NAAWS

NORTH AMERICAN ARCHITECTURAL WOODWORK STANDARDS 4.0

RESOURCE GUIDE

Excerpt

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WOODWORK INSTITUTE

AWMAC ARCHITECTURAL WOODWORK MANUFACTURERS ASSOCIATION OF CANADA

Forward

This excerpt is an educational guide for firms and individuals utilizing the North American Architectural Woodwork Standards (NAAWS), 4.0. It is not intended to override and/or supersede the NAAWS, but only to serve as a quick reference to its requirements.

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Illustrations are intended to assist in understanding the NAAWS and may not be all inclusive.

REFERENCE SOURCE ACRONYM DIRECTORY

CONTINUING EDUCATION

AIA - American Institute of Architects
AIBD - American Institute of Building Design
APDIQ - Association Professionnele des Dsigners d'interieur du Quebec
BHMA - Builders Hardware Manufacturers Association
CRA - California Redwood Association
IDC - Interior Design of Canada
IIDA - International Interior Design Association
OAQ - Orde des architectes du Quebec
RAIC - Royal Architectural Institute of Canada

STANDARDS & REGULATIONS

AF&PA - American Forest & Paper Association
AHFA - American Home Furnishings Alliance
ANSI - American National Standards Institute
ARE - Association for Retail Environments
ASID - American Society of Interior Designers
AWMAC - Architectural Woodwork Manufacturers Association of Canada
BIFMA - Business + Institutional Furniture Manufacturers Association
CCP - Woodwork Institute Certified Compliance Program
CPA - Composite Panel Association
CSC - Construction Specifications Canada
CSI - Construction Specifications Institute
CSIP - Woodwork Institute Certified Seismic Installation Program
DHI - The Door and Hardware Institute
GIS - AWMAC Guarantee Inspection Service
HPVA - Decorative Hardwoods Association (formally HPVA)
ICC - International Code Council
ISFA - International Surface Fabricators Association
ISO - International Organization for Standardization
IWPA - International Wood Products Association
MCP - Woodwork Institute Monitored Compliance Program
NAM - National Association of Manufacturers
NEMA - National Electrical Manufacturers Association
NFPA - National Fire Protection Association
NHLA - National Hardwood Lumber Association
NIST - National Institute of Standards & Technology
SEFA - Scientific Equipment & Furniture Association
SFI - Sustainable Forest Initiative
UL - Underwriters' Laboratories
WDMA - Window & Door Manufacturers Association
WI - Woodwork Institute
WWPA - Western Wood Products Association

TESTING AND GRADING

APA - The Engineered Wood Association
ASTM - American Society for Testing and Materials
ITS - Intertek Testing Services / Warnock Hersey

SUSTAINABLE BUILDING

CaGBC - Canada Green Building Council
FSC - Forest Stewardship Council
Green Globes:
USA - The Green Building Initiative
Canada - ECD Energy and Environment
SFI - Sustainable Forestry Initiative Inc.
TFF - Tropical Forest Foundation
USGBC - U.S. Green Building Council and Green Build Conferences

SPECIALIZED PRODUCT

KCMA - Kitchen Cabinet Manufacturers Association
LMA - Laminating Materials Association, Inc.
MMPA - Moulding and Millwork Producers Association
NHLA - National Hardwood Lumber Association
WDMA - Window & Door Manufacturers Association
WRCLA - Western Red Cedar Lumber Association

REFERENCE SOURCE CONTACT INFORMATION

AF&PA - American Forest & Paper Association
1111 19th Street NW, Suite 800, Washington, DC 20036
Ph: 800-878-8878 - Fax: 202-463-2700, afandpa.org

AHFA - American Home Furnishings Alliance
Box HP-7, High Point, NC 27261
Ph: 336-884-5000 - Fax: 336-884-5303, ahfa.us

AIA - American Institute of Architects
1735 New York Avenue NW, Washington, DC 20006
Ph: 800-242-3837 - Fax: 202-626-7547, aia.org

AIBD - American Institute of Building Design
529 14th Street, NW, Suite 750, Washington, DC 20045
Ph: 800-366-2423 - Fax: 855-204-0293, aibd.org

ANSI - American National Standards Institute
25 West 23rd Street, 4th Floor, New York, NY 10036
Ph: 212-642-4900 - Fax: 212-398-0023, ansi.org

APA - The Engineered Wood Association
7011 South 19th Street, Tacoma, WA 98466
Ph: 253-565-6600 - Fax: 253-565-7265, apawood.org

ARE - Association for Retail Environments
4651 Sheridan Street, Suite 407, Hollywood, FL 33021-3657
Ph: 954-893-7300 - Fax: 954-893-7500, nasfm.org

ASID - American Society of Interior Designers
608 Massachusetts Avenue NE, Washington, DC 20002-6006
Ph: 202-546-3480 - Fax: 202-546-3240, asid.org

ASTM - American Society for Testing and Materials
100 Barr Harbor Drive, West Conshohocken, PA 19428-2959
Ph: 610-832-9585 - Fax: 610-832-9555, astm.org

AWMAC - Architectural
Woodwork Manufacturers Association of Canada
PO Box 36525, RPO MacTaggart, Edmonton, AB T6R 0T4
Ph: 403-81-7300, awmac.com

BHMA - Builders Hardware Manufacturers Association
355 Lexington Avenue, 15th Floor, New York, NY 10017
Ph: 212-297-2122 - Fax: 212-370-9047, buildershardware.com

BIFMA - Business + Institutional Furniture Manufacturers Association
678 Front Avenue, NW Suite 150, Grand Rapids, MI 49504-5368
Ph: 616-285-3968 - Fax: 616-265-3765, bifma.org

CPA - Composite Panel Association
19465 Deerfield Avenue, Suite 306, Leesburg, VA 20176
Ph: 703-724-1128 - Fax: 703-724-1588, compositepanel.org

CRA - California Redwood Association
818 Grayson Road, Suite 201, Pleasant Hill, CA 94523
Ph: 925-935-1499 - Fax: 925-935-1496, calredwood.org

CSC - Construction Specifications Canada
120 Carlton Street, Suite 312, Toronto, ON, M5A 4K2, Canada
Ph: 416-777-2198 - Fax: 416-777-2197, csc-dcc.ca

CSI - Construction Specifications Institute
99 Canal Center Plaza, Suite 300,Alexandria, VA 22314
Ph: 800-689-2900 - Fax: 703-684-8436, csinet.org

DHI - The Door and Hardware Institute
14150 Newbrook Drive, Suite 200, Chantilly, VA 20151-2223
Ph: 703-222-2010 - Fax: 703-222-2410, dhi.org

FSC - Forest Stewardship Council
USA:
212 Third Avenue North, Suite 445, Minneapolis, MN 55401
Ph: 612-353-4511 - Fax: 612-208-1565, fscus.org
Canada:
70 The Esplanade, Suite 400, Toronto, ON M5E 1R2
Ph: 514-394-1137, fsccanada.org

GREEN GLOBES:
USA:
The Green Building Initiative
2104 SE Morrison, Portland, Oregon 97214
Ph: 877-424-4241 - Fax: 503-961-8991, hegbi.org
Canada:
ECD Energy and Environment
165 Kenilworth Avenue, Toronto, ON M4L 3S7
Ph: 416-699-6671, greenglobes.com

HPVA - Decorative Hardwoods Association (formally HPVA)
1825 Michael Faraday Drive, Reston, VA 20190
Ph: 703-435-2900 - Fax: 703-435-2537, decorativehardwoods.org

ICC - International Code Council
500 New Jersey Avenue NW, 6th Floor, Washington, DC 20001-2070
Ph: 888-422-7233 - Fax: 202-783-2348, iccsafe.org

REFERENCE SOURCE CONTACT INFORMATION (continued)

IDC - Interior Design of Canada
C 536-43 Hanna Avenue, Toronto, Ontario, M6K 1X1, Canada
Ph: 416-649-4425 - Fax: 416-921-3660, idcanada.org

IIDA - International Interior Design Association
13-122 Merchandise Mart, Chicago, IL 60654-1104
Ph: 312-467-1950 - Fax: 312-467-0779, iida.org

ISFA - International Surface Fabricators Association
P. O. Box 627, Ingomar, PA 15127
Ph: 888-599-4732, isfanow.org

ISO - International Organization for Standardization
Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland
Ph: +41 22 749 01 11, iso.com

ITS - Intertek Testing Services
Ph: 800-967-5352, intertek.com

IWPA - International Wood Products Association
4214 King Street West, Alexandria, VA 22302
Ph: 703-820-6696 - Fax: 703-820-8550, iwpawood.org

KCMA - Kitchen Cabinet Manufacturers Assoc.
1899 Preston White Drive, Reston VA 20191-5435
Ph: 703-264-1690 - Fax: 703-620-6530, kcma.org

LEED® - Leadership in Energy and Environmental Design

USGBC - U.S. Green Building Council
2101 L Street, NW, Suite 500, Washington, DC 20037
Ph: 800-795-1747 - Fax: 202-828-5110, usgbc.org

CaGBC - Canada Green Building Council
47 Clarence Street, Suite 202, Ottawa, ON K1N 9K1
Ph: 866-941-1184 - Fax: 613-241-4782, cagbc.org

MMPA - Moulding and Millwork Producers Association
507 First Street,Woodland, CA 95695
Ph: 530-661-9591 - Fax: 530-661-9586, wmmpa.com

NAM - National Association of Manufacturers
733 10th Street, NW, Suite 700, Washington, DC 20001
Ph: 800-814-8468 - Fax: 202-637-3182, nam.org

NEMA - National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752, Rosslyn, Virginia 22209
Ph: 703-841-3200 - Fax: 703-841-5900, nema.org

NFPA - National Fire Protection Association
1 Batterymarch Park, Quincy, MA 02169-7471
Ph: 617-770-3000 - Fax: 617-770-0700, nfpa.org

NHLA - National Hardwood Lumber Association
6830 Raleigh-Lagrange Road, Memphis, TN 38184-0518
Ph: 901-377-1818 - Fax:901-382-6419, nhla.com

NIST - National Institute of Standards & Technology
100 Bureau Drive, Stop 3460, Gaithersburg, MD 20899-3460
Ph: 301-975-6478 - Fax: 301-926-1630, nist.gov

RAIC - Royal Architectural Institute of Canada
330-55 Murray Street, Ottawa, Ontario, K1N 5M3, Canada
Ph: 631-241-3600 - Fax: 613-241-5750, raic.org

SEFA - Scientific Equipment & Furniture Association
65 Hilton Avenue, Garden City, NJ 11530
Ph: 877-294-5424 - Fax: 516-294-4765, sefalabs.com

SFI - Sustainable Forest Initiative, Inc.

USA:
2121 K Street, NW, Suite 750, Washington, DC 20037
Ph: 202-596-3450 - Fax: 202-596-3451

Canada:
1306 Wellington Street, Suite 400, Ottawa, ON K1Y 3B2
Ph: 613-747-2454 - Fax: 613-747-2453, sfiprogram.org

TFF - Tropical Forest Foundation
2121 Eisenhower Avenue, Suite 200, Alexandria, VA 22314
Ph: 703-518-8834 - Fax: 703-518-8974, tropicalforestfoundation.org

UL - Underwriters' Laboratories
333 Pfingsten Road, Northbrook, IL 60062-2096
Ph: 847-272-8800 - Fax: 847-272-8129, ul.com

WDMA - Window & Door Manufacturers Association
2025 M Street, NW, Suite 800, Washington DC, 20036-3309
Ph: 800-223-2301 - Fax: 847-299-1286, wdma.com

WI - Woodwork Institute
1455 Response Rd., Ste. 110, Sacramento, CA 95815
Ph: 916-372-9943 - Fax: 916-372-9950, woodworkinstitute.com

WRCLA - Western Red Cedar Lumber Association
1501-700 West Pender Place 1, Business Building, Vancouver, BC, Canada V6C 1G8
Ph: 866-778-9096, realcedar.org

WWPA - Western Wood Products Association
Yeon Building, 522 SW Fifth Avenue, Portland, OR 97204-2122
Ph: 503-224-3930 - Fax: 503-224-3934, wwpa.org

MISCELLANEOUS CODES

PRESERVATIVE & WATER REPELLENT TREATMENTS

- **Within the U.S**. - Governed under I.S. - 4, latest edition, as published by the Window and Door Manufacturers Association (WDMA), wdma.com, subject to any applicable EPA or local Air Quality Management District's restrictions on what may be used for the project location.
- **Within Canada** - Governed by the National Building Code of Canada, Section 3.8, Appendix A. Contact the National Research Council Canada at nrc.ca.

FIRE RETARDANT COATINGS

Fire retardant coatings are typically subject to listing by an accredited testing laboratory and require a registration number for approval recognized by fire inspectors.

FIRE CODES

- **Within the U.S.** - Governed by the International Code Council, Inc. (ICC), iccsafe.org, and the National Fire Protection Association (NFPA), nfpa.org.
- **Within Canada** - Governed by the National Building Code of Canada, Section 3.8, Appendix A. Contact the National Research Council Canada at nrc.ca.

ADA REQUIREMENTS

- **Within the U.S.** - Governed by the Federal Americans with Disabilities Act (ADA) subject to any applicable state or local requirements that might be more stringent for the project location. Contact the Access Board at access-board.gov and ADA.gov.
- **Within Canada** - Contact the National Building Code of Canada, Section 3.8, Appendix A. Contact the National Research Council Canada at nrc.ca.

RATED FIRE DOOR ASSEMBLIES

- **Within the U.S.** - Rated fire door assemblies are governed in accordance with the National Fire Protection Association's Publication NFPA 80, nfpa.org, "Standard for Fire Doors and Fire Windows," subject to any applicable state or local requirements that might be more stringent for the project location.
- **Within Canada** - Governance is by the National Building Code of Canada, Section 3.8, Appendix A, which can be reviewed at nrc.ca.

BUILDING CODE REQUIREMENTS

- **Within the U.S.** - Governed by the International Building Code (IBC), iccsafe.org, subject to any applicable state or local requirements that might be more stringent for the project location.
- **Within Canada** - Governed by the National Building Code of Canada, Section 3.8, Appendix A. Contact the National Research Council Canada at nrc.ca.

SEISMIC FABRICATION & INSTALLATION REQUIREMENTS

- **Within the U.S.** - Governed by the International Building Code (IBC), iccsafe.org, subject to any applicable state or local requirements that might be more stringent for the project location.
- **Within Canada** - Governed by the National Building Code of Canada, Section 3.8, Appendix A. Contact the National Research Council Canada at nrc.ca.

SUBMITTALS

INTRODUCTION

At the beginning of every woodwork project is the submittal stage, the various items are the foundation of every project – Shop Drawings, Approvals, Samples and Scheduling.

PURPOSE

Shop drawings are the means by which the design concept is turned into reality, serving as the primary instructions for woodwork engineering and fabrication, and as a guide for other trades. As the primary communication among manufacturer, general contractor and design professional, shop drawings serve a valuable coordinating function. Shop drawings should indicate methods of construction, exact material selections, finishes, method of attachment and joinery, exact dimensions and should include the manufacturer's technical suggestions.

WHAT TO EXPECT

The key to achieving a detailed and useful set of shop drawings is concise and continual communication between design professional and manufacturer.

The manufacturer shall submit samples, product data and shop drawings of sufficient detail and scale to demonstrate compliance with the Grade specified.

LEVEL OF DETAIL

The level of detail required on shop drawings is established by the complexity of the project. The specifier is at liberty to specify any level of detail as a requirement of the project and of the contract documents. It should be noted that requirements for local codes and utilization of fire-retardant wood products is to be researched and directed by the design professional and are not the responsibility of the manufacturer.

What constitutes the minimum expectation for a set of shop drawings is not simple, since there are many variables as to the complexity, quality and type of work being specified.

SCHEDULING

Most projects are encumbered by a tight production schedule, especially for the finish trades such as woodworking, painting, carpeting and wall coverings. Prompt review of shop drawings and accurate coordination of multiple trades can save weeks of time and eliminate problems before construction begins.

The design professional should work with the manufacturer through the contractor to determine the maximum "approval-to-fabrication" timeline needed to keep the job on schedule (e.g., "Shop drawings must be returned approved to fabricate seven (7) days after submittal").

Schedules vs. Drawings - In some cases shop drawings are not required to communicate the necessary quality, type, quantity and details of an item. Tabular schedules are used instead, generally for such items as doors, frames, stock factory cabinets, closet shelves, and furniture items.

APPROVALS

For the design professional, the approval stage provides an opportunity, prior to fabrication, to review the manufacturer's proposed shop drawings. Shop drawings, however, are not an extension of the design development process; therefore, changes by either party of intent or concept made during shop drawing review may result in a change of cost and/or time.

During the review process the design professional should consider the following:

- Unless noted otherwise, two copies are necessary for checking purposes. After being reviewed, one marked copy should be returned to the contractor or manufacturer.
- Those charged with review of shop drawings should be familiar with woodwork fabrication, and have an understanding or working knowledge of the referenced standards as well as design concept.
- Deviations from the contract documents are often recommendations for improvement, and not necessarily a criticism of design. It is as wrong for a reviewer to arbitrarily stamp "Revise and Resubmit" on a shop drawing that proposes a change, as it is wrong to automatically accept shop drawings because they contain duplicates of the original plans.

For the manufacturer, shop drawings are drawings, diagrams, schedules and other data specifically prepared to illustrate their portion of the work. Their purpose is to demonstrate the way by which the manufacturer proposes to conform to the information given and the design concept expressed in the Contract Documents.

The four common levels of approval are:

- Approved
- Approved As Noted
- Revise and Resubmit
- Rejected

Approvals are generally indicated by a stamp on the cover sheet of the shop drawings. When selecting "Approved As Noted" rather than "Revise and Resubmit," the design professional can often save weeks of production time provided the concept and all changes are clearly marked on the drawings.

North American Architectural Woodwork Standards 4.0, Effective September 01, 2021, ©2021 AWMAC | Woodwork Institute, as updated by ERRATA through December 01, 2021 and may be furthe updated by errata at naaws.com

LUMBER

SUGGESTION

INTRODUCTION

Solid wood, both Hardwood and Softwood, are covered here.

WOOD AS A PLANT

The trunk and its branches: The cross section of a tree shows the following well-defined features in succession from the outside to the center: bark and cambium layer, wood, which in most species is clearly differentiated into sapwood and heartwood, and pith, the small central core. The pith and bark, of course, are excluded from finished lumber.

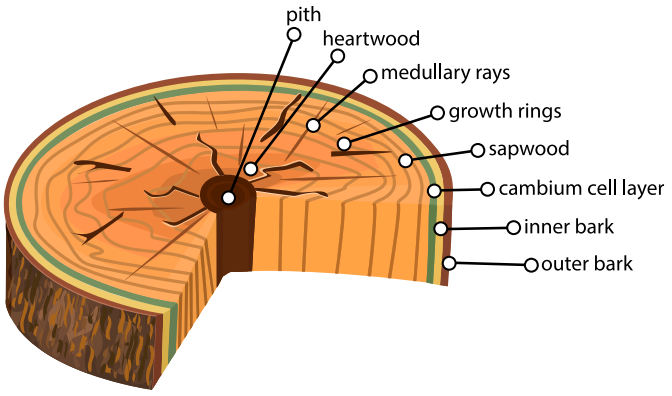

Figure: RG-001

Most branches originate at the pith, and their bases are inter-grown with the wood of the trunk as long as they are alive. These living branch bases constitute inter-grown or tight knots.

After the branches die, their bases continue to be surrounded by the wood of the growing trunk and therefore loose or encased knots are formed. After the dead branches fall off, the stubs become overgrown, and subsequently clear wood is formed.

Growth in thickness takes place in the cambium layer by cell division. No growth in either diameter or length takes place in wood already formed; new growth is purely the addition of new cells, not the further development of existing cells.

ANNUAL RINGS

Most species grown in temperate climates produce well-defined annual growth rings, which are formed by the difference in density and color between wood formed early and late in the growing season. The inner part of the growth ring formed first is called “spring wood,” and the outer part formed later in the growing season is called “summer wood.”

Spring wood is characterized by cells having relatively large cavities and thin walls. Summer wood cells have smaller cavities and thicker walls, and consequently are denser than spring wood. The growth rings, when exposed by conventional methods of sawing, provide the grain or characteristic pattern of the wood. The distinguishing features of the various species are thereby enhanced by the differences in growth ring formation.

Some tropical species, on the other hand, experience yearlong even growth which may result in less obvious growth rings.

HEARTWOOD

Heartwood consists of inactive cells formed by changes in the living cells of the inner sapwood rings, presumably after their use for sap conduction and other life processes of the tree have largely ceased. The cell cavities of heartwood may also contain deposits of various materials that frequently provide a much darker color. Not all heartwood, however, is darker.

The infiltrations of material deposited in the cells of heartwood usually make lumber cut from there more durable when exposed to weather. All wood, with the possible exception of the heartwood of Redwood and Western Red Cedar, should be preservative treated when used for exterior applications.

SAPWOOD

Sapwood contains living cells and performs an active role in the life processes of the tree. It is located next to the cambium and functions in sap conduction and storage of food. Sapwood commonly ranges from 1” to 2” (25.4 mm - 50.8 mm) in thickness. The Maples, Hickories, Ashes, and some of the Southern Yellow Pines and Ponderosa Pine may have sapwood 3” to 6” (76 mm - 152 mm) in thickness, especially in second growth trees.

SUGGESTION

MEDULLARY RAYS

Medullary rays extend radially from the pith of the log toward the circumference. The rays serve primarily to store food and transport it horizontally. They vary in height from a few cells in some species to four or more inches in the Oaks and produce the fleck (sometimes called flake) effect common to the quarter-sawn lumber in these species.

FOREST MANAGEMENT CERTIFICATION

The Sponsor Associations acknowledge and have adopted the International Wood Products Association's (IWPA) Statement on Certification as modified below.

- We acknowledge the interest in certified timber products and verification of good forest management.
- A number of certification and verification systems are in operation or in development today, and we make no judgment against or endorsement of any single plan.
- Certification can serve as an audit of work already being done toward improved forest management. An absence of certification, however, does not mean there is a lack of quality forest management.
- We wish to recognize the efforts that many countries and companies are making with regard to improved forest management practices. Further, we strongly endorse the right of individual countries and companies that become involved with certification or the verification of forest management to pursue the development of their own internal auditing system or the selection of one that is already established.
- Global consensus has not been reached regarding the scope and viability for any single system of certification to be appropriate for all locations and conditions. Efforts are being made to develop an international framework of mutual recognition between credible and market-oriented sustainable forest management standards and certification systems.

The development of a mutual recognition process should ensure that these various certification or verification systems:

- Do not discriminate against different forest types.
- Should be regularly reviewed and updated.
- Should be transparent.
- Should be cost-effective.

We strongly endorse the development of a mutual recognition system and support any and all efforts that will further enhance management of the world's forests and the growth of global and sustainable trade in wood products.

LUMBER

Native species of trees and the lumber used in architectural woodwork produced by these trees are divided into two botanical classes:

- **Hardwoods (**angiosperms): are usually deciduous trees (broad leaf). There are more angiosperms on Earth than any other plant group, over 200,000 species. About 900 of those species are commonly available for lumber or veneer throughout the world.
- **Softwoods (**gymnosperms): are typically coniferous such as pine, spruce and fir which have needle-like or scale-like leaves. The gymnosperms are among the largest and oldest living plants and number approximately 600 species.

This botanical classification is sometimes confusing, because there is no direct correlation between calling a species a hardwood or softwood and the hardness or softness of the wood itself. Generally, hardwoods are denser than softwoods, but some hardwoods are softer than many softwoods. If hardness is a desired characteristic, refer to the Comparative Table of Wood Species later in this section.

SPECIES SELECTION

The selection of the proper wood species for an architectural design can be the end result of a number of contributing factors and conditions. Intended use, costs, hardness, and relative stability are among many important considerations.

Lumber grades should always be referenced when specifying architectural woodwork. Selection of a grade (Custom, or Premium) for the finished product will define both materials and workmanship for that product. Lumber grades defined by the lumber material suppliers' associations allow some defects which the manufacturer must remove (cut out), or otherwise work around (by gluing, etc.).

The architect and designer may make his selection from a large variety of foreign and domestic species, now commercially available. The unique quality that wood imparts to design is that each species has its own distinguishing characteristics. Once the species is chosen, its effectiveness may vary according to the manner in which it is sawn, sliced as veneer, treated, and finished.

This Section is designed to advise the architect and designer in the comparisons, considerations, and species which should be evaluated before decisions are made and specifications are written. This Section will help you correlate and tabulate the information needed. An informed choice will reward the owner with the best possible performance by a natural building material.

COMPARATIVE TABLE OF WOOD SPECIES

In order to simplify species selection, the following Comparative Table of Wood Species has been prepared showing pertinent characteristics of some species of domestic and foreign woods used by the architectural woodwork industry. The table can aid a design professional in proper species selection after studying the characteristics.

Careful analysis of the table will make it possible for an architect, designer or specification writers (who may have only a limited knowledge of architectural wood species) to make an informed selection. It is our intent that this tool will enhance understanding between the manufacturer of the woodwork you have designed and your profession, thereby enabling the building industry to better service the client, and:

- **Cost** has been broken into Low, Moderate, High, and Very High. The cost of lumber, as with other commodities, is influenced by supply and demand, both of which are constantly changing.
- **Hardness** is broken into Soft, Medium, Hard and Very Hard and takes into consideration the ability of the lumber species to sustain stress; resist indentation, abuse and wear; and to carry its anticipated load in applications such as shelving and structural members.
- **Dimensional stability** is helpful in selecting woods for use where humidity conditions may vary widely and where design or fabrication of a wood product does not allow free movement or the use of sheet products. The column figures indicate extreme conditions and show the maximum amount of movement possible in a 12" (305 mm) wide piece of unfinished wood where its moisture content increases or decreases from 10% to 5%. The possible change in dimension demonstrates that unfinished interior woodwork must be carefully protected prior to finishing by keeping it in rooms where relative humidity is between 25% and 55%. The column also shows the variation between species, and between flat grain and edge grain where such cuts are available commercially.

