high-quality exterior house paints as well as sign and bulletin paints perform well on both HDO and MDO. Best finish durability can be expected when using a top-quality acrylic latex house paint system composed of primer and topcoat. Hard, brittle finishes and clear finishes should be avoided. Both air drying and baking finish systems may be used.

Oil-based finishes should be allowed to erode before repainting to avoid a thick paint buildup. Overly thick oil-based films tend to become brittle and fail within themselves.

SPECIFICATIONS

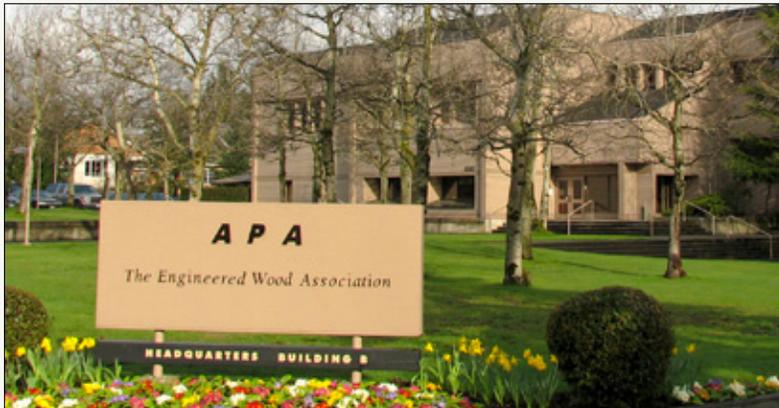
Sample Specification: HDO plywood shall be of Exterior type with both faces of High Density Overlay as described in Voluntary Product Standard PS 1. Each panel shall be identified with the trademark of APA. (If a color other than natural is desired, check local availability before specifying.)

MDO plywood siding shall be of Exterior type with (one) (both) faces of Medium Density Overlay as described in Voluntary Product Standard PS 1. Each panel shall be identified with the trademark of APA.

To order HDO or MDO, designate the Performance Category, grade, Group number, APA trademark, dimensions and number of pieces. Also designate any special requirements, such as face or inner ply grades, surface texture or special weights of surfacing material.

For example: *1/2 Performance Category High Density Overlay (HDO), BB, Group 1, APA trademarked, 48" x 96", 100 pcs.*

ABOUT APA



APA is a nonprofit trade association whose member mills produce approximately 70 percent of the structural wood panel products manufactured in the United States, and a significant percentage of panels produced in Canada.

Founded in 1933 as the Douglas Fir Plywood Association and widely recognized today as the voice of the structural wood panel industry, APA performs numerous

functions and services on behalf of panel product users, specifiers, dealers, distributors, schools, universities and other key groups.

One of the important functions of APA is quality auditing. The APA trademark appears only on products manufactured by APA member mills and is the manufacturer's assurance that the product conforms to the standard shown on the trademark. That standard may be an APA performance standard, the *Voluntary Product Standard PS 1-09 for Structural Plywood* or *Voluntary Product Standard PS-2-10, Performance Standard for Wood-Based Structural-Use Panels*. APA maintains two quality testing laboratories in key producing regions, and a 42,000-square-foot research center at Association headquarters in Tacoma, Washington.

But quality validation is only one of APA's many functions. The Association also:

- Operates one of the most sophisticated programs for basic panel research in the world.
- Maintains a network of field representatives to assist panel product users, specifiers, dealers, distributors and other segments of the trade.
- Conducts informational buyer and specifier seminars and provides dealer and distributor sales training.
- Publishes a vast inventory of publications on panel grades, applications, design criteria and scores of other topics.
- Works to secure acceptance of wood structural panel products and applications by code officials, insuring agencies and lending institutions.
- Develops and maintains performance and national product standards.
- Conducts in-depth market research and development programs to identify and penetrate new panel markets in the U.S. and abroad.
- Works in conjunction with other wood product industry organizations on solutions to problems of common concern.

Always insist on panels bearing the **mark of quality** – the APA trademark. Your APA panel purchase or specification is your highest assurance of quality.

For More Information

For more information about APA panel products and applications, contact APA, 7011 So. 19th St., Tacoma, Washington 98466. A complete listing of other APA product and design/construction guides can be found on the Association website at www.apawood.org.

HDO/MDO Plywood Product Guide

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA trademarked products.

For additional assistance in specifying engineered wood products, contact us:

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REPRESENTING THE ENGINEERED WOOD INDUSTRY