LUMBER (continued)

Table : RG-001 — **COMPARATIVE WOOD SPECIE VALUES**

Species	Costs [1]	Practical Size Limits [2]			Hardness	Dimensional Stability [3]
		Thickness	Width	Length		
Alder, Red	Low	1-1/2"	5-1/2"	10'	Soft	10/64"
Anigre	High	1-1/2"	5-1/2"	12'	Very Hard	No data
Ash, White	Moderate	2-1/2"	5-1/2"	12'	Hard	10/64"
Basswood	Low	2-1/2"	5-1/2"	10'	Soft	10/64"
Beech, American	Low	1-1/2"	5-1/2"	12'	Hard	14/64"
Beech, European	Moderate	2-1/2"	7-1/2"	16'	Hard	No data
Birch, Yellow - natural	Moderate	1-1/2"	5-1/2"	12'	Hard	12/64"
Birch, Yellow - select red	Moderate	1-1/2"	4-1/2"	11'	Hard	12/64"
Birch, Yellow - select white	Moderate	1-1/2"	4"	11'	Hard	12/64"
Cedar, Western Red	High	3-1/4"	11"	16'	Soft	10/64"
Cherry, American Black	High	2-1/2"	4"	7'	Hard	9/64"
Fir, Douglas - Flat grain	High	3-1/4"	11"	16'	Medium	10/64"
Fir, Douglas - Vertical grain	High	1-1/2"	11"	16'	Medium	6/64"
Hickory, True Group	Low	1-1/2"	4-1/2"	12'	Very Hard	11/64"
Mahogany, African - plain sawn	High	2-1/2"	9"	15'	Medium	7/64"
Mahogany, African - quarter sawn	Very High	2-1/2"	5-1/2"	15'	Medium	5/64"
Mahogany, American	High	2-1/2"	11"	15'	Medium	6/64"
Makore	High	1-1/2"	5-1/2"	12'	Very Hard	No data
Maple, Hard - natural	Moderate	3-1/2"	7-1/2"	12'	Very Hard	12/64"
Maple, Hard - select white	Moderate	2-1/2"	5-1/2"	12'	Very Hard	12/64"
Maple, Soft - natural	Moderate	3-1/2"	7-1/2"	12'	Medium	9/64"
Oak, English Brown	Very High	1-1/2"	4-1/2"	8'	Hard	No data
Oak, Red - plain sawn	Moderate	2-1/2"	7-1/4"	12'	Hard	11/64"
Oak, Red - rift sawn	High	1-1/16"	3-1/2"	8'	Hard	7/64"
Oak, Red - quarter sawn	High	1-1/16"	5-1/2"	8'	Hard	7/64"
Oak, White - plain sawn	Low	1-1/2"	5-1/2"	10'	Hard	11/64"
Oak, White - rift sawn	High	3/4"	3"	8'	Hard	7/64"
Oak, White - quarter sawn	High	3/4"	4"	8'	Hard	7/64"
Pecan Group, Hickory	Low	1-1/2"	4-1/2"	12'	Hard	11/64"
Pine, Eastern or Northern White	Moderate	1-1/2"	9-1/2"	14'	Soft	8/64"
Pine, Ponderosa	Moderate	1-1/2"	9-1/2"	16'	Soft	8/64"
Pine, Southern Yellow	Low	1-1/2"	7-1/2"	16'	Medium	10/64"
Pine, Sugar	Moderate	3-1/4"	11"	16'	Soft	7/64"
Poplar, Yellow	Low	2-1/2"	7-1/2"	12'	Medium	9/64"
Redwood, Flat grain heartwood	Moderate	2-1/2"	11"	16'	Soft	6/64"
Redwood, Vertical grain heartwood	Moderate	2-1/2"	11"	16'	Soft	3/64"
Teak	Very High	1-1/2"	5-1/2"	8'	Hard	6/64"
Walnut, American Black	Moderate	2-1/2"	4"	6'	Hard	10/64"

(1) Market conditions will cause these relationships to vary. These are raw costs without consideration of labor.
(2) Maximum practical sizes without lamination / gluing. Only 10% of any order is required to be at maximum sizes.
(3) These figures represent possible width change in a 12" (305 mm) board when moisture content is reduced from 10% to 5%. Figures taken are for plain sawn unless indicated otherwise in the species column.

LUMBER (continued)

ALDER, RED (Alnus rubra)

Red Alder (also know as Oregon, Pacific Coast and Western Alder) has become an important utility lumber. Stable, economical and plentiful, it is used as a core for veneer and in the solid for mass produced furniture. The inner bark turns a reddish orange when exposed to the air, hence the name. Sourced predominately from the states of Oregon and Washington. Varies in color from almost white to pale pinkish brown and there is no visible boundary between heartwood and sapwood. Moderately light in weight and intermediate in most strength properties with relatively low shrinkage.

Figure: RG-002

ANIGRE (Aningeria poteria)

Anigre grows in Africa and is most common in the tropical areas of east Africa. The color varies from light yellowish brown with a pinkish tinge in the heartwood to golden brown. The grain is straight with uniform texture but can be wavy producing a mottled figure. Overall working characteristics are fair. Good nailing, screwing, gluing and staining properties. Used for cabinetwork and furniture.

Figure: RG-003

ASH, WHITE (Fraxinus americana)

While White Ash has always enjoyed widespread use for industrial products where hardness, shock resistance, stability and strength were important, its acceptance for architectural woodwork is increasing. It is open grained and has a strong and pronounced grain pattern. The heartwood is light tan or brown and its sapwood creamy white. Color contrast between the two is minor and its blonde effect makes it particularly appealing when a light or near natural finish is desired. Finished with darker tones it presents a bold effect. Its cost is moderate, and it is readily available in lumber form. In veneered form some size limitation may be experienced but it can be easily produced on special order.

Figure: RG-004

BASSWOOD (Tilia americana)

Basswood is well suited to woodcarving and pattern making. Its critical quality is there being no contrast between early wood and late wood. This is unusual in wood, as normally the late wood would tear as you attempt to work against its natural bias. Otherwise basswood is almost featureless. Creamy white to light tan in color with a pink hue; yellows when a finish is applied. Has a straight grain with fine and even texture. Shrinkage in width and thickness during drying is high; however, seldom warps in use.

Figure: RG-005

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SUGGESTION

BEECH, AMERICAN (Fagus grandfolia)

Beech grows in Eastern U.S. and adjacent Canadian Provinces. Color varies from nearly white sapwood to reddish brown heartwood; however, sometimes there is no clear demarcation between them. Heavy in weight with hard and strong properties that are highly suitable for steam bending. Machines smoothly, wears well, is well suited for turning and is easily treated with preservatives. Used for flooring, furniture, veneer, woodenware and when treated, for railroad ties.

Figure: RG-006

BEECH, EUROPEAN (Fagus sylvatica)

European Beech grows from the southern parts of Scandinavia to Sicily and from the French Atlantic coast to Poland. The color varies from pale pink brown heartwood to reddish brown tone when steamed and may have some dark veining. The grain is straight and fine with an even texture. The steam bending properties are exceptionally good. Stains well and is permeable for preservation treatment. Used for cabinetwork, furniture, flooring, heavy construction and marine piling (when pressure treated).

Figure:RG-007

BIRCH, YELLOW - Natural, Select Red, Select White (Betula alleghaniensis)

Yellow Birch has been and continues to be one of the prominent wood species used for architectural woodwork. This is due not only to its attractive appearance but also to its general availability both as lumber and as veneered products, its adaptability to either paint or transparent finish, and its abrasion resistance. The heartwood of the tree varies in color from medium to dark brown or reddish brown while its sapwood, which comprises a better than average portion of the tree, is near white. Despite its wide usage some confusion exists as to the common terms used to describe Birch lumber and/or veneer. Virtually all commercially used Birch is cut from the Yellow Birch tree, not from the White Birch tree, which botanically is a distinct species. The term “Natural” or “Unselected” Birch means that the lumber or veneer may contain both the sapwood, or white portion, as well as the heartwood, or dark portion, of the tree in unrestricted amounts. The term “Select Red” Birch describes the lumber or veneer produced from the heartwood portion of the tree, and the term “Select White” Birch describes the lumber or veneer produced from the sapwood portion of the tree. To obtain “Red” or “White” Birch exclusively requires selective cutting with corresponding cost premium as well as considerable restriction on the width and length availability in lumber form. Birch, in veneer form, is readily available in all “selections” and is usually rotary cut. While some sliced veneer is produced which simulates the same grain effect as lumber, its availability and cost reflect the same cutting restrictions that are incurred in producing the “select” forms of Birch lumber.

Natural

Figure: RG-008

Select Red

Figure: RG-009

Select White

Figure: RG-010

LUMBER (continued)

CEDAR, WESTERN RED (Thuja plicata)

Found in the Pacific Northwest and along the Pacific Coast to Alaska. With nearly white sapwood which is typically narrow, its heartwood runs reddish or pinkish brown to dull brown. It is generally straight grained with uniform coarse grain. With very low shrinkage, its lightweight, moderately soft, low in strength; however, very resistant to decay. Principally used for shingles, exterior siding, decks, standing and running trim, sash and doors.

Figure: RG-011

CHERRY, AMERICAN BLACK (Prunus serotina)

Wild Black American Cherry is a fine and especially stable close-grained cabinet and veneer wood. Its heartwood color ranges from light to medium reddish brown. Its sapwood, which is a light creamy color, is usually selectively eliminated from the veneer and lumber. In some respects, it resembles Red Birch, but has a more uniform grain and is further characterized by the presence of small dark gum spots which, when sound, are not considered as defects but add to its interest.

Cherry is available in moderate supply as lumber and architectural paneling and is usually plain sawn or sliced. Exceptionally rich appearance is achieved with transparent finishes which, together with its machining characteristics, justifies its identity with Early American cabinetry and furniture manufacturing, thus adding to its prestige as one of our most desirable native woods.

Figure: RG-012

FIR, DOUGLAS (Pseudotsuga taxifolla)

Douglas Fir is a large, fast growing species and is native to the northwest. It accounts for much of the lumber produced in North America. While the preponderance of its production is developed for structural and construction type products, some of its upper grades are used for stock and specialized architectural woodwork. Its heartwood is reddish tan while its sapwood is creamy yellow. Since its growth rings are conspicuous, a rather bold grain pattern develops when either plain sawn for lumber or rotary cut as is common in plywood. Some lumber and veneer is edge cut or vertical grain, producing a superior form of the product since the tendency to "grain-raise" is greatly reduced.

Figure: RG-013

HICKORY, PECAN GROUP

(Carya cordiformis, illinoensis, aquatica and myristiciformis)

Harvested typically in the Eastern half of the U.S. Sapwood is white to nearly white and relatively wide with somewhat darker heartwood. Predominately used for implement handles, furniture and decorative paneling.

Figure: RG-014

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LUMBER (continued)

HICKORY, TRUE GROUP (Carya ovata, glabra, and lacinosa)

Harvested typically in the Middle to Southern Atlantic and Central U.S. The sapwood is white and usually quite wide with reddish heartwood. It is extremely tough, heavy, hard, strong and experiences considerable shrinkage in drying. Typically used for implement handles, ladder rungs, furniture and flooring.

Figure: RG-015

MAHOGANY, AFRICAN (Khaya ivorensis)

This, one of the true Mahoganies, is perhaps the most widely used of the several Mahogany species. This is due to its excellent cutting and working characteristics and versatility. While its use has been largely for interior purposes, its innate stability and moderate decay resistance justifies its consideration for selected and demanding exterior applications. It has a very pleasing open grain, with its heartwood ranging in color from light to medium dark reddish brown. In lumber form it is more readily available as plain sawn and selectively so as quartersawn.

In veneer form the quarter or "ribbon striped" cut predominates, but plain sliced, as well as many of the exotic "figure" cuts, can be produced on special order.

Figure: RG-016

MAHOGANY, AMERICAN (Swietenia macrophylla) **CITES** listed

This Mahogany species is commonly known as "Honduras Mahogany," but actually encompasses all of this species that grow throughout Mexico, Brazil, Peru, and Central America. Its traditional identity with casework and furniture justifies its position as one of the finest woods for this purpose. Its stability, workability, warm appearance, and firm grain make it a favorite of all woodworking craftsmen. It is a semi open grain wood, with its heartwood color ranging from light tan to a rich golden brown depending to some extent on the country of its origin. Its outstanding stability and decay resistance expands its potential to include exterior applications for "monumental" projects. It is most generally available as plain sawn lumber and plain sliced veneer with different veneer cuts available on special order.

Figure: RG-017

MAKORE (Tieghemella heckelii, Tieghemella africana)

Makore grows in Western and Middle Africa. The color varies from pink to reddish brown. The grain has a fine texture with closed pores and can be straight, interlocked or wavy. Generally easy to work, although sections with interlocked grain can cause tear out during planing. Suitable for turning and is easy to glue and finish. Used for cabinetwork, furniture, flooring, boat building and turned objects.

Figure: RG-018

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LUMBER (continued)

MAPLE, SOFT GROUP

(Acer saccharinum, rubrum, negundo and macrophyllum)

Typically found in Eastern U.S. with some in the Oregon Pacific Coast. Similar in appearance to hard Maple, heartwood is somewhat lighter in color than sapwood and wider. Soft Maple is not as heavy, heard or strong as Hard Maple. Typically used for railroad ties, furniture, veneer and wooden ware.

Figure: RG-019

MAPLE, HARD GROUP - Natural or Select White

(Acer saccharum and nigrum)

Hard Maple is very similar in general characteristics to Yellow Birch. It is heavy, hard, strong, and resistant to shock and abrasion. The heartwood of the tree is reddish-brown and its sapwood is near white with a slight reddish brown tinge. Another natural characteristic is the prevalence of dark mineral streaks (predominantly in the heartwood), which can be minimized in the sapwood by selective cutting. Like Birch, common usage of descriptive terms does occasion some confusion. The term “Natural” or “Unselected” Maple indicates that the lumber or veneer may contain both the white sapwood and the darker heartwood. The term “White” Maple means that the lumber or veneer is selected and separated from the pieces containing the dark heartwood. Unlike Birch, the heartwood is so low in content that no comparable selection is available. Maple’s close identity with furniture and specialized industrial use overshadows its potential for architectural woodwork. Its modest cost, and pleasing, mild grain pattern warrants its consideration, especially on items subject to hard usage.

Figure: RG-020

OAK, ENGLISH BROWN (Quercus robur)

The English Brown Oak, or Pollard Oak is a tree which varies in height from 60’-130’ (18-40 m) depending on soil conditions. It varies in color from a light tan to a deep brown with occasional black spots. It produces burls and swirls which are very brittle and fragile, but beautiful work can be obtained with their use. English Brown Oak is considered one of the finest woods in use today.

English Brown Oak is obtained from trees which have had their tops cut out before reaching maturity. This pruning leads to the production of several new branches around the cut, and if these are subsequently lopped off, more new branches are formed. This wood is difficult to season and to work, tending to warp and twist in drying and to tear in working. The best figure is obtained from trees which have been cut out regularly every few years, the branches never being left long enough for the production of large knots. The constant exposure of freshly cut surfaces promotes attack from parasites, the result being that a considerable portion of these trees become decayed sooner or later. This has made the timber relatively scarce and costly.

Figure: RG-021

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SUGGESTION

OAK, RED (Quercus rubra)

Red Oak is one of the most abundant of our domestic hardwoods. Its moderate cost, strength, wear ability, and appealing grain characteristics make its use widespread. It is open grained and in its plain sawn or sliced form expresses a very strong “cathedral” type grain pattern. The heartwood is reddish tan to brown and very uniform in color. Its sapwood is lighter in color and minimal in volume, making its elimination by selective cutting very easy. Red Oak is also available in rift sawn or sliced form, which produces a very uniform straight grained effect. Less frequently it is quarter sawn or sliced, still producing a straight grain but with the fleck (sometimes called flake) of the medullary ray accented. Some sacrifice in width and length availability occurs when producing either rift or quarter sawn lumber.

Rift

Figure: RG-022

OAK, WHITE (Quercus alba)

White Oak, like Red Oak, is perhaps one of the best-known hardwoods in the world, and its use for architectural woodwork is widespread. It is hard and strong. Its heartwood has good weathering characteristics, making its use for selected exterior applications appropriate. It is open grained and in its plain sawn form is highly figured. The heartwood varies considerably in color from light grayish tan to brown, making the maintenance of color consistency difficult. Its sapwood is much lighter in color, is fairly prevalent, and its elimination is accomplished by selective ripping. White Oak is often rift sawn or sliced, producing a very straight grained effect or frequently quarter sawn or sliced, producing straight grain, but with the fleck (sometimes called flake) of the medullary ray greatly pronounced. The special cuts mentioned are more readily attained in veneer form since the solid lumber cutting techniques greatly restrict its width and length potential.

Plain Sliced

Rift

Figure: RG-023

PECAN - (see Hickory, Pecan Group)

LUMBER (continued)

PINE, PONDEROSA (Pinus ponderosa)

Ponderosa Pine is said to be the softwood species most commonly used for exterior and interior woodwork components. Its heartwood is tannish pink, while its sapwood is a lighter creamy pink. Its supply is extensive; found in commercial quantities in every state west of the Great Plains. Ponderosa Pine grows in pure stands and is abundant in mixed stands. Also, like most Pines, the proportion of sapwood is high and its heartwood has only a moderate natural decay resistance. Fortunately, its receptivity to preservative treatment is high, and since all Pines should be so treated when used on the exterior, it can be used interchangeably with them.

Figure: RG-024

PINE, EASTERN WHITE (Pinus strobus)

Found from Maine to Northern Georgia and the Great Lake States, it is typically called White Pine. Heartwood light brown, often with a reddish tinge and turns darker when exposed to air. Has relatively uniform texture, straight grain, low shrinkage and high stability. It's light weight, moderately low in strength and stiffness. Extensively used in patterns, sash, doors, furniture, interior woodwork, knotty paneling and caskets.

Figure: RG-025

PINE, SOUTHERN YELLOW - Short Leaf (Pinus echinata)

Southern Yellow Pine, commonly called Short Leaf Pine, is commercially important in Arkansas, Virginia, Missouri, Louisiana, Mississippi, Texas, and South and North Carolina, and is found in varying abundance from New York and south-central Pennsylvania, south and westerly to eastern Texas and Oklahoma. The yellowish wood is noticeably grained, moderately hard, strong, and stiff. A cubic foot of air dried Southern Yellow Pine weighs 36 to 39 pounds. It is used extensively in-house building, including framing, ceiling, weather boarding, panels, window and door frames, casing, and carved work. The grain shows well in natural finish or when stained. Frames of overstuffed furniture, chairs, desks, agricultural machinery, wood pulp, mine props, barrels, and crates are also made of this Pine.

Figure: RG-026

PINE, SUGAR (Pinus lambertiana)

The world's largest species of pine typically found in California and South Western Oregon. Its heartwood is buff to light brown and sometimes tinged with red. It's straight grained with fairly uniform texture, low shrinkage and dimensionally stable, lightweight, soft, and moderately low in strength and stiffness. Used almost exclusively for boxes, sashes, doors, frames, general architectural woodwork and foundry patterns.

Figure: RG-027

LUMBER (continued)

POPLAR, YELLOW (Liriodendron tulipfera)

Yellow Poplar sometimes incorrectly called “Whitewood,” is an extremely versatile and moderately priced hardwood that is well adapted to general interior woodwork usage. It is even textured, close grained, stable, of medium hardness, and has an inconspicuous grain pattern. The heartwood is pale greenish yellow while the sapwood is white. Occasional dark purple streaks also occur. The tight, close grain results in outstanding paint ability, while its modest figure and even texture permits staining to simulate more expensive hardwood. Due to its indistinct grain figure, Poplar is seldom used for decorative veneered products. Its white sapwood is not appropriate for use in exterior applications.

Figure: RG-028

REDWOOD heartwood (Sequoia sempervirens)

Redwood is the product of one of nature’s most impressive accomplishments. The enormous size and unique inherent characteristics of this tree produce a material ideally suited for exterior applications. Its heartwood color is a fairly uniform brownish red, while its very limited sapwood is lemon colored. In its plain sawn form medium “cathedral” type figure develops, while in the vertical grain a longitudinal striped figure result. Its availability in “all heartwood” form with its outstanding natural resistance to decay accounts for its wide usage for exterior purposes. It is considered a very stable wood and its paint retention qualities are excellent. Redwood’s principal identity with painted exterior application should not preclude its consideration for either exterior or interior use with transparent finish. Its pleasing and uniform color lends to a variety of such finishes suggesting the warmth and honesty of wood in its natural state. The size of the trees yields lumber of unusually character free widths and lengths.

Figure: RG-029

TEAK (Tectona grandis)

Teak is one of the most versatile and valuable woods and has attained great prestige value. The figure variations are extensive, and it is available in both lumber and veneered products. Adding to its appeal is its distinctive tawny yellow to green to dark brown color, often with light and dark accent streaks. It is perhaps most appealing in plain sawn or sliced cuts. While it has unique stability and weathering properties, making it ideal for exterior applications, its high cost usually limits its use to decorative interior woodwork, most often in veneer form. Its great beauty and interest dictate it being finished in its near “natural state”.

Figure: RG-030

WALNUT, AMERICAN BLACK (Juglans nigra)

American Black Walnut is perhaps our most highly prized domestic wood species. Its grain pattern variations are extensive and in veneered form produces, in addition to its normal plain sliced cut, quartered or “pencil striped” as well as specialty cuts such as crotches, swirls, burls, and others. Its heartwood color varies from gray brown to dark purplish brown. The sapwood, which is very prevalent in solid lumber, is cream colored and its complete elimination by selective cutting is very costly. Fortunately, if this natural effect is felt to be undesirable, its appearance can be neutralized by sap staining in the finishing process. The growth conditions of Walnut result in significant width and length limitations in its lumber form. Its potential is best expressed in veneered products.

Figure: RG-031

LUMBER (continued)

SUGGESTION

OTHER SPECIES

There are many other species, both domestic and imported, used in woodworking. Nearly all are ecologically sound and appropriate for use. Using hardwoods for architecture gives value to the species, encouraging improved forest management techniques and the continuation of the species.

ENDANGERED SPECIES

For a current list of endangered species see the Convention on International Trade in Endangered Species (CITES) Appendix I restricted table at cites.org.

AESTHETIC CHARACTERISTICS

One of the qualities which contributes to the widespread use of wood is the option offered for aesthetic selection. It varies between species, between two logs of the same species, and between two boards from the same log. Aesthetic considerations in specifying wood are influenced by the following characteristics:

- **Color** - The basic hue of the species, which may be further enhanced by the finishing process employed.
- **Sapwood** and **heartwood** - The color of wood within a tree varies between the "sapwood" (the outer layers of the tree that continue to transport sap), which is usually lighter in color than the "heartwood" (the inner layers in which the cells have become filled with natural deposits). If desired, sapwood may be stained in the finishing process to blend with the heartwood. This difference in color is so pronounced in certain species that the sapwood is marketed under a different nomenclature from the heartwood.

  Some examples are:

  - **Select White Birch** - sapwood of Yellow or Paper Birch
  - **Select Red Birch** - heartwood of Yellow Birch
  - **Natural Birch** - both sapwood and heartwood of any Birch
  - **Select White Ash** - sapwood of White or Green Ash
  - **Select Brown Ash** - heartwood of Black Ash
  - **Natural Ash** - both sapwood and heartwood of any Ash
  - **Select White Maple** - sapwood of the Sugar Maple
- **Grain** - The appearance produced by the arrangement of wood fibers and pores of the species. Lumber grain may not match veneer grain.
- **Open Grain and Closed Grain** - Open grain woods are said to be ring porous and usually show a distinct grain pattern. Close grain woods are said to be diffuse-porous with even grain. The size and distribution of the cellular structure of the wood influences the appearance and uniformity. Open grain hardwoods, such as Elm, Oak, Ash, and Chestnut are ring-porous species. These species have distinct figure and grain patterns. Close grain hardwoods, such as Cherry, Maple, Birch, and Yellow Poplar, are diffuse-porous species. Most North American diffuse-porous woods have small, dense pores resulting in less distinct figure and grain. Some tropical diffuse-porous species (e.g., Mahogany) have rather large pores.
- **Figure** - Various species produce different grain patterns (figures), which influence the selection process. There will be variations of grain patterns within any selected species. The manufacturer cannot select solid lumber cuttings within a species by grain and color in the same manner in which veneers may be selected.
- **Finishing Characteristics** - The many species of wood vary considerably in their receptivity to the multitude of finishing processes on the market. Some woods, because of their open pores, will accept fillers while tighter grained woods will not. Some will show greater contrast between the "early wood" and the "late wood" when stained than others. Design professionals should take into consideration the finish that will be applied when selecting a particular species.

  Consult with a Sponsor Association member / affiliate about finishing prior to selection or specification. Providing large samples of the desired finish to manufacturers during the design phase and bidding process will assure the designer of obtaining an acceptable final product, while enabling the manufacturer to be aware of exactly what is required. Lumber might not accept transparent finishes in the same manner as veneer and special finishing techniques may be required.

LUMBER (continued)

METHODS OF SAWING

Lumber is typically furnished plain sawn unless otherwise specified. Sawing methods, and the selection of boards after sawing the log, as shown below, produce the following types of lumber:

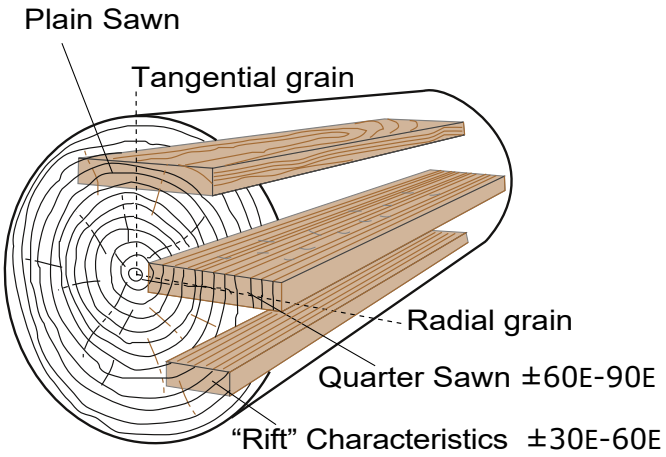

Figure: RG-032

- **Plain Sawn** (Flat Sawn) - Plain sawing, the most common type of lumber sawing, yields broad grain, the widest boards and least waste. The annular rings are typically 30 degrees or less to the face of the board.

Figure: RG-033

- **Quarter Sawn** - Most often cut as Rift and Quartered, and then sorted for appearance, quarter sawn lumber is available in certain species, yields a straight grain, narrow boards, and fleck (sometimes called flake) or figure which runs across the grain in some species (notably the Oaks). Dimensional stability across the grain is the best. The annular rings run approximately 60 to 90 degrees to the face of the board, with the optimum being 90 degrees. Quartered lumber is generally narrower and more expensive than plain sawn of the same species.

Figure: RG-034

- **Rift Sawn** - Rift sawing produces small flecks caused by cutting through the wood rays. Only certain species produce these flecks, primarily Red and White Oak. Rift cutting reduces yield and increases cost. The annular rings run about 30 to 60 degrees to the face of the board, with the optimum being 45 degrees.

Figure: RG-035

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SUGGESTION

AVAILABILITY and SIZE LIMITATIONS

The supply of lumber is in constant flux throughout the world. It is affected by many factors such as current demand, export regulations of the country of origin, natural forces of weather, fire, disease, political situations, etc. Certain trees (species) naturally grow larger, thus producing longer and wider lumber. Other trees are smaller and produce narrow and shorter boards. The manufacturer must work with the available lumber, which must be considered when selecting any species. Consult a Sponsor Association member / affiliate before specifying an uncommon species, or thickness, and/or long lengths which may not typically be available. If available, the cost may be substantially higher. Economies can be realized by detailing and specifying thicknesses and widths within the finish sizes of these standards.

VENEERED CONSTRUCTION

Lumber can be used to secure wide and thick members in species with limited cutting potential. An acceptable technique is to apply thin lumber or veneer to the faces and edges of a compatible density lumber, structural composite lumber (SCL), or a medium density fiberboard core.

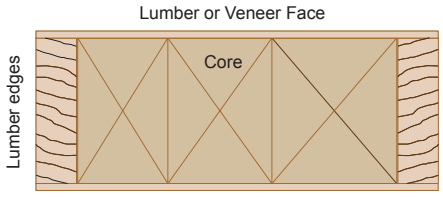

Figure: RG-036

DIMENSIONAL STABILITY, RELATIVE HUMIDITY, and MOISTURE CONTENT

All woods are affected significantly by moisture and to a lesser degree by heat. Lumber swells and shrinks primarily in two directions: thickness and width. There is insignificant change in length. The changes in dimension due to moisture vary with different species, thus influencing the selection of lumber to use and the design elements.

Prevention of dimensional problems in architectural woodwork products as a result of uncontrolled relative humidity is possible. Wood products perform, as they have for centuries, with complete satisfaction when correctly designed and used. Problems directly or indirectly attributed to dimensional change of the wood are usually, in fact, the result of faulty design or improper humidity conditions during site storage, installation, or use.

Wood is a hygroscopic material, and under normal conditions all wood products contain some moisture. Wood readily exchanges this moisture with the water vapor in the surrounding atmosphere according to the relative humidity. In high humidity, wood picks up moisture and swells. In low humidity, wood releases moisture and shrinks. As normal minor changes in humidity occur, the resulting dimensional response in properly designed construction will be insignificant. To avoid problems, it is recommended that the appropriate recommendations from Section 13 be maintained. Uncontrolled extremes are likely to cause problems. Together with proper design, fabrication, and installation, humidity control is the important factor in preventing dimensional change problems. The book *Understanding Wood* by Bruce Hoadley contains excellent data of wood and moisture.

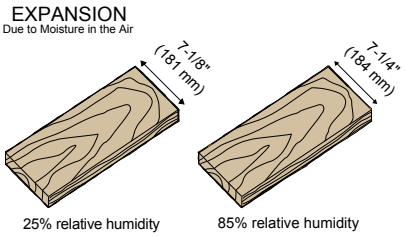

Figure: RG-037

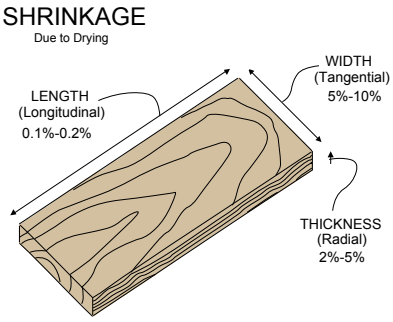

Figure: RG-038

SUGGESTION

DIMENSIONAL STABILITY, RELATIVE HUMIDITY, and MOISTURE CONTENT (continued)

Wood is anisotropic in its shrinkage characteristics. It shrinks most in the direction of the annual rings when it loses moisture from the cell walls. This illustration from USDA's The Wood Handbook (latest edition), published by their Forest Products Laboratory, shows the typical distortion of cuts from various parts of a log.

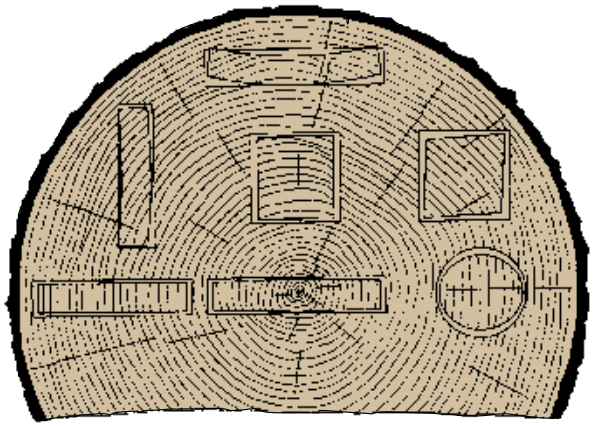

Figure: RG-039

Moisture can also cause iron stain (oxidation) in wood, also referred to as blue / black stain. Iron stain is a natural reaction of acids with iron, oxygen, and moisture (either high relative humidity or direct moisture) in wood. Control of moisture is a simple way to protect wood products from iron stain.

PRESERVATIVE TREATMENTS

Modern technology has developed methods of treating certain species to extend their life when exposed to the elements. Some lumber species used for exterior architectural woodwork may be treated with an industry tested and accepted formulation. One such formulation is a liquid containing 3-iodo-2-propynyl butyl carbamate (IPBC) as its active ingredient, which must be used according to material supplier's directions.

The Window & Door Manufacturers Association (WDMA), through the treatments and coatings committee, has reviewed information from third party testing laboratories which indicates that the number of formulations at the stated in use concentration meet the requirements of WDMA I.S.4 (latest edition). The formulations are acceptable for use under the WDMA Hallmark Water Repellent Non-Pressure Preservative Treatment Certification Program and are adopted to meet all requirements.

FIRE RETARDANT WOOD

The natural-fire retardant qualities and acceptability of treatments vary among the species. Where items of architectural woodwork are required to have a flame spread classification to meet applicable building and safety codes, the choice of lumber species must be a consideration. Most treated species are structural softwoods.

Following are some references to assist in making these choices. Additional data on various species may be available from USDA's The Wood Handbook (latest edition), published by their Forest Products Laboratory.

- **Built-up construction** to Improve Fire Rating: In lieu of solid lumber, it is often advisable, where a fire rating is required, to build up members by using treated cores clad with untreated veneers not thicker than 1/28" (0.9 mm). Some existing building codes, except where locally amended, provide that facing materials 1/28" (0.9 mm) or thinner finished dimension are not considered in determining the flame spread rating of the woodwork.

  In localities where basic model building codes have been amended, it is the responsibility of the specifier to determine whether the application of the facing material specified will meet the code.

- **Fire retardant treatments** (FRT): Some species may be treated with chemicals to reduce flammability and retard the spread of flame over the surface. This usually involves impregnating the wood, under pressure, with salts suspended in a liquid. The treated wood must be re-dried prior to fabrication. FRT wood may exude chemicals in relative humidity above 85%, damaging finishes and corroding metals in contact with the FRT surface. Consult with a manufacturer about the resulting appearance and availability of treated woods prior to specification.

  Hardwoods currently being treated (Flame spread less than 25) include 4/4 Red Oak, and 4/4 to 8/4 Poplar. These woods can be machined after treatment, although machining may void the label classification. Fire Retardant treatments may affect the finishes intended to be used on the wood, particularly if transparent finishes are planned. The compatibility of finishes should be tested before they are applied. (from Section 06)

  According to the traditional model codes in the USA and subject to local code modifications, untreated wood and wood products can usually be used in up to 10% of the combined surface area of the walls and ceiling. Casework, furniture, and fixtures are rarely fire rated, and can be built of combustible materials.

SUGGESTION

FLAME SPREAD CLASSIFICATIONS

This is the generally accepted measurement for fire rating of materials. It compares the rate of flame spread on a particular species with the rate of flame spread on untreated Oak. Most authorities accept the following classes for flame spread:

- Class A 0-25
- Class B 26-75
- Class C 76-200

Table: RG-003 - FLAME SPREAD and SMOKE DEVELOPED INDEXES

Common woods species, adapted from USDA's The Wood Handbook (latest edition), published by their Forest Products Laboratory, and based on 3/4" (19.0 mm) thick solid lumber:

Species	Flame Spread Index	Smoke Developed Index
SOFTWOODS		
Yellow Cedar	78	90
Bald Cypress	145 - 150	---
Cedar, Western Red	70	213
Fir, Douglas	70 - 100	---
Fir, Pacific Silver	69	58
Hemlock, Western	60 - 75	---
Pine, Eastern White	85 - 215	---
Pine, Ponderosa	105 - 230	---
Pine, Red	142	229
Pine, Southern	130 - 195	---
Pine, Western White	75	---
Redwood	70	---
Spruce, Eastern	65	---
Spruce, Sitka	74 - 100	---
HARDWOODS		
Birch, Yellow	105 - 110	---
Cottonwood	115	---
Maple	104	---
Poplar, Yellow	170-185	---
Oak, Red / White	100	100
Sweetgum	140-155	---
Walnut	130 - 140	---

RECLAIMED or RECYCLED WOOD

EVOLUTION - In recent years, with the interest in "Green" alternative materials and the reuse of previously used materials, the architectural woodwork industry has seen an increase in the specifying of reclaimed wood. While there are many similarities between reclaimed wood and new wood there are enough significant differences to create a need for enhanced industry standards.

MOTIVATION - The reuse of previously used wood in architectural woodwork projects comes from the desire to:

- Reduce the need for harvesting trees from our forests. Every board we can reclaim from prior use is a tree we do not need to cut down. This comes from a sincere desire to retain our natural resources for future generations.
- Reduce the unnecessary additions to our landfill. In the past most of the wood that was previously used was demolished and sent to landfill. In many cases the wood is of high quality and easily re-purposed for use again.
- Gain LEED credit.
- Create a connection to the past from characteristics such as weathering, nail holes, or other distress or patina imprinted on the material by time and previous use are elements which are valued in this design choice.

SOURCES - Examples of reclaimed lumber are so-called barn wood and wood from old demolished structures like water storage tanks, wine tanks, wood pilings and even underwater forests and sunken logs.

Sources and types of reclaimed materials vary greatly in their type, quality, availability. Aesthetics and cost. A sample of material used for selection may not match actual available material in species, color, texture, surface quality or structural composition when it comes time to make a purchase.

Design professionals and specifiers should be aware of the limitations of availability of species, cut, quantity, lead time, waste factor and cost of material. These materials are normally sold "as is" and are not returnable.

Logs harvested over 100 years ago and transported by water often sank in route to mills. The resulting "lost underwater forest" lay on the bottoms of rivers and lakes until recently as proper environmental and mechanical procedures for retrieving them have been developed.

SUGGESTION

RECLAIMED or RECYCLED WOOD (continued)

Reclaimed submerged materials are utilized in all aspects of construction of furniture, architectural woodwork and musical instruments. Submerged lumber is generally processed in both solid lumber, plain sliced and rotary veneer.

The uniqueness of the harvesting procedures, the high quality of the material and unusual aesthetic qualities are a few of desirable traits associated with this special material.

It is advisable that the design professional and woodworker see the material at the supplier to determine the availability and suitability for the intended use.

LACK OF STANDARDS - Whereas conventional wood and veneer materials have been relatively easy to set industry standards for, the very nature of reclaimed wood and the reasons we use it make its classification and standardization more subjective, such as:

- There are no standard dimensions for reclaimed wood.
- There are no grading standards for appearance or surface condition, therefore there are no measurable characteristics and defects established by which to reject unsuitable materials once such is purchased.
- Often, what are considered flaws and degrades in conventional lumber (checks, splits, knots and warp) might be considered desirable “character” in reclaimed applications.
- Because of the finite nature of reclaimed wood, the quantities available may not match the quantities required for a given project.

It is advisable that the design professional and woodworker see the material at the supplier to determine the availability, suitability and performance needs for the intended use and agree on the materials range of color, grain, distress, character, and patina.

MATERIAL SELECTION - Because reclaimed or recycled wood is unique and finite, specification begins with specific material selection made by the design professional or client, possibly in collaboration with the woodwork manufacturer.

Early involvement of the woodwork manufacturer will typically lead to a better understand the design intent and their assistance in finding suitable reclaimed material in the appropriate dimensions and quantities. They will also be able to help with suggestions about species, surface condition and color. Important considerations:

- Aesthetic consideration.
- Desired surface condition (original surface, re-sawn, surfaced).
- Desired finish condition (painted as it comes, newly painted, sealed, unfinished).
- Acceptability of natural defects (knots, checks, etc.), evidence of previous use (bolt holes, nail holes, gouges and notches) or evidence of previous bug infestation.
- Desired grain (flat sawn, vertical grain).
- Intended use (i.e. paneling, furniture, indoors, outdoors).
- Intended fastening (face nailed, blind nailed, panel clips).
- Approximate quantity of material required.

Once a material source has been selected, control samples (that are labeled, numbered, dated and signed) should be developed to establish the agreed acceptability of material finish, characteristics, whether natural or from previous use. Taking into consideration that providing large and repetitive samples to show a full range or material characteristics is recommended.

SUGGESTION

RECLAIMED or RECYCLED WOOD (continued)

CARE & STORAGE - Beyond the basic rules of Section 13 ambient humidity and initial moisture content of reclaimed wood can be very important factors in insuring dimensional stability of the end product:

- With reclaimed wood moisture content may need to be addressed on a case by case basis. Typically "barn wood" is supplied "dry" and is of little concern in this regard. On the other hand timbers encrusted in earth or reclaimed from moist environments exposed to rain and water may require further drying to ensure stability.
- Additional drying may be particularly important when secondary milling is required to create the final form. Wood that may appear to be dry may contain a reservoir of moisture at its core which could be activated by further milling. This could result in a product which checks, cracks and distorts in unacceptable ways.
- For some design purposes instability may be a desired result. In other words, initial high moisture content may cause lumber to twist and crack after installation over time in ways that achieve a particular aesthetic result. Achieving these effects is the responsibility of the design professional working in close collaboration with the architectural woodwork manufacturer.

DESIGN PROFESSIONAL RESPONSIBILITY With unique material like reclaimed or recycled wood for architectural woodwork the design professional needs to take an active role in sourcing and pre-approving their desired selections. With these materials there is no traditional guidelines to reassure either the woodwork manufacturer or architect of achieving the result they expect.

There will be situations where the design professional may have to directly participate in the selection process piecemeal, accepting some material and rejecting others as not suited to the purpose.

CONTRACT DOCUMENTS, shall clearly indicate or delineate all material, fabrication, installation and applicable building code / regulation requirements with the clear understanding that incomplete design choices, changes in scope or material selection, lack of material selection, or design choices made after initial bid may impact the cost or not be possible.

The contract documents shall specifically list the material source and identifier, and address the allowable:

- Variation in color or tone
- Defects, such as nail holes, checking, cracking, discoloration, milling marks, roughness in terms of quantity, locations, repetition, etc.
- Distortion in terms of straightness, cupping, flatness, etc.

NONTRADITIONAL MATERIALS

Covers materials re-purposed from other industrial and manufacturing areas but assigned to the woodwork manufacturer and treated similarly to traditional architectural woodwork items like wall paneling. From a design perspective, consideration of appearance, color, finish, variation and relation are deemed important as they would be with traditional wood products.

Examples of non-traditional materials could be a fiber / cement panel designed for fire resistance, insulation re-purposed as a decorative panel, metal products, cloth, acrylics, etc.

Because these materials are unique, contract documents, shall clearly indicate or delineate all the necessary material, fabrication, installation and building code / regulation direction and requirements as may be applicable for the manufacturer / installer to reasonably accomplish the intended design concept.

ENGINEERED PRODUCTS

STRUCTURAL COMPOSITE LUMBER (SCL) — A man made composite that utilizes grain-oriented wood strands from a variety of tree species, providing an alternative to dimension lumber. The material is engineered for strength and stability. While SCL is not really "lumber," it is marketed as a lumber substitute. SCL can be specified as core, stile backers, and core for stiles and rails, so long as all other criteria of these standards are met in relation to its use.

LAMINATED VENEER LUMBER (LVL) - A lumber substitute made with veneer plies bonded in parallel. LVL is made using many tree species and this diversity increases the performance characteristics and product potential.

LUMBER (continued)

Table: RG-004 - **SPECIFIC GRAVITY / WEIGHT OF MISCELLANEOUS SPECIES**

SPECIES	SPECIFIC GRAVITY [1]	WEIGHT [2]
ALDER, RED Alnus rubra	0.37	28
ASH, WHITE Average of 4 species	0.54	41
ASPEN Populus tremuloides	0.35	27
AVODIRE Turraeanthus africanus	0.48	36
BASSWOOD Tilia americana	0.32	26
BEECH Fagus grandifolia	0.56	45
BIRCH, SWEET Betula lenta	0.60	46
BIRCH, YELLOW Betula alleghaniensis	0.55	43
BUBINGA Guibourtia demeusil	0.78	55
BUTTERNUT Juglans cinerea	0.36	27
CATALPA, NORTHERN Catalpa speciosa	0.38	29
CATIVO Prioria copaifera	0.40	29
CHERRY, BLACK Prunus serotina	0.47	35
CHESTNUT Castanea dentata	0.40	30
COTTONWOOD, EASTERN Populus deltoides	0.37	28
CUCUMBER TREE, YELLOW Magnolia acuminata	0.44	34
CYPRESS (BALD CYPRESS) Taxodium distichum	0.42	32
DOGWOOD, FLOWERING Cornus florida	0.64	51
EBONY, GABOON (NIGERIAN) Diospyros crassiflora	0.82	63
ELM, AMERICAN Ulmlus Americana	0.46	36
HACKBERRY Celtis occidentalis	0.49	37
HICKORIES, TRUE Average of 4 species	0.65	51
HOLLY Ilex opaca	0.50	40
IPE Handroanthus serratifolius	0.91	69
LIMBA Terminalia superba	0.45	34
LOCUST, BLACK Robinia pseudoacacia	0.66	48
MAHOGANY, AFRICAN Khaya ivorensis	0.43	31
MAHOGANY, CUBAN Swietenia mahogany	0.57	41
MAHOGANY, CENTRAL AMERICAN Swietenia species	0.45	32
MAKORE Tieghemella heckelii	0.55	40
MAPLE, RED Acer rubrum	0.49	38
MAPLE, SILVER Acer saccharinum	0.44	33

(continued)

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SUGGESTION

Table: RG-004 - **SPECIFIC GRAVITY / WEIGHT OF MISCELLANEOUS SPECIES** (continued)

SPECIES	SPECIFIC GRAVITY [1]	WEIGHT [2]
MAPLE, SUGAR Acer saccharum	0.57	44
MYRTLE Umbellularia Californica	0.51	39
NARRA Pterocarpus indicus	0.52	42
OAK, COMMERCIAL RED Average of 9 species	0.56	44
OAK, COMMERCIAL WHITE Average of 6 species	0.59	47
ORIENTAL WOOD (Queensland Walnut) Endiandro palmerstoni	0.53	44
OSAGE ORANGE Maclura pomifera	0.76	n/a
PADUAK (AFRICAN) Pterocarpus soyauxii	0.61	43
PADUAK (ANDAMAN) Pterocarpus dalbergioides	0.62	45
PADUAK (BURMA) Pterocarpus macrocarpus	0.75	54
PALDAO Dracontomelum dao	0.59	44
PECAN Carya illinoensis	0.60	47
PEARWOOD (EUROPEAN) Purus communis	0.52	43
PHILIPPINE HARDWOODS		
RED LAUAN Shorea negrosensis	0.40	36
WHITE LAUAN Pentacme contorta	0.43	36
TANGUILE Shorea polysperma	0.53	39

SPECIES	SPECIFIC GRAVITY [1]	WEIGHT [2]
POPLAR, YELLOW (TULIPTREE) Liriodendron tulipifera	0.38	28
PRIMAVERA Cybistax donnell-smithii	0.40	30
ROSEWOOD (BRAZIL) Dalbergia nigra	0.68	50
SAPELE Entandrophragma cylindricum	0.54	40
SATINWOOD (EAST INDIAN) Chloroxylon swietenia	0.83	67
SONORA (MANGGASINORO) Shorea philippinensis	0.42	31
SWEETGUM (RED AND SAP) Liquidambar styraciflua	0.44	34
SYCAMORE Platanus accidentalis	0.46	35
TEAK Tectona grandis	0.60	43
TIGERWOOD Lavoa klaineana	0.45	34
TUPELO, WATER Nyssa aquatica	0.46	35
WALNUT, AMERICAN (BLACK) Juglans nigra	0.51	39
WILLOW, BLACK Salix nigra	0.34	26
ZEBRAWOOD Microberlinia brazzavillensis	0.62	48

The data for native species as furnished on this chart are from both the U.S. Forest Products Laboratory's Technical Bulletin 158 http://fpl.fs.fed.us and The Wood Database wood-database.com.

[1] Based on green volume and oven dry weight.

[2] Based on pounds per cubic foot at 12% moisture content.

SHEET PRODUCTS

SUGGESTION

INTRODUCTION

Herein we address a wide range of sheet goods, Hardwood and Softwood Veneers, HPL, TFL, Backer, Solid Surface, CGS (Compact Laminate), Epoxy Resin, and Natural and Engineered Stone.

PLYWOOD

The term “plywood” is defined as a panel manufactured of three or more layers (plies) of wood or wood products (veneers or overlays and/or core materials), generally laminated into a single sheet (panel).

TYPES OF PANELS

There are a wide range of panel materials available for the fabrication of architectural woodwork.

Property and performance characteristics are influenced by the panel grade, panel thickness, and materials used for the core:

- Surface uniformity has a direct relationship to the performance of the face veneers.
- Dimensional stability relates to the effect of exposure to wide swings in temperature and relative humidity.
- Screw holding and bending strength are influenced by and should be considered in design engineering.

Architectural panels with applied decorative surface materials are made up of a variety of core types including: Particleboard, Medium Density Fiberboard (MDF), Veneer, Hardboard, Lumber, Combination and Agrifiber.

PRIMARY CORE MATERIALS

INDUSTRIAL GRADE PARTICLEBOARD - Sometimes referenced as composite core, is made of wood particles of various sizes that are bonded together with a synthetic resin or binder under heat and pressure.

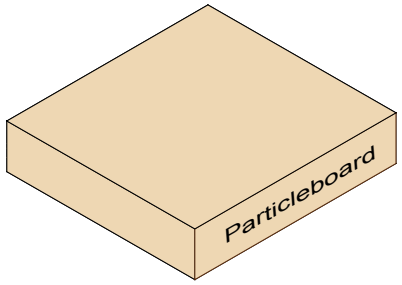

Figure: RG-040

Medium Density Industrial Particleboard is used in the broadest applications of architectural woodwork. It is especially well suited as a core for veneers and HPL or TFL.

When used as panels without surface plies, the product is referred to as particleboard. When used as an inner core with outer wood veneers, the panel is referred to as particle core plywood.

Industrial particleboard is commercially classified by “density,” which is measured by the weight per cubic foot of the panel product:

- **Medium Density** (M series) = generally between 40-50 pounds per ft^3 (640-800 kg per m^3).
- **High Density** (H series) = generally above 50 pounds per ft^3 (800 kg per m^3).

MOISTURE RESISTANT PARTICLEBOARD - Some Medium Density Industrial Particleboard is bonded with resins more resistant to swelling when exposed to moisture. The most common grades are ANSI A-208.1 (latest edition) Type M-2-Exterior Glue and M-3-Exterior Glue.

FIRE RETARDANT PARTICLEBOARD - Some Medium Density Industrial Particleboard has been treated during manufacture to carry a UL stamp for Class A flame spread rating (Flame spread 20, Smoke developed 450). Fire retardant Medium Density Fiberboard is also available.

SHEET PRODUCTS (continued)

PRIMARY CORE MATERIALS (continued)

MEDIUM DENSITY FIBERBOARD (MDF) - Sometimes referenced as composite core, is made of wood particles reduced to fibers in a moderate pressure steam vessel, combined with a resin, and bonded together under heat and pressure.

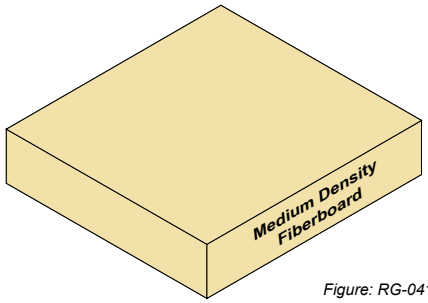

Figure: RG-041

Due to the finer texture of the fibers used in manufacturing Medium Density Fiberboard (MDF) it is smoother than Medium Density Particleboard. The uniform texture and density of the fibers create a homogenous panel that is very useful as a core for paint, thin overlay materials, veneers and decorative laminates. MDF is among the most stable of the mat formed panel products. When used as an inner core with outer wood veneers, the panel is referred to as MDF core plywood.

MOISTURE RESISTANT MDF - Can be manufactured to meet the ANSI A-208.2 (latest edition) reduced thickness swell criteria.

VENEER - Is separated into two groups according to materials and manufacturing:

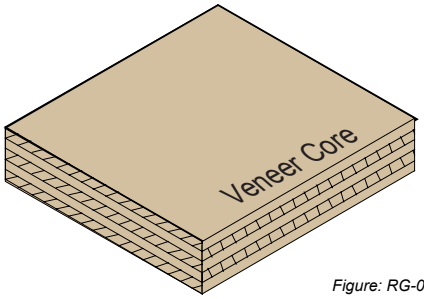

Figure: RG-042

- **Hardwood Veneer** - Panels manufactured of hardwood veneers.
- **Softwood Veneer** - Panels manufactured of softwood veneers.

Hardwood or Softwood Veneers used as a core is not recommended in many areas of these standards due to poor stability but do have many other structural characteristics. It is recommended that veneer core panels be used only when they can be housed or in areas where warping is not a significant issue.

What many think of as traditional “plywood”, is a panel core made up of an odd number of plies, 3 or more (except when the center is constructed of two unidirectional plies), alternating layers of veneers, all less than 1/4” (6.4 mm) thick, pressed and glued into a single sheet. The two outside veneer layers are the Face and Back. The interior veneer bands are cross bands and parallel bands. The latter are sometimes referenced as centers. Veneer bands are layered at right angles to the adjoining veneer layer.

HARDBOARD - Is defined as inter felted fibers consolidated under heat and pressure to a density of 500 kg per m^3 (31 pounds per cubic foot) or greater.

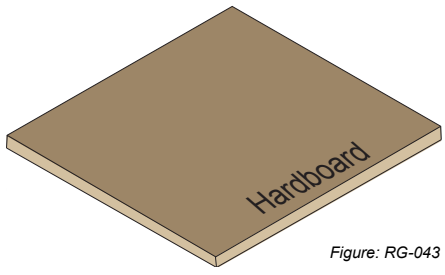

Figure: RG-043

Hardboard is available with either one side (S1S) or two sides (S2S) smooth. There are typically two types of hardboard core used by architectural manufacturers:

- **Standard** (untempered).
- **Tempered**, which is standard hardboard subjected to a curing treatment increasing its stiffness, hardness, and weight.

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SHEET PRODUCTS (continued)

PRIMARY CORE MATERIALS (continued)

LUMBER - Is where the center ply, called the "core" is composed of strips of lumber edge glued into a solid slab.

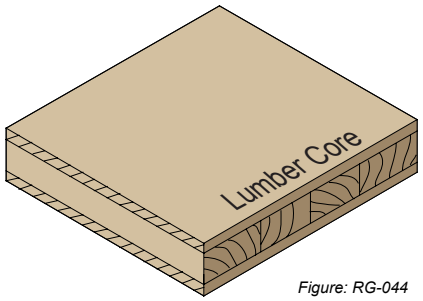

Figure: RG-044

This type is usually 5-ply, 3/4" (19.0 mm) thick, but other thickness from 1/2" (12.7 mm) to 1-1/8" (28.6 mm) are manufactured for special uses. There are three main types:

- **Staved** - is where the core strips are random length and butt joined.
- **Full Length** - is where the core strips are one piece in length.
- **Banded** - is where the outside strips run full length and the others are random length. Banding may be the same species of lumber as the rest of the core, but it is usually matched to the face and might include all four edges. Banded plywood is typically produced for special uses, such as furniture and desktops.

COMBINATION - A balanced hybrid blend of veneer and composition core materials offering some of the properties of both.

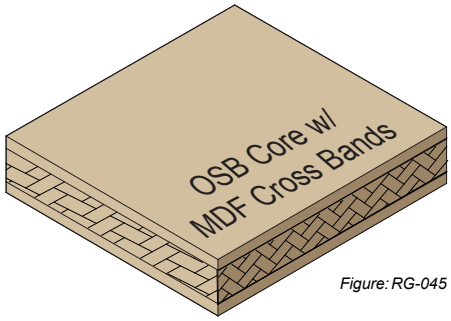

Figure: RG-045

Typically, these cores have internal layers which are constructed of three or five plies of veneer or a center layer of wafer board (randomly oriented wafers) or other wood fiber which are sandwiched between thin laminations of a composite product like MDF, particleboard, hardboard, etc.

Typically, these products result in stronger, lighter weight, dimensionally stable panels with increased screw holding ability, and superior surface flatness. Combination panels shall meet the standards of particleboard or MDF as stated in this manual, density excepted.

AGRIFIBER - Panel products made from straw and similar fiber are appearing in the marketplace. Panels shall meet the performance characteristics of ANSI A208.1 or ANSI A208.2 standards.

The characteristics of agrifiber core material performance vary by material supplier and are not included in the following table.

FORMING (Bendable) **-** Assembled and/or machined cores made of hardboard, veneer, particleboard and/or MDF for radius work are manufactured under various trade names. When used for freestanding work these Forming Cores must be a balanced panel but if bound (restrained) the panel is not required to be balanced.

CGS (Compact Laminate) - A composite of resins molded with a homogeneous core of organic fiber reinforced phenolic and one or more integrally cured surfaces of compatible thermosetting resins. CGS has seen some use in recent years as wall surfacing, casework parts, and countertops.

OTHER PANEL MATERIAL - Shall meet the minimum performance characteristics of ANSI A208.1, ANSI A208.2 or ANSI/HPVA HP-1 (latest edition) standards.

ENGINEERED WOOD / PANEL - Is a general term used to describe any wood or plant fiber composite panel. Such products as Particleboard, MDF, SCL and LVL are described as an engineered wood or plant fiber. Typically, they are made from wood or plant fiber or wood pieces and have specific esthetic and physical attributes.

BAMBOO - Is attracting much attention due to its quick replenishing and growing cycles as a green product. It is a grass product and not a true wood product. Due to its relatively new emergence in use as a building material, the performance evaluation as a stable and viable building material has not been established. These standards do not cover or endorse the use of bamboo and encourages the design professional to consult with Bamboo material suppliers and distributors as to its characteristics and viability as an architectural woodwork product.

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SHEET PRODUCTS (continued)

Table: RG-005 - **CHARACTERISTICS OF CORE PERFORMANCE**

It is important for the reader to understand the difference between "flatness" and "dimensional stability" characteristics. Particleboard and MDF are the recommended cores for HPL and wood veneer work because of their excellent flatness. Fair dimensional stability (expansion / contraction in panel size) is acceptable unless the product is exposed to wide swings in relative humidity, generally below 25% or above 55% with swings of more than 30 points.

Core Type	Flatness (Warp Resistance)	Visual Edge Quality	Surface Uniformity	Dimensional Stability	Screw Holding Face	Bending Strength
Particleboard, Medium Density	Excellent	Good	Excellent	Fair	Fair	Good
Particleboard, Moisture Resistant	Excellent	Good	Good	Fair	Fair	Good
Particleboard, Fire Retardant	Excellent	Fair	Good	Fair	Fair	Good
Medium Density Fiberboard (MDF)	Excellent	Excellent	Excellent	Fair	Good	Good
MDF, Moisture Resistant	Excellent	Excellent	Excellent	Fair	Good	Good
MDF, Fire Retardant	Excellent	Excellent	Excellent	Fair	Good	Good
Veneer	Fair	Good	Fair	Excellent	Excellent	Excellent
Lumber	Fair	Good	Good	Fair	Excellent	Excellent
Combination	Good	Fair	Excellent	Good	Excellent	Excellent

Various characteristics above are influenced by the grade and thickness of the core and specific gravity of the core species. Visual Edge Quality is rated before treatment with edgebands or fillers and Visual Edge Quality of lumber core assumes the use of "clear edge" grade. Surface Uniformity has a direct relationship to the performance of veneers placed over the surface. Dimensional Stability is usually related to exposure to wide swings in relative humidity. Screw Holding and Bending Strength are influenced by proper design and engineering.

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SHEET PRODUCTS (continued)

DECORATIVE FACE MATERIAL AND CONSTRUCTION BALANCE

All panels may be used as cores for the application of decorative faces (e.g. veneer, HPL) to the face and back. The whole is referred to as a panel. The parts being a core covered by a face and a balancing back. To achieve balanced construction, panels must be an odd number of layers (plies) symmetrical from the center line; e.g., inner plies, except the innermost middle ply, should occur in pairs, using materials and adhesives on both sides that contract and expand, or are moisture permeable, at the same rate.

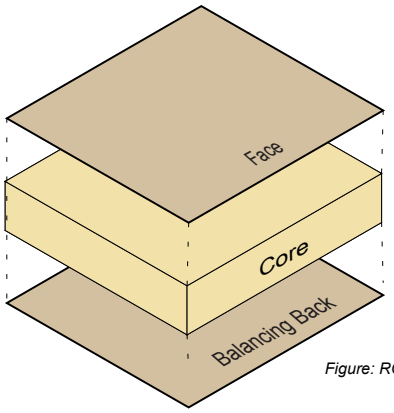

Figure: RG-046

A ply may consist of a single veneer, particleboard, medium density fiberboard, or hardboard. Each pair of inner plies should be of the same thickness and direction of grain at 90 degrees. Each ply of each pair is placed on opposite sides of the innermost ply or layer, alternating grain directions from the center out. (Particleboard and MDF do not have a specific grain orientation).

The thinner the facing material, the less force it can generate to cause warping. The thicker the core, the more it can resist a warping movement or force.

TYPES OF PLYWOOD PANELS:

PARTICLEBOARD CORE

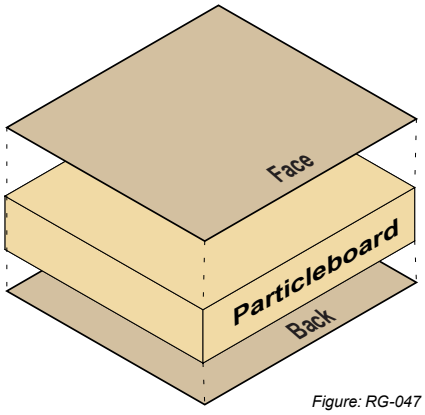

Figure: RG-047

MEDIUM DENSITY FIBERBOARD (MDF) CORE

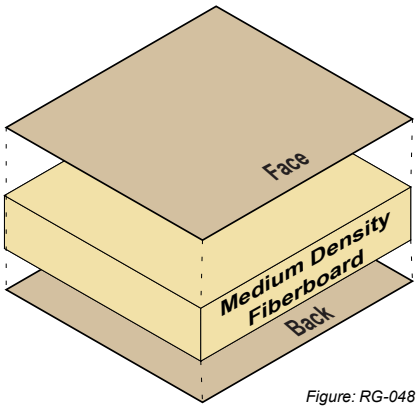

Figure: RG-048

VENEER CORE

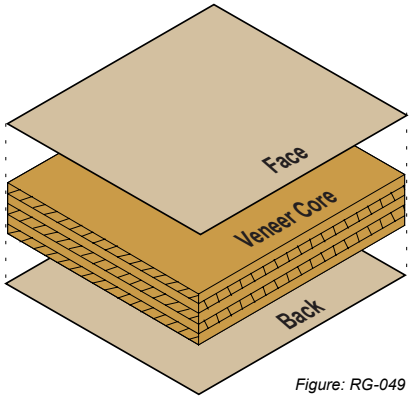

Figure: RG-049

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SHEET PRODUCTS (continued)

TYPES OF PLYWOOD PANELS (continued)

LUMBER CORE

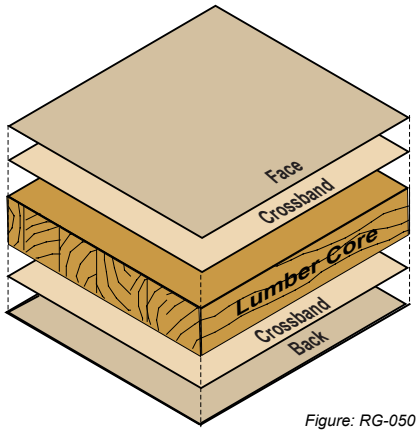

Figure: RG-050

COMBINATION CORE

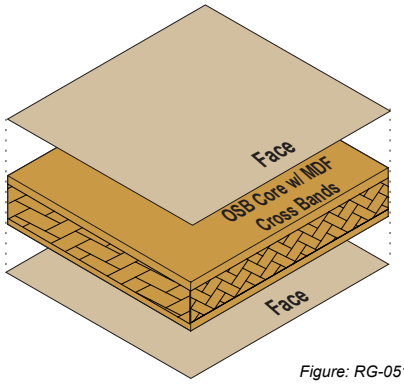

Figure: RG-051

WOOD VENEERS

Wood veneer is produced by veneer suppliers in a variety of "industry standard" thicknesses. The slicing process is controlled by a number of variables. The thickness of the raw veneer has little bearing on the ultimate quality of the end product so long as show-through and sand-through is avoided.

HARDWOOD VENEER - Species: Available in many domestic and imported wood species. Normally cut as plain sliced. Rift sliced and quarter sliced available in certain species at additional cost.

SOFTWOOD VENEER - Species: Most common is Douglas Fir; Pines are available; other softwoods in limited supply. Most softwood veneer is Rotary cut. Plain sliced softwood veneer and "vertical grain" (quarter sliced) softwood veneer are limited in availability with long lead times and higher prices associated with special orders.

Rotary-cut softwood sheets are typically manufactured in various grades referring to the appearance of the face, back, and interior plies of the sheet and are intended for exterior (with a fully waterproof glue line) or interior (with a moisture resistant, but not waterproof, glue line). Clear faces, free of patches, are not typically available.

VENEER GRAIN might not match the grain of solid stock, and it might not accept transparent finishes in the same manner; additional finishing steps might achieve similar aesthetic value.

FIGURE is not a function of a species grade, and special desires must be so specified.

SPECIAL CHARACTERISTICS, such as sapwood, heartwood, ribbon stripe, birdseye and comb grain, must be so specified.

NATURAL, as a type of wood species selection, allows an unlimited amount of heartwood and/or sapwood within a face and is the default selection, unless specified otherwise.

SELECT RED OR WHITE simply means all heartwood or all sapwood, respectively, and must be so specified.

SPECIES, such as Hickory, Pecan, Butternut, or Maple, may exhibit special character or figure and users are advised to thoroughly investigate the expected grain and color of these species.

RECONSTITUTED VENEERS are logs that are first sliced into veneer leaves, the leaves may be dyed, then glued under pressure in a mold to produce a large laminated block. The laminated block is then sliced across the glue line to create a faux grain with a designed appearance that is highly repeatable. Not all pre-dyed veneers are colorfast, consult with material supplier.

SUGGESTION

SHEET PRODUCTS (continued)

SUGGESTION

SPECIALTY SHEET PRODUCTS

Plywood with textured faces, pre-finished plywood, overlaid plywood, composition sheets, flame spread rated plywood, moisture resistant plywood, lead lined sheets, projectile resistant armor (bullet proofing), reconstituted veneers, bamboo sheets, acrylic sheets, or PVC sheets are the products of the individual material supplier, and are covered by their specification - not by these standards.

PANEL ADHESIVES

Are defined as:

- **Type I** Waterproof bond (2-Cycle Boil Test plus Shear Test).
- **Type II** Water resistant bond (3-Cycle Soak Test).

FIRE RETARDANCE

Sheets are available with various types of fire-retardant treated core, such as veneer, lumber, particleboard, and mineral core.

Flame-spread rating will vary for different species of untreated face veneers on treated cores, directly with the density of the untreated face veneers; the higher the density, the higher the flame spread rating.

Fire Retardant treatments may affect the finishes intended to be used on the wood, particularly if transparent finishes are planned. The compatibility of finishes should be tested before they are applied.

Refer to the latest edition of the Underwriters' Laboratories listings for various flame-spread ratings available bearing U.L. Labels, ul.com.

PHOTODEGRADATION

The effect on the appearance of exposed wood faces caused by exposure to both sun and artificial light sources is called photodegradation. If an entire face is exposed to a light source, it will photodegrade somewhat uniformly and hardly be noticeable, whereas partially exposed surfaces or surfaces with shadow lines might show nonuniform photodegradation. Some woods, such as American Cherry and Walnut, are more susceptible than others, and extra care should be taken to protect against the effects of nonuniform photodegradation.

OXIDATION

The effect on the appearance of exposed wood faces caused by exposure to atmosphere is called oxidation. This is analogous to browning reactions in freshly cut fruit; for instance, apples. Hardwoods can develop deep yellow to reddish brown discolorations on the surface of the wood when exposed to air immediately after sawing or peeling. These discolorations are especially noticeable on Cherry, Birch, Red Alder, Sycamore, Oak, Maple, and Sweet Gum. Some species, such as Alder, Oak, Birch, and Maple, develop these discolorations during air-seasoning. A related gray stain on several varieties of Southern Oaks also appears to be oxidative in nature. Proper selection, sanding, and finishing can minimize the effects of oxidation.

VENEER CUTTING

The manner in which a log segment is cut with relation to the annual rings will determine the appearance of the veneer. When sliced, the individual pieces of veneer, referred to as leaves, are kept in the order in which they are sliced, thus permitting a natural grain progression when assembled as veneer faces. The group of leaves from one slicing is called a flitch and is usually identified by a flitch number and the number of gross square feet of veneer it contains. The faces of the leaves with relation to their position in the log are identified as the tight face (toward the outside of the log) and the loose face (toward the inside or heart of the log). During slicing the leaf is stressed on the loose face and compressed on the tight face. When this stress is combined with the natural variation in light refraction caused by the pores of the wood, the result is a difference in the human perception of color and tone between tight and loose faces.

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SHEET PRODUCTS (continued)

FOUR COMMON VENEER CUTS

- **Plain Slicing** (or Flat Slicing) - This is the slicing method most often used to produce veneers for architectural woodwork. Slicing is done parallel to a line through the center of the log. A combination of cathedral and straight grain patterns results, with a natural progression of pattern from leaf to leaf.

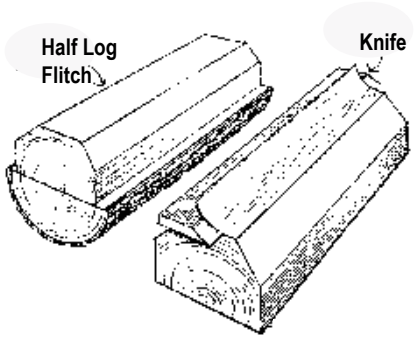

Figure: RG-052

- **Quarter Slicing** (or Quarter Cut) - Quarter slicing simulates the quarter sawing process of solid lumber, roughly parallel to a radius line through the log segment. In many species the individual leaves are narrow as a result. A series of stripes is produced, varying in density and thickness from species to species. "Fleck" (sometimes called flake) is a characteristic of this slicing method in Red and White Oak.

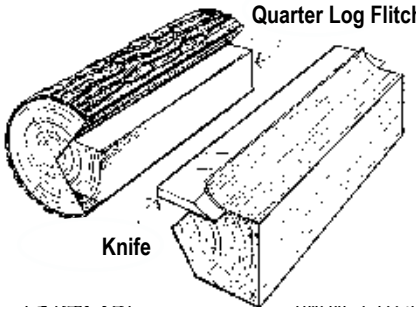

Figure: RG-053

Figure: RG-054

- **Rift Slicing** (or Rift Cut) - Rift veneers are produced most often in Red and White Oak. Note that rift veneers and rift sawn solid lumber are produced so differently that a "match" between rift veneers and rift sawn solid lumber is highly unlikely. In both cases the cutting is done slightly off the radius lines minimizing the "fleck" (sometimes called flake) associated with quarter slicing.

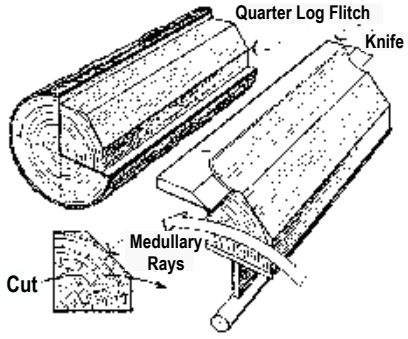

Figure: RG-055

- **Rotary Slicing** - The log is center mounted on a lathe and "peeled" along the general path of the growth rings like unwinding a roll of paper, providing a generally bold random appearance.

  When transparent finish is specified; rotary sliced hardwood veneers are sometimes specified for:

  - **Wall Surfacing**: Institutional panel faces.
  - **Doors:** Institutional flush door faces.
  - **Cabinets**: Semi-exposed (interior) surfaces and used in a limited way for exposed surfaces.

  Some species may possess a special figure, for example birds eye, which is achieved by rotary slicing.

  Careful consideration, specification, and communication are recommended when rotary cut is contemplated.

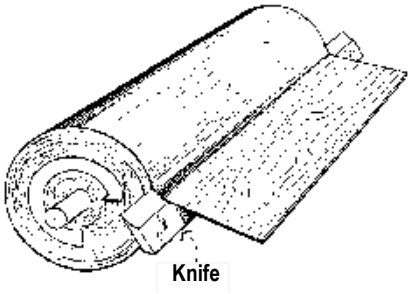

Figure: RG-056

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SHEET PRODUCTS (continued)

Table: RG-006 - **COMMON HARDWOOD VENEER SPECIES and CUTS**

SPECIES	ROTARY	PLAIN SLICED	QUARTER SLICED	RIFT
Anigre		●	●	
Ash		●	●	
Beech		●	●	
Birch	●	●		
Cherry		●	●	
Hickory		●		
Lauan	●		●	
Mahogany, African		●	●	
Mahogany, American		●	●	
Makore		●	●	
Maple	●	●	●	
Oak, Red	●	●	●	●
Oak, White		●	●	●
Pecan		●		
Poplar	●	●		
Sapele		●	●	
Walnut		●	●	

SHEET PRODUCTS (continued)

Table: RG-007 - **GENERAL CHARACTERISTICS OF SELECTED WOOD SPECIES:**

SPECIES	CUT (1)	WIDTH TO	LENGTH	FLITCH SIZE	COST (2)	AVAILABILITY
Alder	Plain Sliced	12" (305 mm)	10' (3048 mm)	Medium	Moderate	Moderate
Anigre	Plain Sliced	12" (305 mm)	10' (3048 mm)	Large	Moderate	Good
	Quarter Sliced	8" (203 mm)	12' (3658 mm)	Medium	High	Good
Anigre, Figured	Quarter Sliced	8" (203 mm)	12' (3658 mm)	Medium	Very High	Limited
Ash, American	Plain Sliced	12" (305 mm)	10' (3048 mm)	Large	Moderate	Moderate
	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Medium	High	Moderate
Ash, European	Plain Sliced	10" (254 mm)	10' (3048 mm)	Medium	Moderate	Limited
	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Small	Moderate	Moderate
Beech, European	Plain Sliced	10" (254 mm)	10' (3048 mm)	Large	Moderate	Good
	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Medium	High	Good
Birch, Natural	Rotary	36" (914 mm)	10' (3048 mm)	Large	Low	Good
	Plain Sliced	8" (203 mm)	10' (3048 mm)	Small	Medium	Limited
Birch, Select Red and White	Rotary	36" (914 mm)	10' (3048 mm)	Large	Moderate	Good
	Plain Sliced	8" (203 mm)	10' (3048 mm)	Small	High	Limited
Cedar, Western Red	Plain Sliced	18" (457 mm)	10' (3048 mm)	Medium	Moderate	Limited
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Medium	Moderate	Limited
Cherry, American (3)	Plain Sliced	12" (305 mm)	12' (3658 mm)	Medium	Moderate	Good
	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Small	High	Moderate
Ebony	Plain Sliced	6" (153 mm)	10' (3048 mm)	Very Small	Extreme	Very Limited
Fir, Douglas (Vertical Grain)	Quarter Sliced	18" (457 mm)	12' (3658 mm)	Large	Moderate	Good
Hickory	Plain Sliced	12" (305 mm)	12' (3658 mm)	Medium	Moderate	Good
	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Small	Moderate	Moderate
Jatoba	Plain Sliced	12" (305 mm)	12' (3658 mm)	Medium	Moderate	Good
Lacewood	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Small	High	Very Limited
Lauan (4)	Plain Sliced	15" (381 mm)	12' (3658 mm)	Medium	Moderate	Good
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Small	Moderate	Moderate
Mahogany, African (5)	Plain Sliced	18" (457 mm)	12' (3658 mm)	Large	Moderate	Good
	Quarter Sliced	10" (254 mm)	12' (3658 mm)	Medium	High	Moderate
Mahogany, American (5) (Swietenia macrophylla CITES listed (6))	Plain Sliced	18" (457 mm)	12' (3658 mm)	Large	Moderate	Very Limited
	Quarter Sliced	10" (254 mm)	12' (3658 mm)	Medium	High	Very Limited
Makore	Plain Sliced	15" (381 mm)	12' (3658 mm)	Large	Moderate	Moderate
	Quarter Sliced	8" (203 mm)	12' (3658 mm)	Medium	High	Limited

(continued)

SHEET PRODUCTS (continued)

Table: RG-007 - **GENERAL CHARACTERISTICS OF SELECTED WOOD SPECIES:** (continued)

SPECIES	CUT (1)	WIDTH TO	LENGTH	FLITCH SIZE	COST (2)	AVAILABILITY
Maple, American	Rotary	36" (914 mm)	10' (3048 mm)	Large	Low	Good
	Plain Sliced	12" (305 mm)	12' (3658 mm)	Medium	Moderate	Good (2)
	Quarter Sliced	6" (153 mm)	10' (3048 mm)	Small	High	Limited
Maple, Birds Eye	Rotary	24" (610 mm)	10' (3048 mm)	Medium	Very High	Limited
Meranti	Plain Sliced	18" (457 mm)	12' (3658 mm)	Large	Moderate	Good
	Quarter Sliced	10" (254 mm)	12' (3658 mm)	Medium	High	Moderate
Oak, English Brown	Plain Sliced	12" (305 mm)	10' (3048 mm)	Medium	High	Limited
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Small	Very High	Limited
Oak, Red	Rotary	36" (914 mm)	10' (3048 mm)	Large	Low	Good
	Plain Sliced	18" (457 mm)	12' (3658 mm)	Large	Low	Good
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Medium	Moderate	Good
	Rift	8" (203 mm)	10' (3048 mm)	Medium	Moderate	Good
Oak, White	Plain Sliced	12" (305 mm)	12' (3658 mm)	Medium	Low	Good
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Small	Moderate	Good
	Rift	8" (203 mm)	10' (3048 mm)	Small	Moderate	Good
Poplar	Plain Sliced	15" (381 mm)	10' (3048 mm)	Medium	Low	Good
Rosewood, American	Plain Sliced	10" (254 mm)	10' (3048 mm)	Small	Very High	Very Limited
Sapele	Plain Sliced	15" (381 mm)	10' (3048 mm)	Large	Moderate	Good
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Medium	Moderate	Moderate
Sycamore	Plain Sliced	15" (381 mm)	12' (3658 mm)	Medium	High	Moderate
	Quarter Sliced	8" (203 mm)	10' (3048 mm)	Small	High	Limited
Teak	Plain Sliced	12" (305 mm)	12' (3658 mm)	Medium	High	Moderate
	Quarter Sliced	5" (127 mm)	10' (3048 mm)	Small	High	Limited
Walnut (3)	Plain Sliced	15" (381 mm)	12' (3658 mm)	Large	Moderate	Good
	Quarter Sliced	6" (152 mm)	10' (3048 mm)	Small	High	Moderate
Wenge	Plain Sliced	10" (254 mm)	10' (3048 mm)	Small	High	Limited

(1) When only Plain Sliced is listed, the width dimension for quartered Cut is narrower.
(2) Seasonal factors may affect availability.
(3) Cherry, Walnut and certain other hardwood species are required to be specified by origin, such as American Cherry, American Walnut, or English Brown Oak, because they can be significantly different in color and figure.
(4) Lauan (White and Red), Tanguile, and other species are native to the Philippine Islands and are sometimes referred to as Philippine Mahogany; however, they are not a true Mahogany The generic term Mahogany should not be specified without further definition.
(5) Mahogany, American and African vary in color from a light pink to a light red, reddish brown to a golden brown or yellowish tan. Some Mahogany turns darker or lighter in color after machining. The figure or grain runs from plain sliced, plain stripe to broken stripe, mottled, fiddleback, swirl, and crotches.
(6) CITES, Convention on International Trade in Endangered Species or Wild Fauna and Flora.

SUGGESTION

SHEET PRODUCTS (continued)

VENEER FACE GRADE DESCRIPTIONS as used in ANSI/ HPVA HP-1 (latest edition) decorativehardwoods.org Characteristic charts:

GRADE - AA - Veneer will be smooth, tight cut, and full length. When the face consists of more than one veneer component or piece, the edges will appear parallel and be edge matched. All components of a book or slip matched face will be from the same flitch. Rotary cut faces may be whole piece or multi piece with edge joints tight and no sharp color contrast at the joints. Species specified for natural color will allow color contrasts but will be book matched or conform to the type of matching as specified. The components of plain sliced (flat cut) and multi piece rotary faces will be book matched unless otherwise specified with a running, balanced, or center matched arrangement. Unless otherwise specified, components in plain sliced faces will have a matching arrangement selected by the material supplier. Plain sliced faces will consist of two or more components with no component less than 6" (152 mm) wide except for outside components, which may be less than 6" (152 mm) to allow for certain types of matching or panel edge loss. No plain sliced components will have a split heart. No full quartered cut is permitted in plain sliced faces. The width of any single component in quarter cut, rift cut faces will not be less than 3" (76 mm) except for outside components, which may be less than 3" (76 mm) to allow for certain types of matching or panel edge trim loss.

GRADE - A - Veneer will be smooth, tight cut, and full length. When the face consists of more than one veneer component or piece, the edges will appear parallel and be edge matched. All components of a book or slip matched face will be from the same flitch. Rotary cut faces may be whole piece or multi piece with edge joints tight; however, no sharp color contrasts are permitted at the joints, and the face will provide a good general appearance. Species specified for natural color will allow color contrasts but will be book matched or conform to the type of matching as specified. The components of plain sliced (flat cut) and multi piece rotary faces will be book matched, unless otherwise specified with a running, balanced, or center matched arrangement. Unless otherwise specified, components in plain sliced faces will have a matching arrangement selected by the material supplier. Plain sliced faces will consist of two or more components with no component less than 5" (127 mm) wide except for outside components, which may be less than 5" (127 mm) to allow for certain types of matching or panel edge trim loss. Split heart is permitted if manufactured cathedral is achieved. No full quarter cut is permitted in plain sliced faces. The width of any single component in quarter cut, rift cut, or comb grain faces will not be less than 3" (76 mm) except for outside components, which may be less than 3" (76 mm) to allow for certain types of matching or panel edge trim loss. In some species, sapwood is permitted; however, in other species, it may be permitted by agreement between buyer and seller.

GRADE - B - Veneer will be smooth, tight cut, and full length as described for the various species. All components of a book or slip matched face will be from the same flitch. Slip or book matched veneers are available if specified by the buyer. If not specified, multi piece faces will be pleasingly matched. Sharp color contrasts at the joints are not permitted. Species specified for natural color will allow color contrasts but will be book matched or conform to the type of matching as specified. Plain sliced faces will consist of two or more components with no component less than 4" (102 mm) wide to allow for certain types of matching or panel edge trim loss. Some full quarter cut is permitted in plain sliced faces. For some species, unlimited sapwood is permitted, and in other species, a percentage of sapwood is permitted.

GRADE - C - Permits unlimited color streaks and spots and color variation. An unlimited number of small burls and pin knots are permitted with no restrictions on the size of the dark pin knot centers, as long as the diameter of pin knots does not exceed 1/4" (6.4 mm) in diameter. The size of sound and repaired knotholes and similar shaped openings cannot exceed 1/2" (12.7 mm) in diameter, with a specified number permitted based on individual species. Faces will provide a sound face, free of open defects, with only minimal areas of rough grain.

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SHEET PRODUCTS (continued)

SUGGESTION

TERMINOLOGY DEFINITIONS as used in ANSI/HPVA HP-1 (latest edition) decorativehardwoods.org Characteristic charts:

BARK POCKET: Bark around which normal wood has grown.

BRASHNESS: Condition of wood characterized by low resistance to shock and by abrupt failure across the grain without splintering.

BURL, BLENDING: A swirl, twist, or distortion in the grain of the wood which usually occurs near a knot or crotch but does not contain a knot and does not contain abrupt color variation. A blending burl is detectable at 72" to 96" (1829 to 2438 mm) as a swirl or roundel.

BURL, CONSPICUOUS: A swirl, twist, or distortion in the grain of the wood which usually occurs near a knot or crotch. A conspicuous burl is associated with abrupt color variation and/or a cluster of small dark piths caused by a cluster of adventitious buds.

COMB GRAIN: A quality of rift cut veneer with exceptionally straight grain and closely spaced growth increments resembling the appearance of long strands of combed hair.

CROSS BAR: Irregularity of grain resembling a dip in the grain running at right angles, or nearly so, to the length of the veneer.

FLAKE: See Fleck, Ray.

FLECK, RAY: Portion of a ray as it appears on the quartered or rift cut surface. Fleck is often a dominant appearance feature in Oak.

GUM POCKETS: Well defined openings between rings of annual growth, containing gum or evidence of prior gum accumulations.

GUM SPOTS AND STREAKS: Gum or resinous material or color spots and streaks caused by prior resin accumulations sometimes found on panel surfaces.

HAIRLINE: A thin, perceptible line showing at the joint of two pieces of wood.

HEARTWOOD: The non-active or dormant center of a tree, generally distinguishable from the outer portion (sapwood) by its darker color, sometime referred to as heart.

KNOT: Cross section of tree branch or limb with grain usually running at right angles to that of the piece of wood in which it occurs, further defined as:

> **CONSPICUOUS PIN:** Sound knots 1/4 inch (6.4 mm) or less in diameter containing dark centers.
>
> **HOLES**: Openings produced when knots drop from the wood in which they were embedded.
>
> **OPEN**: Opening produced when a portion of the wood substance of a knot has dropped out or where cross checks have occurred to produce an opening.
>
> **SOUND TIGHT**: Knots that are solid across their face and fixed by growth to retain their place.
>
> **SPIKE**: Knots cut from 0º to 45º to the long axis of limbs.

REPAIRS: A patch, shim, or filler material inserted and/or glued into veneer or a panel to achieve a sound surface.

RIFT CUT: A straight grain appearance achieved through the process of cutting at a slight angle to the radial on the half round stay log or through the use of veneer cut in any fashion that produces a straight grain with minimal ray fleck.

ROUGH CUT: Irregular shaped areas of generally uneven corrugation on the surface of veneer, differing from the surrounding smooth veneer and occurring as the veneer is cut by the lathe or slicer.

RUPTURED GRAIN: A break or breaks in the grain or between springwood and summerwood caused or aggravated by excessive pressure on the wood by seasoning, manufacturing, or natural processes. Ruptured grain appears as a single or series of distinct separations in the wood such as when springwood is crushed leaving the summerwood to separate in one or more growth increments.

SAPWOOD: The living wood of lighter color occurring in the outer portion of a tree, sometimes referred to as sap.

SLIGHT: Visible on observation but does not interfere with the overall aesthetic appearance with consideration of the applicable grade of the panel.

SPLITS: Separations of wood fiber running parallel to the grain.

STREAKS, MINERAL: Sharply contrasting elongated discolorations of the wood substance.

VINE MARK: Bands of irregular grain running across or diagonally to the grain which are caused by the growth of climbing vines around the tree.

WORMHOLES: Holes resulting from infestation of worms.

WORM TRACKS: Marks caused by various types of wood attacking larvae. Often appear as sound discolorations running with or across the grain in straight to wavy streaks. Sometimes referred to as "pith flecks" in certain species of Maple, Birch and other hardwoods because of a resemblance to the color of pith.

SUGGESTION

MATCHING ADJACENT WOOD VENEER LEAVES

It is possible to achieve certain visual effects by the manner in which the leaves are arranged. Matching of adjacent wood veneer leaves, as with the effect of different veneer cuts, can alter the appearance of a given panel or an entire installation. To create a particular appearance, the veneer leaves of a flitch are edge glued together in patterns.

Individual leaves of veneer in a sliced flitch increase or decrease in width as the slicing progresses. Thus, if a number of panels are manufactured from a particular flitch, the number of veneer leaves per panel face will change as the flitch is utilized. The manner in which these leaves are "laid up" within the panel requires specification.

Rotary cut veneers are difficult to match; therefore, most matching is done with sliced veneers. The matching of adjacent veneer leaves must be specified. Special arrangements of leaves such as "diamond" and "box" matching are available. Consult your manufacturer for choices.

White dashed lines on the following illustrations indicate the veneer trim lines.

BOOK MATCHING - A common match used in the industry. Every other piece of veneer is turned over so adjacent pieces (leaves) are opened like the pages of a book.

Figure: RG-57

- **Visual Effect -** Veneer joints match, creating a symmetrical pattern yields maximum continuity of grain. When sequenced panels are specified, prominent characteristics will ascend or descend across the match as the leaves progress from panel to panel.

- **Barber Pole Effect in Book Match** - Because the tight side and loose side of the veneer leaf faces alternate in adjacent pieces of veneer, they may accept stain differently, and this may result in a noticeable color variation. Book matching also accentuates cell polarization, causing the perception of different colors. These natural characteristics are often called barber pole and are not a manufacturing defect.

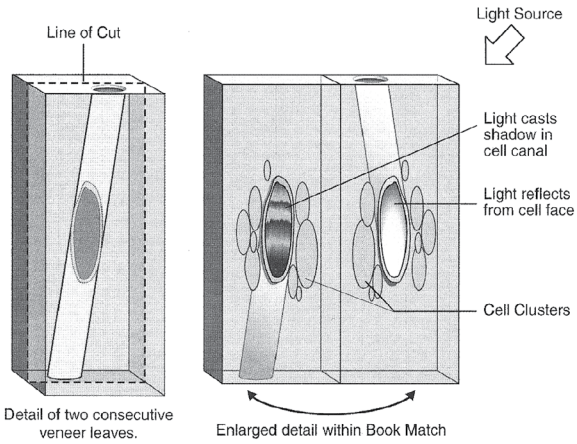

Figure: RG-058

SLIP MATCHING - Often used with quarter sliced and rift sliced veneers. Adjoining leaves are placed (slipped out) in sequence without turning, resulting in the same face sides being exposed.

- **Visual Effect -** Grain figure repeats; but joints do not show visual grain match.

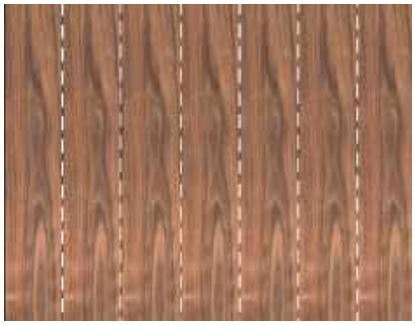

Figure: RG-059

The lack of grain match at the joints can be desirable. The relatively straight grain patterns of quartered and rift veneers generally produce pleasing results and a uniformity of color because all faces have the same light refraction.

SUGGESTION

MATCHING ADJACENT WOOD VENEER LEAVES
(continued)

RANDOM MATCHING - Veneer leaves are placed next to each other in a random order and orientation, producing a "board by board" effect in many species.

- **Visual Effect -** Casual or rustic appearance, as though individual boards from a random pile were applied to the product. Conscious effort is made to mismatch grain at joints.

  Degrees of contrast and variation may change from panel to panel. This match is more difficult to obtain than book or slip match and should be clearly specified and detailed.

Figure: RG-060

END or BUTT MATCHING (aka Architectural End Match) - Often used to extend the apparent length of available veneers for high wall panels and long conference tables.

Leaves are individually book (or slip) matched, first end to end and then side to side, alternating end and side.

- **Visual Effect -** Yields best continuous grain patterns for length as well as width. Minimizes misalignment of grain pattern.

Figure: RG-061

MATCHING WITHIN INDIVIDUAL PANEL FACES

The individual leaves of veneer in a sliced flitch increase or decrease in width as the slicing progresses. Thus, if a number of panels are manufactured from a particular flitch, the number of veneer leaves per panel face will change as the flitch is utilized. The way these leaves are "laid up" within the panel requires specification, and is classified as follows:

RUNNING MATCH - The panel face is made from components running through the flitch consecutively. Any portion of a component left over from a face is used as the beginning component or leaf in starting the next panel.

THIS METHOD IS THE DEFAULT FOR CUSTOM GRADE.

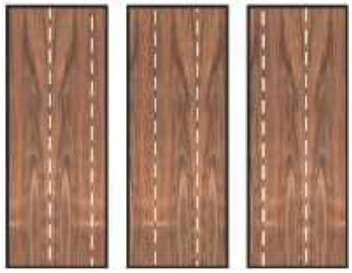

Figure: RG-062

BALANCE MATCH - Each panel face is assembled from veneer leaves of uniform width before edge trimming. Panels may contain an even or odd number of leaves, and distribution may change from panel to panel within a sequenced set.

THIS METHOD IS THE DEFAULT FOR PREMIUM GRADE

However, it must be specified for other Grades, and it is the most common assembly method at moderate cost.

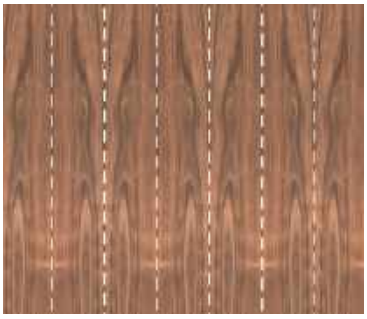

Figure: RG-063

SHEET PRODUCTS (continued)

MATCHING WITHIN INDIVIDUAL PANEL FACES
(continued)

BALANCE AND CENTER MATCH - Each panel face is assembled of an even number from veneer leaves of uniform width before edge trimming. Thus, there is a veneer joint in the center of the panel, producing horizontal symmetry. A small amount of figure is lost in the process. Considered by some to be the most pleasing assembly at a modest increase in cost over Balance Match.

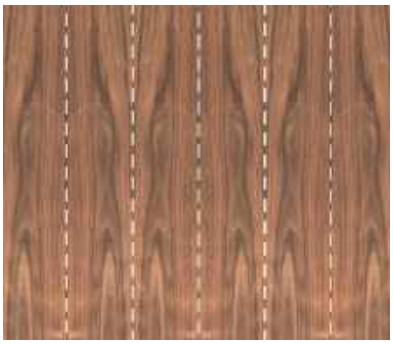

Figure: RG-064

SLIP, CENTER, BOOK MATCH - Each panel face is assembled of an even (four or more) number of veneer leaves, generally of uniform width. The veneer leaves are laid out as a slip matched panel face; then at the center, one half of the leaves are booked to the other half. Quarter and rift sliced veneers are generally used for this match, which allows for a pleasing balance of sweep and character marks.

Slip Left ◀ | ▶ Slip Right

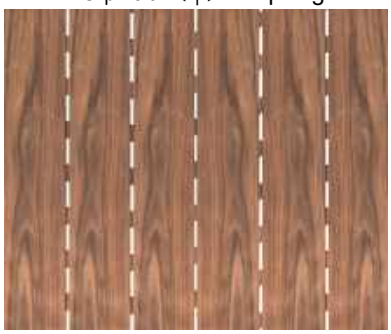

Figure: RG-065

SWING MATCH - is made by dividing the panel into multiple paired sets. For each paired set, two leaves of veneer are cut at half the width of the set. One of these two veneer leaves is rotated 180 degrees and joined to the other. This pair is then adjoined to the other pairs assembled in the same way.

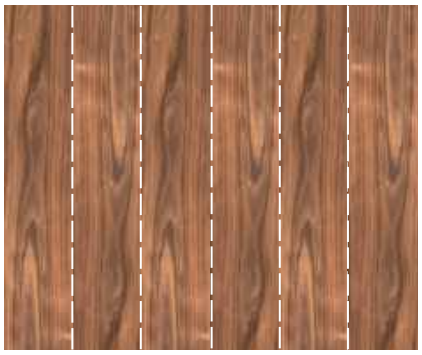

Figure: RG-066

SHEET PRODUCTS (continued)

SPECIALTY OR SKETCH MATCHES OF WOOD VENEERS

There are regional variations in the "names" of the following veneer leaf matching techniques, drawn as squares for simplicity. It is strongly recommended that the design professional use both names and drawings to define the desired effect, using a rectangle, polygon, circle, ellipse, or other shape. Rift sliced, quarter sliced, and highly figured veneers are generally used for these specialty matches. The different matches of veneer cause the reflection of light to vary from adjoining leaves, bringing "life" to the panel. Due to the inherent nature of the layup process, alignment at corners might vary.

HERRINGBONE OR V BOOK MATCH - is one or more pairs of assembled slipped or booked leaves. Each assembled set of leaves is cut at generally 45 degrees to one edge of the panel. The assembled set of leaves is then end matched to the adjoining assembled set of leaves.

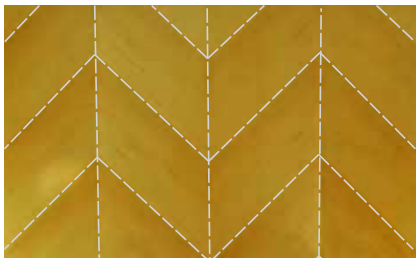

Figure: RG-067

SUNBURST MATCH - is made of six or more veneer leaves cut at the appropriate angle with the grain radiating from the center. These veneer leaves are then book matched, assembled, and trimmed for final size.

Figure: RG-068

BOX MATCH - is made of four leaves with the grain running parallel to the perimeter of the panel. The leaves are cut at the appropriate angle and end matched.

Figure: RG-069

REVERSE OR END GRAIN BOX MATCH - is made of four leaves with the grain running at right angles to the perimeter of the panel. The leaves are cut at the appropriate angle and book matched.

Figure: RG-070

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SHEET PRODUCTS (continued)

SPECIALTY OR SKETCH MATCHES OF WOOD VENEERS (continued)

DIAMOND MATCH - is made of four leaves with the grain running 45 degrees to the perimeter of the panel and surrounding the center. The leaves are cut at the appropriate angle and end matched.

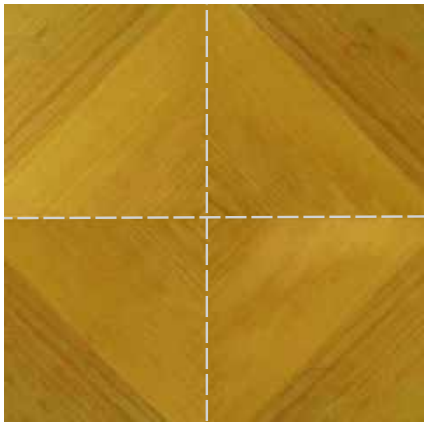

Figure: RG-071

REVERSE DIAMOND MATCH - is made of four leaves with the grain running 45 degrees to the perimeter of the panel and radiating from the center. The leaves are cut at the appropriate angle and book matched.

Figure: RG-072

PARQUET MATCH - is made by dividing the panel into multiple equal sized pieces and cutting the veneer to the same size. Each veneer leaf is joined at right angles to the adjoining piece of veneer.

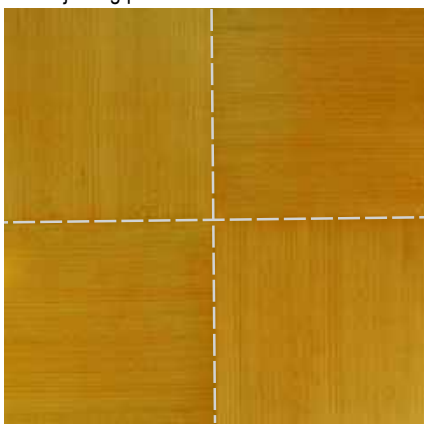

Figure: RG-0373

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SHEET PRODUCTS (continued)

MATCHES BETWEEN PANELS

NOT MATCHED - Veneered panels are generally manufactured without matching and may or may not be similar in grain and color.

SEQUENCE MATCHED - Veneered panels may be sourced and/or manufactured in sequence. These panels will be well matched for grain and color.

SEQUENCE MATCHED & CUSTOM WIDTH - Generally veneered panels are manufactured in 4'x 8' and occasionally in 4'x 10' panels. The design professional may specify veneered sequence panels in custom width for the specific project and/or elevation. These panels will be well matched for grain and color.

BLUEPRINT MATCHED - The design professional may specify blueprint matched panels which will be custom sized height and width as well as sequencing for the specific project and/or elevation. These panels will be matched for grain and color.

DECORATIVE LAMINATES, OVERLAYS, and PRE-FINISHED PANEL PRODUCTS

Decorative surfacing materials are often applied to wood product cores such as industrial particleboard, fiberboard, hardboard, etc. Terminology and definitions of these overlay products follow, broadly grouped as:

- **Medium Density Overlay (MDO)** - Pressed resin impregnated paper overlays, highly resistant to moisture, applied to suitable cores for both interior and exterior uses. The seamless panel face and uniform density furnishes a sound base for opaque finishes and paint.
- **High Density Overlay (HDO)** - Is a thermosetting resin impregnated, cellulose fiber overlay that provides a hard, smooth, uniformly textured surface of such character that further finishing is not necessary. Some evidence of underlying grain may appear.
- **Thermoplastic Sheet** - Semi rigid sheet or roll stock extruded from a nonporous acrylic / polyvinyl chloride (PVC) alloy solid color throughout. Withstands high impact. Minor scratches and gouges are less conspicuous due to the solid color.
- **Vinyl Films** - Polyvinyl chloride (PVC) film, either clear or solid color, used extensively for decorative vertical surfaces in mobile homes, recreational vehicles, commercial panels and movable walls. Some films are available with scuff resistant top coatings.
- **HPL (High Pressure Laminate)** - Is a stand-alone product that can be laminated onto a core as the face of a sheet product or directly onto a structure as a covering. Decorative laminate is produced in a one step process by fusing together, under heat and pressure, multiple layers of Kraft paper saturated with thermosetting resin, together with a layer of melamine saturated decorative paper.

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SHEET PRODUCTS (continued)

DECORATIVE LAMINATES, OVERLAYS, and PRE-FINISHED PANEL PRODUCTS (continued)

- **HPL (High Pressure Laminate)** (continued)

  The assembly offers resistance to wear and many common stains and chemicals. Common uses include casework exteriors, countertops, and wall paneling.

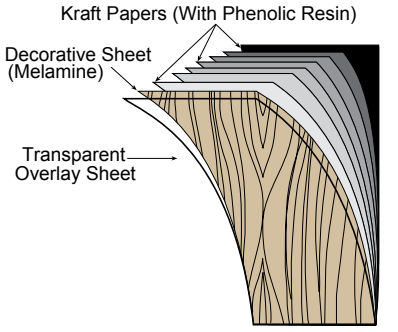

Figure: RG-074

  Some decorative laminates utilize a white background paper to achieve the high fidelity, contrast, and depth of color in their printed patterns, which leaves a white line at the exposed edges of the laminate and can be extremely noticeable in darker colors.

- **CONTINUOUS PRESSURE LAMINATE** (CPL) is an alternative to HPL, manufactured of multiple layers of thermosetting resin saturated Kraft paper in combination with a layer of decorative melamine saturated paper, fused together under heat and pressure with similar properties as HPL.
- **Thermally Fused Laminate (TFL)** - Decorative thermally fused panels flat pressed from a thermoset polyester or melamine resin impregnated web. Most products are pre-laminated to Industrial Particleboard or Medium Density Fiberboard cores when they arrive at the woodwork fabricator. Performance characteristics are similar to HPL except for the impact test.

  Thermally fused papers and foils are similar to that used in the manufacture of decorative laminate. Saturated with reactive resins and partially cured during manufacture to allow for storage and handling, the papers achieve final curing when they are hot press laminated to a core, providing a hard, permanent thermoset bond between the paper and the core:

  - Melamine - Impregnated papers, the most common, are noted for their hardness, scratch resistance, and color stability.
  - Polyester - Impregnated papers are noted for their chemical, stain, water, and impact resistance; color clarity; and machinability.

COMMON HPL TYPES

The basic types form the majority of applications of HPL in North America are:

GENERAL PURPOSE (HGP) Used for most horizontal applications, such as desktops and self-edged kitchen countertops, and offer durability, resistance to stains, and resistance to heat.

VERTICAL (VGP) A slightly thinner material, are produced for areas which will receive less wear and impact than typical horizontal materials. They are an excellent choice for cabinet doors, the sides of casework, primarily decorative display shelves and vertical panels.

POST-FORMING (HGP or VGP) Specifically for applications where a radiused surface is desirable and offer strong performance in both horizontal and vertical applications.

A major advantage of formed surfaces on the exposed corners of casework and service counters is the edge's resistance to chipping damage. Most chip damage occurs at sharp 90° corners. Surfaces are thermo-formed under controlled temperature and pressure.

CABINET LINER (CLS) A thin vertical sheet, this type is designed for areas where the surface, which is not considered decorative, generally white or off white in color, but will need to withstand less wear, such as the inside surfaces of cabinets and closets.

BACKING SHEET (BKL) Backing materials are essential in the fabrication of decorative laminate clad surfaces to prevent warping and to protect against dimensional instability of both laminate and core in conditions of changing temperature and humidity. Backing sheets are non-decorative, and both economical and effective in the creation of a successful application. Produced without a decorative face and available as standard (slightly thinner than decorative) or regrind (reclaimed decorative laminate with decorative sheet sanded off).

SUGGESTION

SUGGESTION

COMMON HPL TYPES (continued)

FLAME RETARDANT (HGF) Some of these laminates can provide flame retardant characteristics as determined by test methods required by the authority having jurisdiction. HGF is the most common type used.

In summary, these common types have the following limitations of:

- They are for interior use only and will not be successfully used outdoors or under heavy exposure to the ultraviolet rays of the sun.
- They should not be used as cutting surfaces, because knives and other sharp tools will readily deface the surface and lower its other performance capabilities.
- They should not be exposed to caustic chemicals, such as drain and toilet bowl cleaners, which can permanently etch the surface.
- While they offer outstanding heat resistance, exposure to constant heat from a curling iron, an electric skillet or coffee pot, for example can harm the surface and may cause it to delaminate, discolor or blister.

COLOR THROUGH HPL

The interest in specifying solid color decorative laminates and the resurgence of interest in very pale pastels and neutral shades have caused increasing concern with the brown line visible at glued decorative laminate edges.

Color through decorative laminates were formulated specifically to provide light colors without this brown line.

Color through decorative laminate may be applied to cores in three basic ways:

- **As sheets**, to form a decorative face with a true monolithic look;
- **As edge trims**, to match a face of conventional decorative laminate or to accent a natural material such as wood or leather;
- **As decorative inlays**.

Color through decorative laminate is produced with multiple layers of decorative papers, rather than the decorative plus Kraft composition of conventional laminate. As a result, this material is slightly stiffer and slightly more brittle when flexed.

Selection of adhesive should take into consideration that a visible glue line may detract. Adhesive should be un-tinted.

CGS (Compact Laminate)

Are produced by several material suppliers in thicknesses adequate to preclude the use of a core (minimum 1/8" (3.2 mm)).

Unlike conventional sheets, they may be drilled and tapped, and offer significant screw holding capacity.

Depending on thickness, these laminates may be used for many flat applications, such as toilet and dressing room partitions, workbenches, shelving, and tabletops.

Panels are heavy for their size—an asset in sturdiness of the end application, but a factor which must be considered when planning for time and cost of labor and transportation as well as for support structures.

STATIC-DISSIPATIVE HPL

HPL is a good electrical insulator, in fact, it was for the specific purpose of electrical insulation that the product was originally developed.

HPL does not store static electricity, and it is therefore a suitable material for use in hospital areas, i.e.: operating rooms, X-ray rooms, and computer room controlled environments where the accumulation and retention of static electricity must be avoided.

However, the growing need for work surfaces in areas such as electronic clean rooms, where electrostatic charges must be actively, continuously channeled away, has triggered the development of specifically conductive (static-dissipative) laminates such as: Anti-Static, Static Dissipative and Conductive.

These HPL sheets have a conductive layer enclosed in, or backing, the sheet. Connected to suitable grounding, they create a decorative, sturdy, practical work surface. Applications include electronic workbench tops and work areas around instrument monitoring devices, in lab testing environments, around photo equipment and on computer desktops.

Antistatic laminates are produced in a number of compositions, thicknesses, colors and patterns. Consult material suppliers' literature for details.

SHEET PRODUCTS (continued)

SUGGESTION

CHEMICAL-RESISTANT HPL

Chemical resistant HPL offers the familiar advantages of HPL: resistance to wear, conductive and radiant heat, and impact; as well as ease in cleaning, color fastness, and relatively light weight. Although this product may resist some chemicals, depending on the testing methods of the individual manufactures, it is the design professional's responsibility to select the appropriate material for the chemical resistance required.

These laminates may be applied on vertical as well as horizontal surfaces, to extend protection to cabinet doors and sides. And they may be post-formed for seamless edges.

Adhesives should be specified carefully. Edges which may be exposed to chemical attack should be glued with chemical-resistant adhesives.

Formulation of chemical-resistant decorative laminate differs from producer to producer. Consult product literature to make sure the material you specify meets the needs of your projects.

They are available in varying thicknesses and a number of color and patterns depending on material supplier.

METAL-FACED HPL

Is produced with metal veneers and a backer of Kraft paper and thermosetting resin.

The material used for much of the metal laminates is interior-type anodized aluminum. Other materials, including copper and nickel alloys may be specified in various formats; however, some metals, such as stainless steel or plated metal, are not conducive to machining with woodworking equipment.

FLAME SPREAD RATING of HPL

Safer materials for interiors are a primary concern for commercial and institutional design professionals across North America. The threat of fire and its concomitant hazard of smoke has created a critical need for interior materials that address this concern without aesthetic sacrifice.

Material suppliers of HPL offer fire and smoke retardant grades for interior application. The addition of fire retardant does not affect the performance characteristics of HPL; wear and stain resistance, ease of maintenance, and color stability remain very strong.

Rated HPLs are evaluated and certified according to ASTM-E-84 test procedures (cataloged as ASTM-E-84 Tunnel Test, astm.org; and as Test No. 723 by Underwriters Laboratories, Inc., ul.com. Similar Canadian testing is cataloged by Underwriters Laboratories of Canada as CAN/ULC S-102, canada.ul.com/ulcprograms/buildingandconstructionmaterials/

With appropriate choices of core and adhesive, panels clad with fire-rated decorative laminate may be produced to comply with Class A fire codes. Finished panels, already certified, may also be specified from some decorative laminate material suppliers.

Major applications of rated HPL include door, wall, and wainscot cladding in corridors, stairwells, entries, and elevators; as well as surfacing on fixtures and casework. These materials are supplied in both horizontal and vertical types, in a wide range of colors and patterns.

They may not be post-formed; the special formulation that produces fire retardant is not compatible with heat forming.

Adhesive choice for fire-rated HPL is important. As with many types of fire-retardant particleboard, some PVA adhesives are incompatible with the fire-retardant chemical composition of the decorative laminate material. Resorcinol adhesives are best for both chemical compatibility and flame spread rating of the end product. Contact adhesives do surprisingly well in some cases. Verify test ratings with your decorative laminate material supplier.

SHEET PRODUCTS (continued)

NATURAL WOOD HPL

An excellent example of the ongoing evolution of the HPL process. Presently, natural wood laminates may be specified in two formats; both feature thin veneers of woods bonded under high pressure and heat to a core of Kraft papers and thermosetting resins. One process leaves the face of the wood untreated, and ready to finish. The other adds a protective face of melamine resin.

Performance characteristics vary with the presence or absence of the melamine resin.

In both cases, the ease of cutting and bonding, as well as the wear resistance, improve in comparison to raw wood veneer. With the melamine face, the natural wood assumes much of the easy care and long wear properties of conventional HPL.

Sequence matching of natural wood laminate panels is extremely limited; consult the laminate material supplier.

SPECIAL SHEET PRODUCTS

Included in this classification are special panel products such as lead lined panels for X-ray areas, bullet resistant panels, honeycomb core panels when light weight is a consideration, etc.:

- **Lead Lined Panels** - Usually a sheet of lead of a specified thickness, to meet X-ray shield requirements, is laminated between 2 layers of core material. A decorative overlay and balancing sheet can then be applied as required.
- **Bullet Resistant Panels** - Available as steel plate, glass, polycarbonate, acrylic or fiberglass reinforced material which can offer protection against many available small arms fire, depending upon the thickness specified. These panels are usually built into the interior of the structure of the counter, teller's lines, judge's benches, etc.

SOLID SURFACE

Solid Surface is a manufactured, filled cast polymeric resin panel. The fillers enhance both its performance properties and aesthetics. With a homogeneous composition throughout its thickness, solid surface requires no finish coat and is capable of being fabricated with inconspicuous seams and repaired to its original finish. Products (and material supplier's warranties) vary and should be fabricated according to material supplier's recommendations, including the use of unique fasteners and adhesives. Many decorative inlays are available. Consult your material supplier about performance issues, materials, colors, and patterns. To ensure color and pattern match it is suggested to use same batch material at adjacent sheets.

OTHER PANEL PRODUCTS

Many new panel products are available, from recycled glass and epoxy impregnated metal shavings to plastic or acrylic panels created from a variety of natural and recycled materials. The options are wide spread and the sheer volume of products make it difficult to quantify. These standards acknowledge these products and encourages design professionals to verify with individual product material suppliers that their products meet required performance standards. These standards do not at present address these products.

NONTRADITIONAL MATERIALS

These materials are re-purposed from other industrial and manufacturing areas but assigned to the woodwork manufacturer and treated similarly to traditional architectural woodwork items like wall paneling. From a design perspective, consideration of appearance, color, finish, variation and relation are deemed important as they would be with traditional wood products.

Examples of non-traditional materials could be a fiber / cement panel designed for fire resistance, insulation re-purposed as a decorative panel, metal products, cloth, acrylics, etc.

Because these materials are unique, contract documents, shall clearly indicate or delineate all of the necessary material, fabrication, installation and building code / regulation direction and requirements as may be applicable for the manufacturer / installer to reasonably accomplish the intended design concept.

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FINISHING

SUGGESTION

INTRODUCTION

Section 05 pertains to shop and field finishing of architectural woodwork. Thirteen finishing systems are outlined with application rules and methods of testing.

PURPOSE

The purpose of finishing woodworking is twofold. First, the finish is used traditionally to enhance or alter the natural beauty of the wood. Second, the finish shall offer protection to the wood from damage by moisture, contaminants, and handling. It is important to understand that a quality finish must offer acceptable performance and also meet the aesthetic requirements of the project.

The Standard illustrates a number of finishing systems. The finishing system provides a protective surface for the product. Some of these systems are in general use; others are intended for special conditions and can only be applied under a strictly controlled environment. The cost of the systems varies, the higher performing finishes usually being more costly than the lower performing finishes. Unnecessary cost could be added to a project through over specification.

When specifying, use the system name as set forth in these Standards. Involve your woodwork manufacturer early in the design process to evaluate the systems in relation to your project requirements. Choose performance characteristics which meet, but do not exceed, the needs of your project in the interest of value engineering.

The listing of a finish system in these Standards does not imply an endorsement of the materials and/or methods or compliance with federal and/or local Environmental Protection Agency or other requirements.

FACTORY or FIELD FINISHING

Both are permitted, provided there is no violation of applicable codes or regulations:

- **Factory finishing** is usually specified for high quality work where superior appearance and performance of the finish is desired. Benefits of factory finishing include consistency, control of film thickness, environmental compliance, and curing / drying of the finish in a controlled atmosphere. Its use assumes a maximum degree of manufacturer prefabrication so that site installation can be performed with a minimum amount of cutting, fitting, and adjustment to facilitate project completion.
- **Field finishing** is typically specified when there is not a demand or specific need for a superior appearance and is not necessarily part of the woodwork contract. This would normally be specified in the painting specification section. The finisher / painter is responsible for examining and accepting the woodwork as supplied prior to the commencement of finishing. The finisher / painter is responsible for meeting or exceeding the control sample for surface performance characteristics (such as color, texture, and sheen), including proper surface preparation, shading, and blending of color, and other requirements as defined in this standard when so referenced.
- **Wood parts on decorative laminate cabinets**: finish is required on all wood pulls, trims, applied molding, edgebands, drawer boxes, and interior wood parts of decorative laminate casework.

FINISHING (continued)

SUGGESTION

IMPORTANT CONSIDERATIONS

- **Specifications** too often, call for finishes based on samples or guide language from a specialty material supplier.

  Select the performance criteria which best meets the needs of your client from the finish tables. Finish chemistry, performance, value to performance ratio, and your finisher's abilities should be considered.

- **Varying costs** of finish systems typically relate directly to their performing characteristics.

- **Intermixing systems** will likely cause quality and/or performance problems; they are usually not compatible with each other.

  Examples include the over specification of polyurethane or polyester topcoats when they are neither necessary or available from a custom fabricator.

- **Application** of finish material in excess of material supplier's film thickness recommendations can cause the finish to fail.

  Brush applied finishes are not recommended for factory finished architectural woodwork and are not covered by these Standards.

  Application techniques and other variances make the execution of the finish system difficult to determine. These standards provide the minimum requirements. The desired result is to provide a finish that is both durable and achieves the desired appearance.

- **Curing** of finish systems have a wide range of variance. Shortest cure time is UV cured coatings, and longest being water-based air dry coatings. Heat and air movement will speed the recoat and cure time.

  For the most part the method should not concern the design professional or specification writer. It is the performance of the topcoat which is important.

  UV (ultraviolet light) is typically used for high volume, repetitive applications, and requires special reactors to cure. A number of pre-finished panel products are coated with materials designed specifically for UV curing. A wide range of UV cured roll coat flat line panel finishes are available. Just as there are in the conventional spray / air cured coatings. Consult with the fabricator for performance tests and details.

- **Pre-finished Wood Panels** and decorative overlays have aesthetic and performance characteristics which meet or exceed these Standards, and should be evaluated, approved and specified by the design professional when desired.

- **Panel products** and/or wood doors require balanced coats of finishing materials for stability and to remain free of warp.

- **Barber pole** effect is most evident when veneer leaves are book matched. Because book matched veneer panels or door faces are made up by turning every other piece (leaf) of veneer over, like the pages of a book, the face of one leaf and the back of the next leaf is exposed. This exposes the "tight" and "loose" face of the leaves. One of the most striking examples of Barber Pole effect can be seen in book matched rift and quarter cut Oak. Check with your manufacturer when you are considering specifying rift or quartered veneers.

- **Grain** can significantly impact a finish's visual appearance and smoothness. If a filled finish is required it must be so specified. As a rule, close grain woods do not require filler. See Table.

  For finishing purposes, the following woods are classified as:

Open Grain	Close Grain
Ash	Alder, Red
Butternnut	Beech
Chestnut	Birch
Mahogany, African	Cherry
Mahogany, American	Fir
Mahogany,Philippine	Gum
Oak, Red	Maple
Oak, White	Pine
Walnut	Poplar

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FINISHING (continued)

SUGGESTION

IMPORTANT CONSIDERATIONS (continued)

- **Color** and **grain enhancement** of a system, from the addition of a single stain, to a multiple step build of one color on another with wash coats in between for enhanced appearance is not included in the basic systems and needs to be specified.

  Aesthetically, systems may vary from no stain, to a single stain, to a multiple step application. Some samples will require multiple color and finish steps in order to meet the architect's requirements. The system specified may not include all steps necessary to match the architect's example or requirements.

  Color and grain enhancement of some finishes require the build of one-color step on another. This will sometimes require an additional protective wash coat between color steps. Generally, this procedure adds to the depth and beauty of the finish. Each added step increases costs and shall be specified.

- **Color match** and **consistency** is often misleading. The best case achievable using a natural product like wood in a wide variety of lighting conditions is a good "blend" of color and tone throughout the project area. The natural color of the wood product is altered by the application of even a clear topcoat. Further alteration is achieved through the use of stains, glazes, bleaches, etc. Wood changes color; especially Cherry, Fir, American and African Mahogany, Walnut, Teak, and others. Filled nail holes will not change with wood. The apparent consistency of the color is a combination of light reflectance, cellular structure, natural characteristics, applied colors, and sheen.

  Color and "matching" of a sample are often highly subjective. Individual perception, ambient lighting, and reflectivity influence judgement. Design professionals are encouraged to consult directly with a manufacturer during the design and selection phase of each project.

- **Sheen** is the result of many factors, including finishing techniques, processes, stains, topcoats and the wood itself. Coating material suppliers use a variety of names for different sheens. An untrained eye can see a 10 point or greater difference in sheen.

  The following sheen ranges were developed by measuring the reflectance of a direct light source at a 60-degree angle with a gloss meter:

  - **Flat** = **8 - 14**
  - **Satin** = **15 - 25**
  - **Satin Gloss** = **26 - 49**
  - **Semi gloss** = **50 - 70**
  - **Gloss** = **71 - 90**

- **Transparent** finishes are applied in varying operations, typically consisting of some combination of hand sanding to remove job handling marks, staining, filling, sealing, sanding, and surface coating. Some exotic species have a high natural oil content and do not accept finishes similar to other hardwoods; because of this, the most common finish used is penetrating oil without any filling or sealing dyes or pigments in a stain.

- **Blotchy appearance** occurs because some wood species exhibit an uneven distribution of large and small pores in their structure. The occurrence of this is readily apparent in such hardwood species as Maple and Birch and, to a lesser degree, in Cherry. This irregular distribution of pores usually causes an uneven absorption of stain, hence, an apparent blotchy appearance in the finish. Reduction of the blotching condition can sometimes be achieved by proper sanding, wash coating (prior to staining) or by choosing non penetrating pigments, such as dyes, alcohol stains or glaze. When these steps are required or desired, they shall be specified in addition to finish system selection.

FINISHING (continued)

TECHNIQUES TO CONSIDER

While a blotchy appearance and the "barber pole effect" may occur in any species, due to the natural characteristics of wood, there are steps that can be taken to reduce these effects. The following are two of the techniques that are of particular importance:

- **Sanding** - While the selection of species, cut and match are major factors in the final appearance of a project, the first step, in controlling the quality of finished appearance, is proper sanding.

  An important element of this standard is the statement "just prior to staining." Specifications that indicate "factory shall finish sand prior to shipment" do not provide a correct solution for proper surface preparation. Such a directive fails to take into account the length of time panels will be stored at the job site, potential damage from handling and the effects of changes in the relative humidity. Proper sanding can only be done, just prior to staining / finishing.

  The successful sanding of panels, or flush doors, is best accomplished with a hand block, powered pad sander, wide belt sander or stroke sander, exerting uniform pressure over the entire surface. Depending upon the condition of the surface it may be necessary to use successively finer grits of abrasive to properly prepare the surface, brushing off the surface between grits. These Standards set forth the smoothness requirement for all Grades of work. Proper and complete surface preparation is the key factor in the successful finish procedure.

- **Wash Coat** - A wash coat is a thin coat of material, usually clear lacquer or vinyl sealer (6 to 10 parts thinner to one-part sealer, topcoat). A wash coat can fulfill several purposes such as: to stiffen the small wood fibers that are raised by the staining operation, so they can be cut off easily with fine sandpaper (320 grit), to seal the stain, particularly if it is a bleeding type, to aid in the wiping and cleanup of filler, and to minimize excessive penetration of stain or filler to minimize blotchiness. As with any finish process, samples should always be prepared to ensure that the desired finish is achieved.

IRON STAIN

Iron stain occurs in some species of veneers when natural tannic acid in the wood comes in contact with iron and or moisture. Enough moisture may occur during heavy rains or high humidity in buildings not yet temperature controlled.

To prevent iron stain, never use steel wool on the bare wood. Fine particles of the wool will cling to the wood and cause trouble later. If you use shellac (a solvent for iron), it should not be stored in iron containers. To remove iron stain prior to finishing, we recommend a solution of oxalic acid crystals. The solution is made by dissolving 12 ounces of crystals in one gallon of lukewarm water. Use a plastic or rubber container. Wear rubber gloves while working with the solution. Apply it to the stained areas with a brush or sponge.

To remove the oxalic acid, use a sponge and a bucket filled with lukewarm water. Squeeze the sponge to remove excess water and wipe the entire surface of the Oak wood to remove the acid residue. Rinse the sponge frequently in clean lukewarm water as you wipe. Pour out the water and add 1 qt. of fresh lukewarm water to the bucket. Add 2 tablespoons. baking soda to the water and stir with a spoon to dissolve. Insert a fresh sponge into the solution and squeeze out the excess water. Wipe the entire surface of the Oak to neutralize any remaining acid residue and stop the bleaching process. Allow the surface to dry and sand with 150 to 180 grit sandpaper. The entire surface should be treated to avoid spotting. Failure to rinse the treated area adequately may have a damaging effect on the finish subsequently applied, or may cause damage to nearby glass, porcelain or other surfaces in confined areas. Damage may not result immediately but may result during storage or after installation.

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SUGGESTION

FIRE RETARDANT TREATED WOOD and COATINGS

Fire retardant treatments may affect the finishes intended to be used on the wood, particularly if transparent finishes are planned. The compatibility of finishes should be tested before they are applied.

"Fire retardant" coatings usually are of the intumescent type. They may be water based or solvent based, but both contain ingredients which, under the influence of heat, produce gases and char like products, resulting in the formation of a thick nonflammable crust that effectively insulates combustible cores from heat and flame. However, these ingredients are for the most part water sensitive and therefore reduce durability and range of usage of the coatings.

These coatings only delay the spread of fire and help contain it to its origin. To be of appreciable value, fire retardant coatings must be applied in strict conformance with the material supplier's instructions. These finishes are not particularly durable and their use should be restricted to application over interior surfaces.

The need for, and effectiveness of, fire retardant and fire-resistant finishes depends on the type of construction, nature of occupancy, and other technical features of the building. Because these finishes are considerably more expensive and have reduced durability, their use should be carefully limited to those areas where confining fire spread is the overwhelming consideration; for example, interior entrances, hallways, stairwells and ceilings.

NAAWS FINISHING SYSTEMS

Apply to both transparent or opaque applications, unless otherwise indicated: Specification of a system requires listing both the system number and the name, along with any desired enhancements.

SYSTEM - 1, Lacquer, Nitrocellulose

SYSTEM - 2, Lacquer, Pre-Catalyzed

SYSTEM - 3, Lacquer, Post Catalyzed

SYSTEM - 4, Latex Acrylic, Water Based

SYSTEM - 5, Varnish, Conversion

SYSTEM - 6, Oil, Synthetic Penetrating (available in transparent only)

SYSTEM - 7, Vinyl, Catalyzed

SYSTEM - 8, Acrylic Cross Linking, Water-Based

SYSTEM - 9, UV Curable, Acrylated Epoxy, Polyester or Urethane

SYSTEM - 10, UV Curable, Water Based

SYSTEM - 11, Polyurethane, Catalyzed

SYSTEM - 12, Polyurethane, Water Based

SYSTEM - 13, Polyester, Catalyzed

NAAWS FINISHING SYSTEMS OVERVIEW TABLES

The following system overview tables are intended to give an overview of and help identify the correct standard or specialty finishing system to meet a project's needs; however, they are only relative to the topcoat, not any prior color or filler coats. Differences between systems of 10 points or fewer are not generally considered significant enough to justify the typical added expense of a higher-rated system. This systems listing does not imply an endorsement of the materials or compliance with applicable codes and regulations. Due to changing environmental regulations and finish technologies, design professionals need to discuss finish options with a manufacturer located in the area of the project.

SUGGESTION

Table: RG-008 - **GENERAL PERFORMANCE CHARACTERISTICS** of **NAAWS FINISHING SYSTEMS:**

	SYSTEM NUMBER and DESCRIPTION												
	Lacquer, Nitrocellulose	Lacquer, Pre Catalyzed	Lacquer, Post Catalyzed	Latex Acrylic, Water Based	Varnish, Conversion	Oil, Synthetic Penetrating (available in transparent only)	Vinyl, Catalyzed	Acrylic Cross Linking, Water-Based	UV Curable, Acrylated Epoxy, Polyester or Urethane	UV Curable, Water Based	Polyurethane, Catalyzed	Polyurethane, Water Based	Polyester, Catalyzed
	1	2	3	4	5	6	7	8	9	10	11	12	13
General Durability	2	2	3	2	4	1	4	2	5	5	5	3	5
Repairability	5	4	3	3	3	5	4	4	1	3	2	4	1
Abrasion Resistance	2	4	4	3	4	1	4	4	5	4	5	4	5
Finish Clarity	5	4	5	2	3	5	3	4	5	5	3	4	4
Yellowing in Time	1	2	3	5	4	2	1	4	3	5	4	4	3
Finish Flexibility	1	2	3	3	4	5	4	3	2	3	4	4	1
Moisture Resistance	3	3	4	1	4	1	5	3	5	4	5	4	5
Solvent Resistance	1	2	4	1	5	1	5	3	5	5	5	4	5
Stain Resistance	2	4	5	3	5	1	5	4	5	5	5	4	5
Heat Resistance	1	2	5	1	5	1	5	3	5	5	5	4	5
Household Chemical Resistance	3	4	5	3	5	2	5	4	5	5	5	4	5
Build / Solids	2	3	3	3	4	1	4	3	5	4	4	3	4
Drying Time	5	5	5	2	4	2	5	4	5	5	5	3	2

5 = Excellent to 1 = Poor. The numerical ratings are subjective judgments based on the general performance of generic products. Special formulations and facilities will influence some of the performance characteristics.

NOTES for *Table: RG-009* on following page.

Testing was evaluated in an ISO 9000-certified laboratory using the following ASTM test criteria: Chemical Resistance Testing - ASTM D1308 (latest edition), Wear Index - Abrasion Resistance Testing - ASTM D4060 (latest edition), Cold Check Resistance - ASTM D1211 (latest edition), Cross Hatch Adhesion - ASTM D3359 (latest edition). Baseline data for application prior to testing: A. 45-55% humidity at 70-80 degrees Fahrenheit; B. Water-borne coatings must be cured in a dehumidified atmosphere and can be assisted with infrared light and good air movement. Performance indicator numbers are used, with the following definitions:

For chemical resistance and wear index - abrasion resistance:

5 - No effect from the test.
4 - Minimal effect or slight change and little repair required.
3 - Some effect; noticeable change, and the coating will recover with minimal repairs.
2 - Moderate effect, performance adversely affected and repairs required.
1 - Poor performance and film failure is imminent and repairs difficult.

For cross-hatch adhesion:

5 - Edges of the cuts are completely smooth; none of the squares of the lattice are detached.
4 - Small flakes of the coating are detached at intersections; less than 5% of the area is affected.
3 - Small flakes of the coating are detached along the edges and at the intersections of cuts; 5 to 15% of the area is affected.
2 - Coating has flaked along the edges and on parts of the squares; 15 to 35% of the area is affected.
1 - Coating has flaked along the edges of the cuts in large ribbons and whole squares have detached; 35 to 65% of the area is affected.

SUGGESTION

Table: RG-009 - **SPECIFIC PERFORMANCE CHARACTERISTICS for NAAWS FINISHING SYSTEMS**

	SYSTEM NUMBER and DESCRIPTION												
	Lacquer, Nitrocellulose	Lacquer, Pre-Catalyzed	Lacquer, Post Catalyzed	Latex Acrylic Water Based	Varnish, Conversion	Oil, Synthetic Penetrating (transparent only)	Vinyl, Catalyzed	Acrylic, Cross Linking, Water-Based	UV Curable Acrylated Epoxy, Polyester or Urethane	UV Curable Water Based	Polyurethane, Catalyzed	Polyurethane, Water Based	Polyester, Catalyzed
	1	2	3	4	5	6	7	8	9	10	11	12	13
Vinegar	3	4	5	4	5	3	5	5	5	5	5	4	5
Lemon Juice	3	4	5	4	5	3	5	5	5	5	5	4	5
Orange Juice	3	4	5	4	5	3	5	5	5	5	5	4	5
Catsup	3	4	5	4	5	2	5	5	5	5	5	4	5
Coffee	3	4	5	4	5	2	5	5	5	5	5	4	5
Olive Oil	2	3	5	3	5	2	5	5	5	5	5	4	5
Boiling Water	3	4	5	4	5	3	5	5	5	5	5	4	5
Cold Water	5	5	5	5	5	3	5	5	5	5	5	4	5
Nail Polish Remover	1	2	3	2	4	1	2	2	5	5	4	3	4
Household Ammonia	3	4	5	4	5	2	4	2	5	5	5	4	5
VM&P Naphtha	3	4	5	4	5	1	4	5	5	5	5	4	5
Isopropyl Alcohol	1	2	3	1	5	2	4	3	5	5	5	4	5
Wine	3	4	5	4	5	2	4	5	5	5	5	5	5
Windex™	3	3	4	3	5	2	3	4	5	4	5	4	5
409 Cleaner™	3	3	4	4	5	1	4	4	5	5	5	4	5
Lysol™	3	5	5	4	5	2	4	3	5	5	5	4	5
33% Sulfuric Acid	3	4	5	3	5	1	4	5	5	5	5	4	5
77% Sulfuric Acid	1	2	3	1	1	1	2	1	4	3	4	3	4
28% Ammonium Hydroxide	1	2	3	1	5	1	4	2	5	5	5	3	5
Gasoline	1	2	5	2	5	1	4	5	5	5	5	4	4
Murphy's Oil Soap™	5	5	5	5	5	2	4	4	5	5	5	5	5
Vodka 100 Proof	3	4	5	4	5	2	4	3	5	5	5	4	5
1% Detergent	3	4	5	4	5	3	4	5	5	5	5	5	5
10% TSP	3	4	5	4	4	1	5	2	5	5	5	5	5
SUBTOTAL	**65**	**86**	**110**	**82**	**114**	**46**	**100**	**95**	**119**	**117**	**118**	**97**	**117**
Wear	2	3	4	2	5	1	4	4	5	5	5	5	4
Cold Check	5	5	5	5	5	5	5	5	5	5	5	5	5
Adhesion	5	5	5	5	5	5	5	5	5	5	5	5	5
TOTAL SCORE	**77**	**99**	**124**	**94**	**129**	**57**	**114**	**109**	**134**	**132**	**133**	**112**	**131**

NOTES are on previous page.

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FINISHING (continued)

Table: RG-010 - **USAGE** and **PERFORMANCE SCORE COMPARISONS** for **NAAWS FINISHING SYSTEMS:**

	TYPICAL USAGE	SCORE	WHY AND WHY NOT
1 Lacquer, Nitrocellulose	Use in climate-controlled environment for trims, furniture, paneling, and ornamental work.	**77**	Why - Repairable; widely available; quick-drying Why not - Lack of durability and resistance to most solvents and water; yellows over time.
2 Lacquer, Pre-Catalyzed	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, stair parts (except treads), frames, windows, blinds, shutters, and doors.	**99**	Why - Repairable; stain-, abrasion-, chemical-resistance. Why not - Some yellowing; moderate build.
3 Lacquer, Post Catalyzed	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, stair parts (except treads), frames, windows, blinds, shutters, and doors.	**124**	Why - Repairable; finish clarity; stain-, heat-, abrasion-,chemical-resistance. Why not - Some yellowing; moderate build.
4 Latex Acrylic, Water Based	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, stair parts (except treads), frames, windows, blinds, shutters, and doors.	**94**	Why - Low VOCs; finish clarity (some formulations); stain resistance; yellowing resistance. Why not - Low durability; solvent- and heat-resistance; slow drying time.
5 Varnish, Conversion	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, stair parts, frames, windows, blinds, shutters, and doors.	**129**	Why - Durable; widely available; good build. Why not - Occasional lack of finish clarity.
6 Oil, Synthetic Penetrating	Use in climate-controlled environment on furniture or trims requiring a close-to-the-wood look or very low sheen.	**57**	Why - Close-to-wood, antique look; low sheen. Why not - Labor-intensive to apply and maintain, refreshing finish required from time-to-time; low resistance properties to most substances.
7 Vinyl, Catalyzed	Use in climate-controlled environment, often on kitchen, bath, office furniture, and laboratory casework.	**114**	Why - Durable; widely available; fast drying. Why not - Occasional lack of finish clarity.
8 Acrylic Cross Linking, Water-Based	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, stair parts, frames, windows, blinds, shutters, and doors.	**109**	Why - Fine durability; excellent abrasion-, solvent-, stain-, and chemical-resistance; moderately fast-drying; resists moisture Why not - Possibility of discoloration over time.
9 UV Curable, Acrylated Epoxy, Polyester or Urethane	Use in climate-controlled environment, doors, paneling, flooring, stair parts, and casework, where applicable; consult your finisher before specifying.	**134**	Why - Low VOCs; durable; near 100% solids usage; quick-drying (cure), may qualify as Green Guard. Why not - Difficult to repair with UV finish, as this requires a handheld UV lamp; availability varies; easy repair with lacquers or conversion varnish.
10 UV Curable, Water Based	Use in climate-controlled environment, doors, paneling, flooring, stair parts, and casework where applicable; consult your finisher before specifying.	**132**	Why - Low VOCs; quick-drying (cure), maybe Green Guard. Why not - Difficult to repair with UV finish, requires handheld UV lamp; availability varies; easy repair with lacquers or conversion varnish.
11 Polyurethane, Catalyzed	Use in climate-controlled environment; some formulas available for exterior environments; floors, stairs, high-impact areas; some doors; generally not good for casework, paneling, windows, blinds, and shutters.	**133**	Why - Durable; good build. Why not - Slow-drying; very difficult to repair; some formulations hazardous to spray-personnel without air make-up suits.
12 Polyurethane, Water Based	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, stair parts, frames, windows, blinds, shutters, and doors.	**112**	Why - Improved durability; excellent abrasion-, solvent-, stain-, and chemical-resistance; moderately fast-drying; resists moisture. Why not - Tannins in some wood species may cause Discoloration over time.
13 Polyester, Catalyzed	Use in climate-controlled environment for furniture, casework, paneling, ornamental work, blinds, shutters, and some doors.	**131**	Why - Durable; good build; can be polished. Why not - Not widely available; slow-curing; requires special facilities and skills; very difficult to repair; brittle finish flexibility.

SUGGESTION

SUGGESTION

INTRODUCTION

Section 6 includes information on standing & running trim, door frames, window frames, sashes, blinds & shutters, screens, ornamental & miscellaneous architectural woodwork composed of solid wood and/or sheet products and their related parts.

METHODS OF PRODUCTION

Flat Surfaces:

- **Sawing** - This produces relatively rough surfaces that are not utilized for architectural woodwork except where a "rough sawn" texture or finish is desired for design purposes. To achieve the smooth surfaces generally required, the rough sawn boards are further surfaced by the following methods:
  - **Planing** - Sawn lumber is passed through a planer or jointer, which has a revolving head with projecting knives, removing a thin layer of wood to produce a relatively smooth surface.
  - **Abrasive Planing** - Sawn lumber is passed through a powerful belt sander with tough, coarse belts, which remove the rough top surface.
  - **Molded Surfaces -** Sawn lumber is passed through a molder or shaper that has knives ground to a pattern which produces the molded profile desired.

SMOOTHNESS of FLAT and MOLDED SURFACES

Planers and Molders: The smoothness of surfaces which have been machine planed or molded is determined by the closeness of the knife cuts. The closer the cuts to each other (i.e., the more knife cuts per inch [KCPI]) the closer the ridges, and therefore the smoother the resulting appearance.

Sanding and Abrasives: Surfaces can be further smoothed by sanding. Sandpapers come in grits from coarse to fine and are assigned ascending grit numbers. The coarser the grit, the faster the stock removal. The surface will show the striations caused by the grit. Sanding with progressively finer grit papers will produce smoother surfaces.

DESIGN and USE of RESOURCES

Moldings should be cut from lumber approximately the same size as the finished piece to make the best use of our natural resources. Designing moldings with the size of typical boards in mind has several advantages.

The typical 1" x 4" (25.4 mm x 102 mm) will yield a very nice 3/4" (19.0 mm) thick molding but will not be thick enough to develop a molding which is a full 1" (25.4 mm) thick in finish dimension. The typical 2" x 4" (50.8 mm x 102 mm) piece of lumber can be made into moldings about 1-3/4" (44.5 mm) thick in a similar manner.

Deep or large moldings are often best cut from more than one piece and built up to make the final profile. Just as in the manufacturing of single moldings, this process minimizes waste and reduces the tendency of the finished profiles to twist, warp, cup, or bow as a result of removing too much material from either side of the initial board.

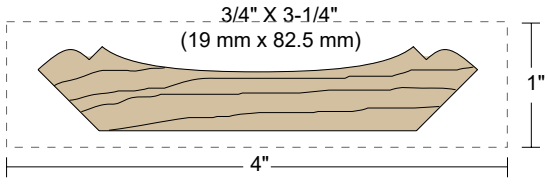

Figure: RG-075

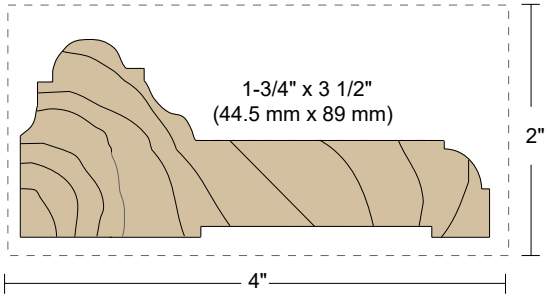

Figure: RG-076

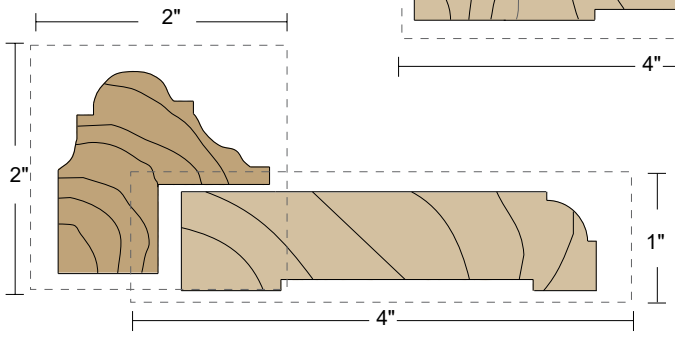

Figure: RG-077

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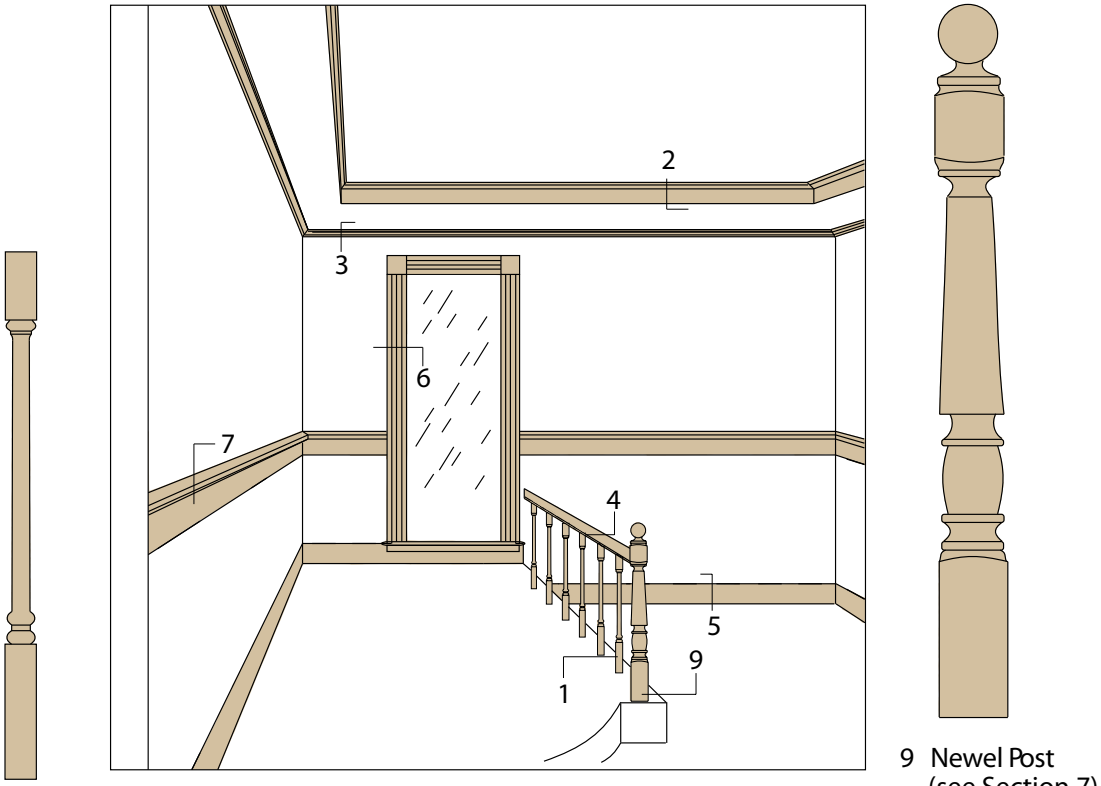
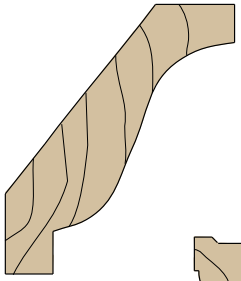
SUGGESTION

EXAMPLES OF STANDING and RUNNING TRIM and RAIL PARTS

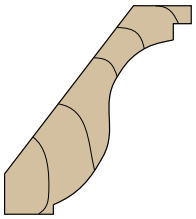


1 Spindle or Baluster (see Section 7)

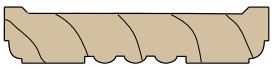
9 Newel Post (see Section 7)



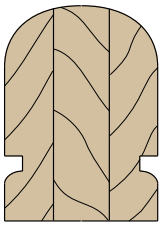
2 Crown Running Trim



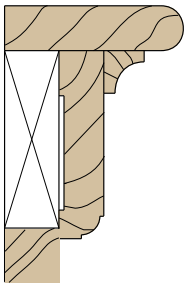
3 Crown Running Trim



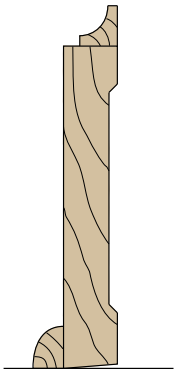
6 Window Casing Standing Trim



4 Handrail



7 Chair Rail Combination (Cap, cove & rail) Running Trim

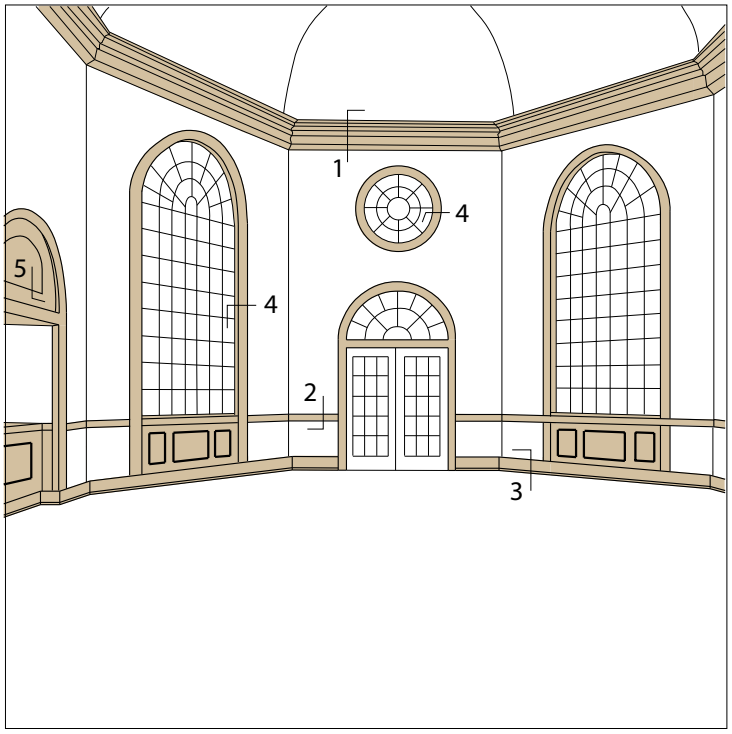


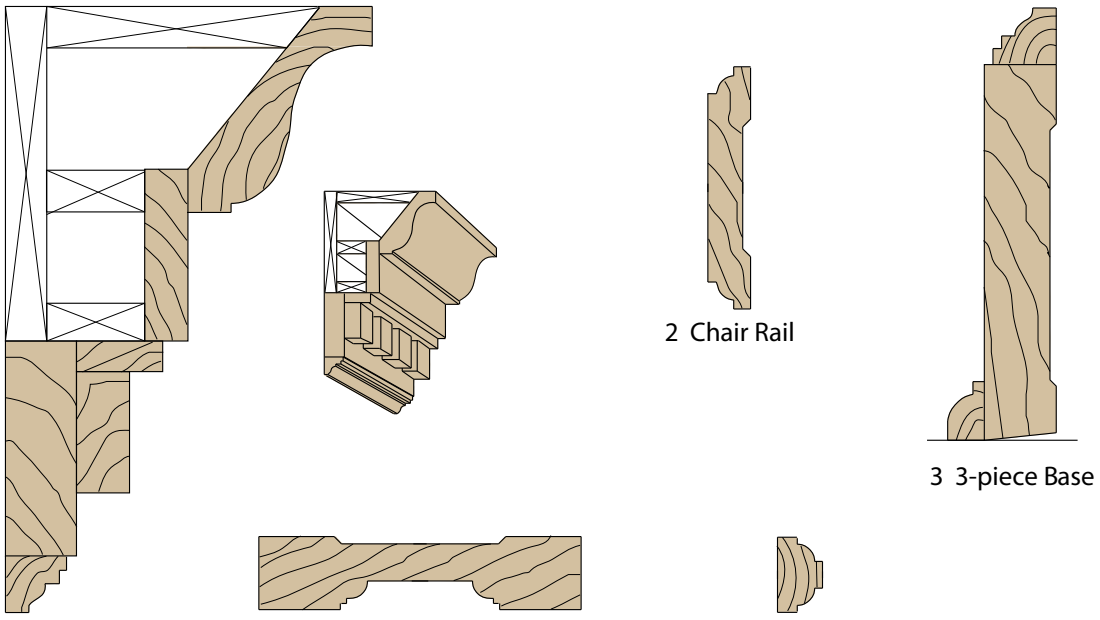
5 Base Combination (Cove, board, shoe) Running Trim

Figure: RG-078

SUGGESTION

EXAMPLES OF STANDING and RUNNING TRIM





1 Cornice

4 Casing

2 Chair Rail

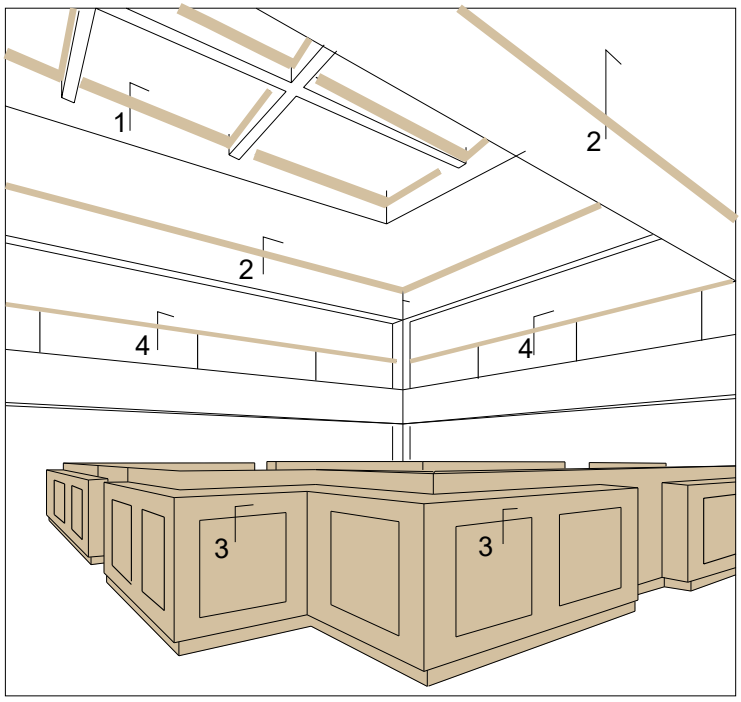
5 Panel Molding

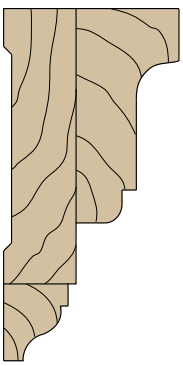
3 3-piece Base

Figure: RG-079

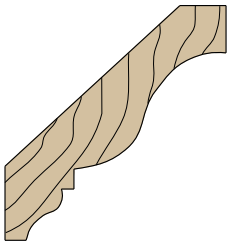
SUGGESTION

EXAMPLES OF STANDING and RUNNING TRIM and RAIL



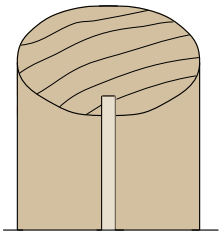


1 Skylight Cornice



2 Crown

3 Panel Molding



4 Handrail

Figure: RG-080

SUGGESTION

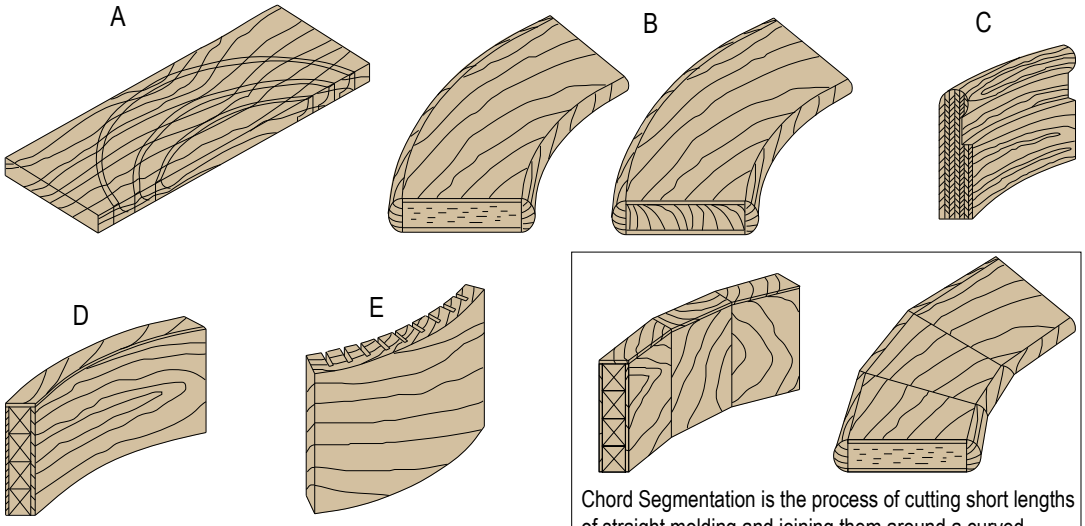
RADIUS MOLDINGS

Both traditional and nontraditional architectural styles often call for radius standing and running trim either in plan, elevation, or both. In situations where the size of the molding and the radius to which it is to be formed is such that a straight molding will not conform to the core, the architectural manufacturer can use several methods to fabricate radius moldings. Moldings applied to radii can be segmented, (typically only by direct specification) bent or steam bent, laminated and formed, pre-shaped, or machined to the radius. Manufacturers will fabricate the moldings in the longest practical lengths, with the purpose of minimizing the field joints:

- **Solid Machined** (Illustration A) woodwork typically starts with a large, often glued up piece of material, from which several nested pieces can be machined. Characteristically, this method limits the length of pieces that can be developed without a joint. It also yields a piece of material with the grain straight on the face, not following the curve. Profiles with a flat face can be machined from sheet products with an edgeband applied, yielding larger pieces with more consistent grain.
- **Core Veneered** (Illustration B) woodwork consists of core machined from lumber or panel product to which finish material is laminated as an exposed face. This technique is limited to certain profiles; however, it offers the ability to minimize glue joints and control grain directions.
- **Laminated Plies** (Illustration C) woodwork consists of thin, bendable plies of lumber in a form that will hold its shape without having to be secured to another surface. The curved piece can then be milled to the desired profile. The glue lines follow the edge grain and the curve, thus minimizing their visibility. The species of wood and the tightness of the radius determine the maximum thickness of each ply.
- **Block Laminated** (Illustration D) woodwork is made of solid machined pieces, glued up typically in a staggered fashion for width and length. When dealing with some cross sections, it can be advantageous to combine band sawing and laminating; however, it must be limited to certain profiles. It does, however, offer the ability to minimize glue joints, is used in radius jambs and often becomes the core for core veneered woodwork.
- **Kerfed** (Illustration E) woodwork consists of lumber with repeated saw cuts on the back face of the piece, perpendicular to the bend. The tightness of the radius determines the spacing and depth of the kerfs. Kerfing allows the piece to be bent to the required radius and then secured in place to hold the bend. Kerfing could result in “flats” on the face, which show in finishing. When dealing with a large radius, it is sometimes possible to stop the kerf prior to going through an exposed edge. In most cases, however, the kerf runs through, and the edge must be concealed.

Cross Grain in band sawn or laminated members and edges in veneer laminated members or where multiple layers are exposed by shaping may cause objectionable color variation when finished.

Unless specifically called out, the architectural manufacturer will have the option of which method to use for fabricating radius molding. Since the fabrication method determines the final appearance of the pieces, especially regarding the direction of grain and visibility of glue joints, the architect or designer may wish to specify the method. It is recommended that an architectural woodwork firm be consulted before making a selection. Mock-ups may be required to visualize the end product.



Chord Segmentation is the process of cutting short lengths of straight molding and joining them around a curved substrate and is NOT permitted unless specified.

Figure: RG-081

SUGGESTION

SOLID LUMBER PANELING PATTERNS

The variety of solid lumber paneling is only limited by the imagination of the design professional. Virtually any machinable profile can be custom manufactured. The following profiles are some of the traditional patterns associated with solid board paneling. They are not dimensioned intentionally, allowing the design professional to determine the scale and proportions most appropriate for the project.

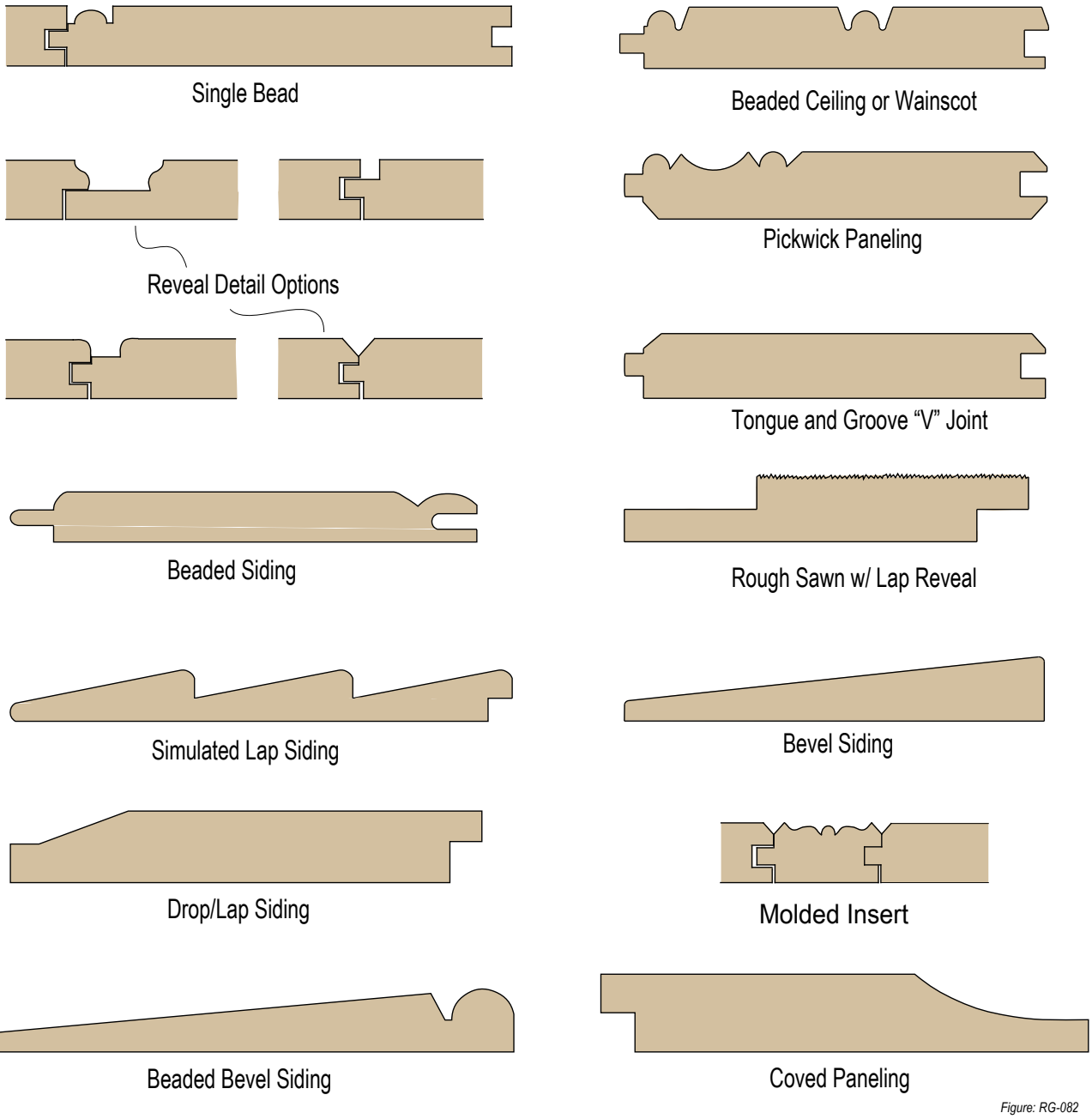


Figure: RG-082

SUGGESTION

BUILT UP MOLDINGS FOR LARGER PROFILES

Used with permission of the Wood Molding and Millwork Producers Association:

- **Ceilings** are the most obvious area for "built up" moldings. This is primarily true of rooms with high ceilings. In low ceiling rooms (96" [2440 mm]), single molding profiles usually work best. A series of "built up" moldings would have a tendency to make a low ceiling appear even lower. But if your ceilings are high 120" (3048 mm) or higher, there is no limit to the rich three-dimensional elegance you can add to the room's appearance with the creative application of moldings. Below are several suggested combinations. Let your imagination create your own combinations and designs.
- **Chair Rails** are a very traditional method of breaking up walls, adding both interest and protection. They prevent the wall from being bumped or scuffed by chairs and can also be used to separate two types of decorating material such as paneling, wallpaper, and paint. Following are some variations of "built up" chair rail combinations.

EXAMPLES OF CEILING PROFILES

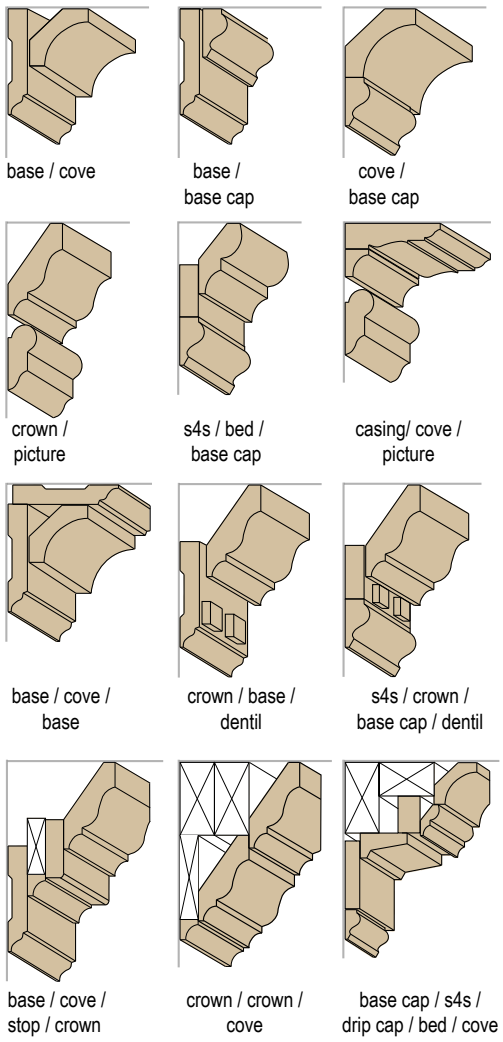


Figure: RG-083

EXAMPLES OF CHAIR RAIL PROFILES

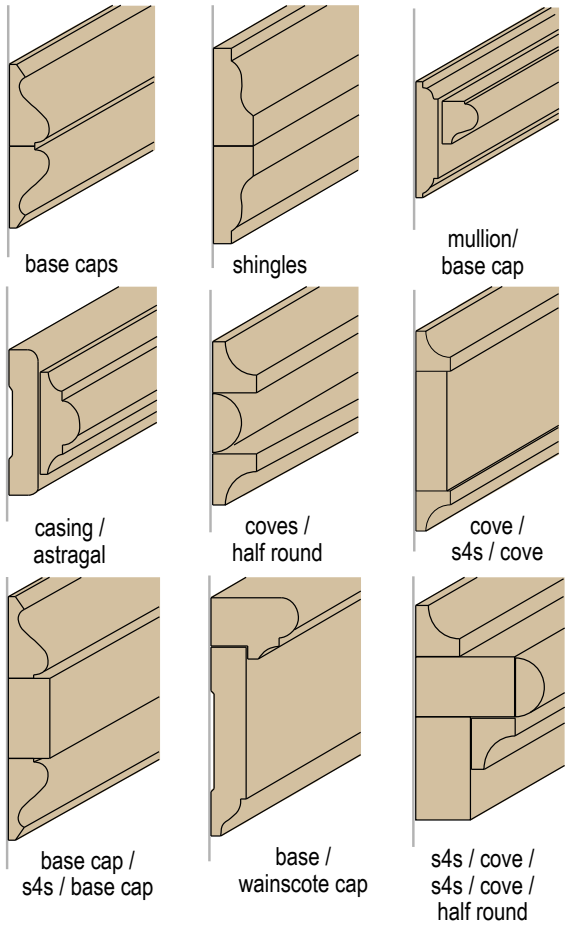


Figure: RG-084

SUGGESTION

BUILT UP MOLDINGS FOR LARGER PROFILES (continued)

- **Fireplaces** highlighted or framed with "built up" moldings is an excellent way to add depth and richness. Below are a few creative but simple to install profile combinations.

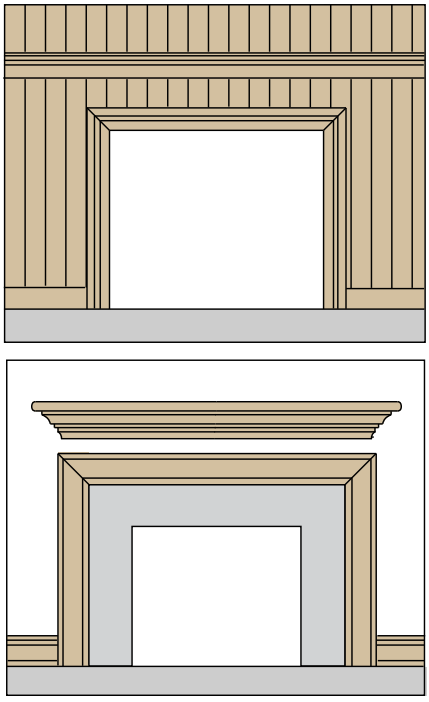


Figure: RG-085

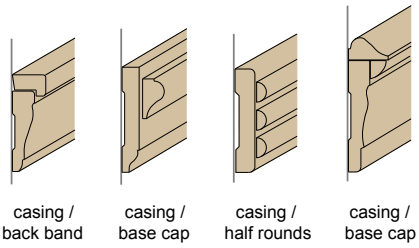


Figure: RG-086

- **Doors** and **Windows** are most commonly done with single molding profiles, but by adding other patterns, the basic trim can easily be transformed into a window or door casing of classical depth and beauty. Installing plinth blocks at the bottom of casing further enhances the traditional look.

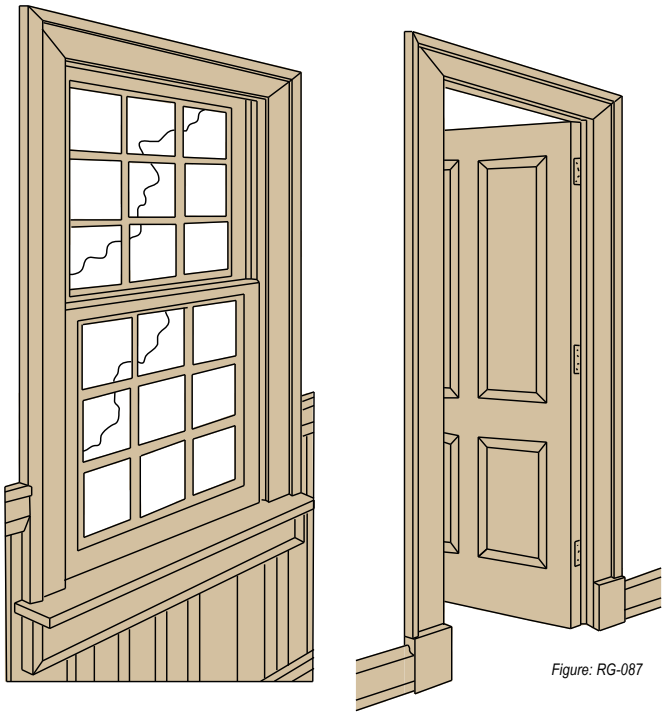


Figure: RG-087

- **Base** the elaborate look of elegance can even be carried through to base moldings where the wall meets the floor, as illustrated in the following variations.

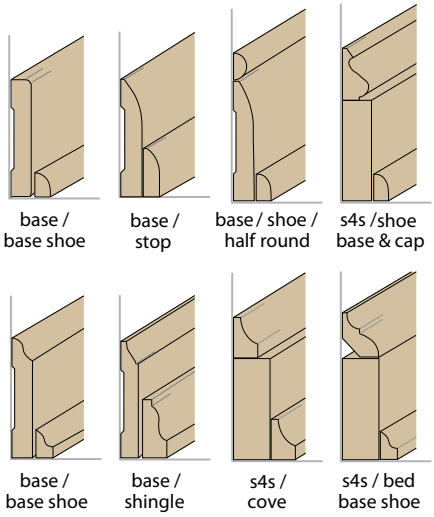


Figure: RG-088

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SUGGESTION

BUILT-UP CORNICE and WALL TRIM EXAMPLES

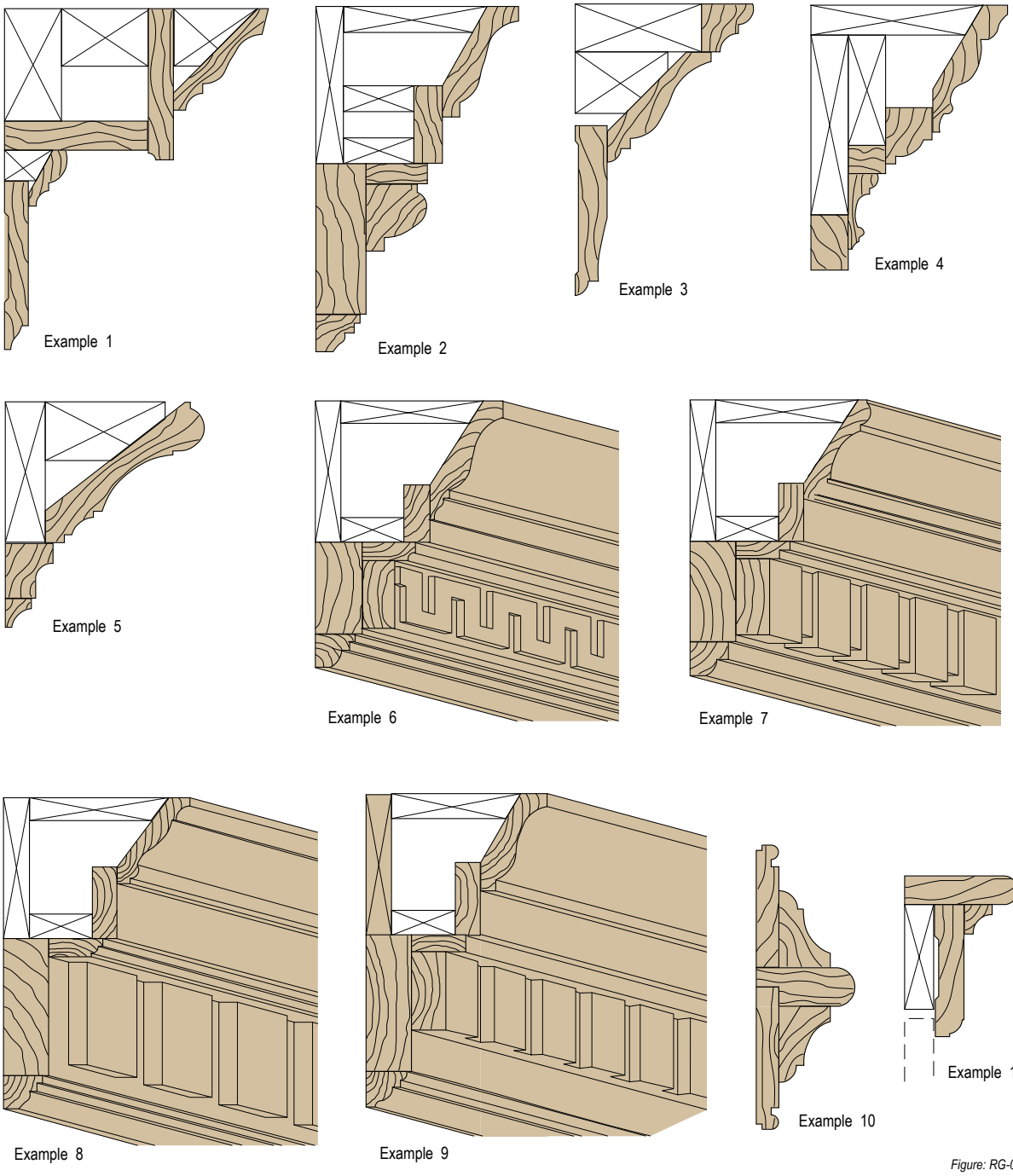

Figure: RG-089

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SUGGESTION

DOOR FRAME and JAMB EXAMPLES

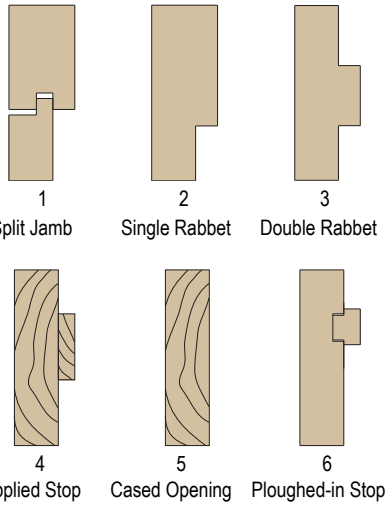


Figure: RG-090

FRAME JOINERY EXAMPLES:

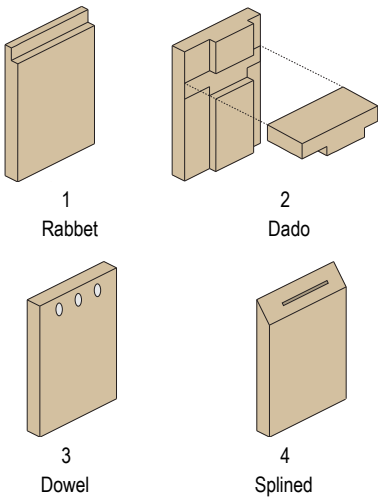
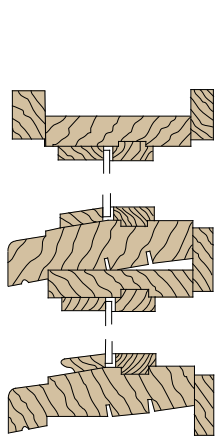


Figure: RG-091

LABELED (flame spread-rated) jamb assemblies are typically available in 20-, 45-, 60-, and 90-minute classifications of limited design / species; however, new designs / ratings are in ongoing development.

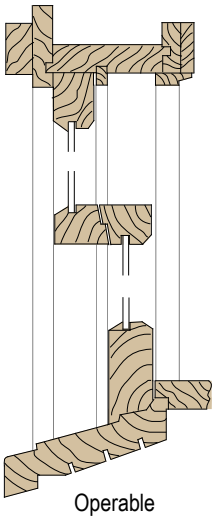
ONLY FIRMS RECOGNIZED BY APPLICABLE CODE OFFICIALS are authorized to label a frame assembly. If a label will be required by the applicable code officials, it is the obligation of the design professional to so specify, and the obligation of the manufacturer to assure a properly licensed assembly. These standards do not cover labeled frames.

WINDOW SASH and FRAME EXAMPLES



Fixed

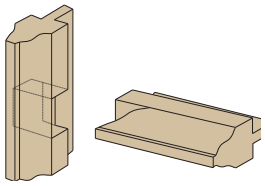
Figure: RG-092



Operable

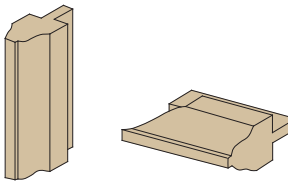
Figure: RG-093

SASH JOINERY EXAMPLES



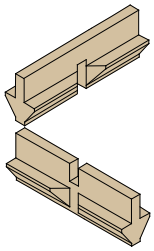
Coped and Mortised

Figure: RG-094



Coped and Nailed

Figure: RG-095



Half-Lapped

Figure: RG-096

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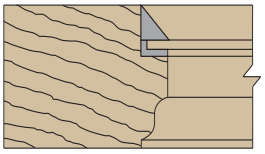
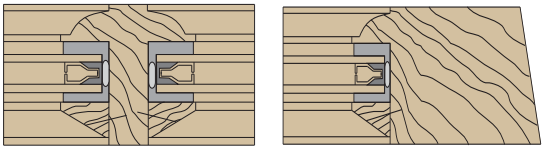
SUGGESTION

GLAZING EXAMPLES



Single Glaze

Figure: RG-097



Double Glazed

Figure: RG-098

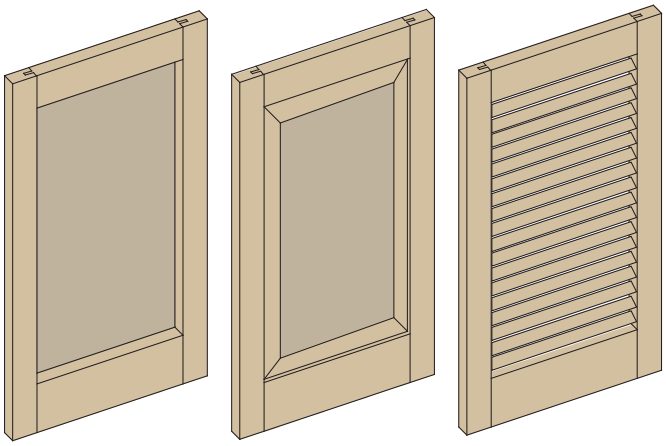
THERMAL INTEGRITY

Wood is a natural insulator that retains heat in winter without a thermal break, resists conductance of cold temperatures 2000 times better than aluminum and is approximately 30% more thermally efficient than comparable aluminum windows. Wood's minimal conduction keeps the inside wood surface of windows warm in the winter and cool in the summer. Wood windows are available in single-, double-, and triple-glazing systems, increasing thermal efficiency.

PERFORMANCE TESTING is applicable only to complete exterior window units and, if required, must be specified and may include all or part of ASTM E 283, Air Infiltration; E 330, Loading; and/or E 547, Water Penetration. ASTM tests must be specified for the current ASTM Grade Level, astm.org.

BLINDS and SHUTTERS

- **HARDWARE** must be specified, as it dictates the details of construction.
- **MANUFACTURER** does not typically supply, machine for, or install operating hardware, locking devices, pulls, lifts, etc.



Flat Panel | Raised Panel | Louvered

Figure: RG-099

SCREENS

- **HARDWARE** must be specified, as it dictates the details of construction.
- **MANUFACTURER** does not typically supply, machine for, or install operating hardware, locking devices, pulls, lifts, etc.

Typical bead detail examples:

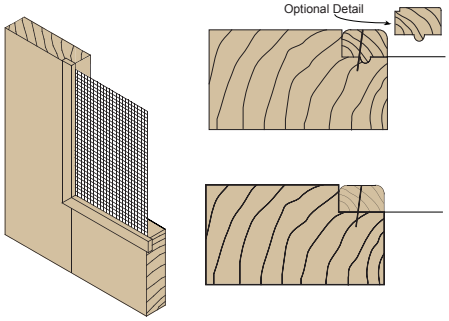


Figure: RG-100

MILLWORK (continued)

SUGGESTION

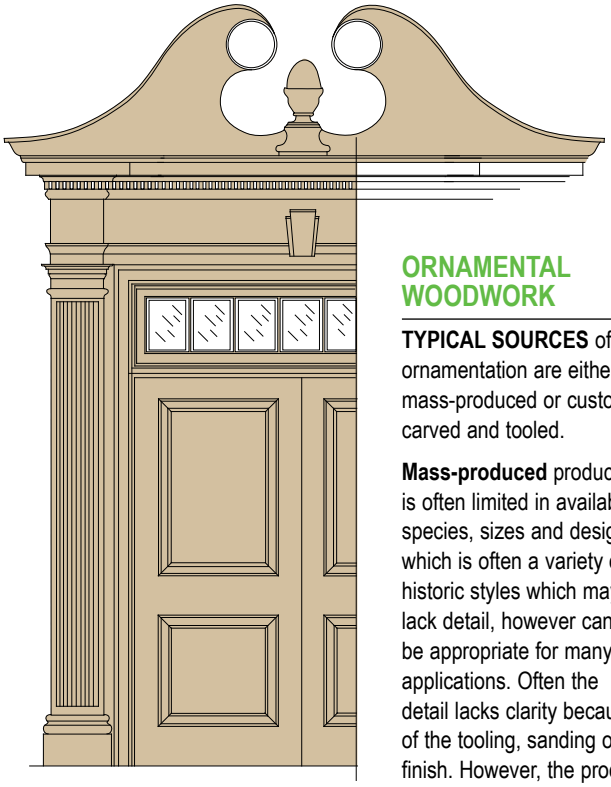


Figure: RG-101

ORNAMENTAL WOODWORK

TYPICAL SOURCES of wood ornamentation are either mass-produced or custom carved and tooled.

Mass-produced product is often limited in available species, sizes and design, which is often a variety of historic styles which may lack detail, however can be appropriate for many applications. Often the detail lacks clarity because of the tooling, sanding or finish. However, the product is relatively inexpensive, consistent in appearance and appropriate for many applications.

Custom carved or **Tooled** work has a special appearance, with depth and clarity or crispness that machine tooling often cannot achieve. Because it is done by a skilled artisan there will be slight irregularities, but this is deemed desirable as it lends character and credence to the work. Whether the surface is sanded smooth or the texture of tool marks is left, is one of the points of discussion between the architectural woodwork company and carver.

Hand tooled and carved work has a special appearance. It has a depth and clarity or crispness which machine tooling often cannot achieve.

There are a number of reasons to contact a custom carver, when:

- Pieces required are impractical or impossible to shape on conventional factory machinery. Examples are tapering profiles as in keystones, acute (interior) corners such as in Gothic tracery and compound curves as in stair handrails.
- Small quantities are specified which are impractical or too expensive to fabricate by computerized methods.
- There is a need to replicate missing (hand carved) elements for restoration or renovation.
- Elements of specified dimensions are required and unavailable otherwise.
- A particular wood species is required.
- Customized logos or lettering is desired.
- Patterns are required for casting in another material such as plaster, metal, or glass.
- Uniqueness is valued by the customer.

WORKING WITH AN ARTISAN - custom carvers usually works by themselves in a studio situation, but this does not necessarily indicate limitations either in quality, production time or fabrication capability. Work is typically done on a commission basis, so it is common to expect reasonable lead times. They will need to know (from the architectural woodwork specifier or customer):

- **Type of element** - molding, capital, bracket, etc.
- **Sizes** - drawings showing elevations and Sections are necessary for accurate cost estimates, whether provided by the architectural woodwork company or drawn by the carver. Often the carver will redraw computer-generated designs or ones not full sized.
- **Species** - of wood and who will supply the “blanks”. Finishes (paint grade, gilding, faux finish) should also be discussed.
- **Context** - and/or installed location should be made clear in order to understand lighting and the degree of detail necessary.
- **Schedule** - or completion date.
- **Budget** - if available as the carver can propose subtle changes in order to oblige a tight budget.

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SUGGESTION

ORNAMENTAL WOODWORK (continued)

A rudimentary explanation of some carving terms will assist the design professional in communicating with the custom carver:

Moldings have multiple uses but one important one is to visually set apart various elements. For instance, they are transitions between the parts of the entablature. They accentuate the trim (architrave) around doors and windows, and around an arch (archivolt). The various terms depend primarily on the profiles, but there are a few terms which indicate use, location or size.

The curving profiles are often separated or offset by a relatively small flat called a fillet.

The small half round is an astragal, often decorated with beads or bead and billet. A larger half round, usually associated with the base of a column or base of a structure is called a torus (plural tori) molding, sometimes decorated with ribbon bundled Bay Laurel, Oak leaves, or reeds.

The ovolo is a quarter ellipse (Greek) or quarter round (Roman) profile, most often carved with egg and dart design, but many other possibilities make it a very popular molding.

The cyma recta is a double curved molding with the concave curve on the outside of the molding, pointing toward the viewer as if reaching, outward. The cyma reversa is the opposite, the convexity nearer the viewer and seems to support or bolster the element to which it is attached. Both profiles are often carved with foliage, generically termed acanthus leaf. Both of these profiles as well as the ovolo often have the curved portion separated from the fillet by deep valleys or quirks.

Medieval moldings were often made of a number of closely placed profiles, often with deep hollows and repeated rounds.

Romanesque architecture continued many of the same principles of classical architecture, though much of the decoration; such as column capitals became more idiosyncratic and depicted the profusion of natural foliage. The innovation of the pointed arch (loosely called the Gothic arch), ubiquitous in Gothic architecture, allowed buildings to soar to great heights and to redistribute weight. This allowed larger windows and the lacy stonework termed tracery. The designs of this tracery are geometrically derived from, for the most part, overlapping and intersecting circles. The circular voids are called foils and the pointed intersections cusps; thus a three lobbed design is a trefoil, while one of four is a quatrefoil, one of five is a cinquefoil. Tracery was found incorporated into the woodwork of choir stalls, paneling and memorial structures.

Much decoration was derived from nature in depictions of vines and animals. Of course, religious figures and symbols were also a primary motif. Foliage climbing the edges of pinnacles and spires consists of the leaves, called crockets, and the terminating leaves, a finial or (especially on pew ends) poppyhead. Moldings were made of multiple profiles and combined with running vines and crestings, or stylized leaves. Square flowers and ballflowers were often spaced along moldings. At intersections of the ribbed vaults were bosses, which depict foliage (like a rosette), figures, or heraldic devises. The Glossary contains selected and partially illustrated terms related to ornament and architecture.

CARVER should provide skill and knowledge through experience. The majority of the cost may be in the labor. Carving is a unique product which adds immeasurably to the character and attractiveness of the overall project, and:

- Carving that closely resembles what is represented in drawings and verbal descriptions.
- Product that is cleanly carved without distracting irregularities and chips or fuzz in the recesses. The agreed upon surface treatment: sanded, tool textured, primed or gilded, etc. should be consistent throughout.
- Completion in a timely manner as agreed upon.
- Quality in artistic handwork which is often a subjective matter, but proper communication and agreement among parties should reduce variance of interpretation.

ARCHITECTURAL WOODWORKER should make reasonable efforts to provide as much information as possible as to design, and material. If providing blanks, effort should be made to fabricate them as accurately as possible. Material should be straight grained and contain a minimum of glue lines and therefore, grain directional changes. Consultation concerning what should be provided (sizes, species, special fabrication such as turning) with the carver is essential.

There are four methods of depicting a design in wood:

- **Incised**: Designs are simply made by shallow grooves in the surface of the material.
- **Relief**: Most architectural carving is carved in relief. The degree to which the design is lifted off the surface is described as low or high relief.
- **Pierced**: Some voids in the design are literally cut through the material and are termed pierced carvings.
- **Sculpture**: Carving in-the-round or sculptural works are incorporated into architectural surroundings.

ORNAMENTAL WOODWORK (continued)

Unless required by the details and/or woodwork specifications, the manufacturer does not typically:

- **Provide** or **Prepare for** electrical, telephone, mechanical, or plumbing equipment;
- **Install** woodwork or furnish common in wall blocking, furring or hanging devices for the support or attachment of the woodwork;
- **Supply** exposed materials other than wood or HPL;
- **Factory finish**; or
- **Supply** "stock" or specialty products. If they are to be supplied, they must be specified by a brand name or material supplier.

ORNAMENTAL WOODWORK can be considered any addition to the purely functional and may partly rely on context for its aesthetic appeal. Among various definitions, the one pertinent here is: "Something that lends grace or beauty; a manner or quality that adorns." Ornamentation is defined as a decorative device or embellishment. A good example is the molding which can have functional uses such as covering joints, or with a profile, can be a design element. The profile can be further embellished or enriched by decorative carving.

Architectural carving combines the flat surfaces and clearly defined lines of geometry with the interpretive modeling of naturalistic forms.

Historic preservation, conservation and restoration disciplines are extensions of ornamental woodwork. Aspects of this work include, but are not limited to, stripping, repair, reconstruction, reuse of historic material, addition of new material, and special documentation for the work.

The United States Department of the Interior (doi.gov/), the National Park Service (nps.gov/), and the Historic Sites and Monuments Board of Canada (parkscanada.gc.ca) publish documents related to work under their jurisdiction. The most recent publications from these entities will provide valuable information for the design professional and the woodwork fabrication, finishing, and installation.

There are a number of related arts which are incorporated into wood constructions, such as stained glass, ceramic tiles, mosaic, fabric, plaster or composition ornament, faux finishes, metal hardware and stone inlays.

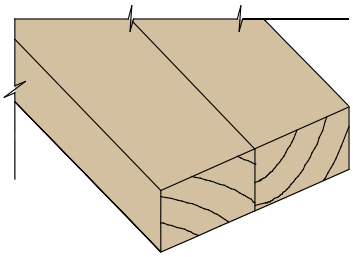
Excludes standing and running trim except as incorporated as integral parts of elements.

FIRE-RETARDANT SOLID LUMBER

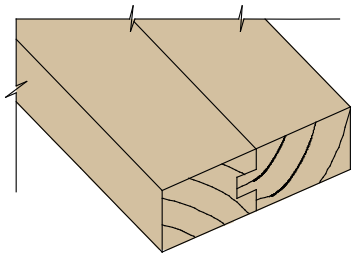
Fire Retardant treatments may affect the finishes intended to be used on the wood, particularly if transparent finishes are planned. The compatibility of finishes should be tested before they are applied.

SUGGESTION

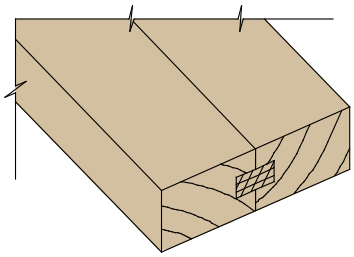
JOINERY DETAILS



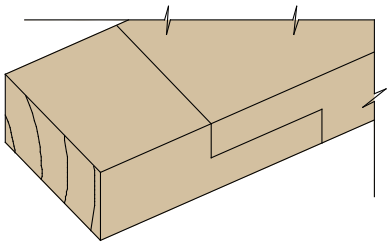
Butt Joint
Figure: RG-102



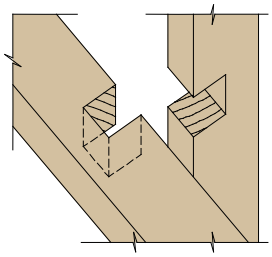
Tongue & Groove Joint
Figure: RG-103



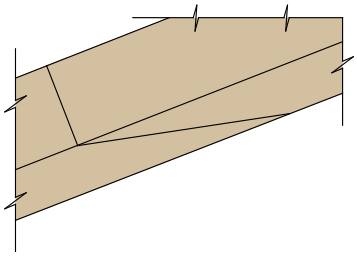
Spline Joint
Figure: RG-104



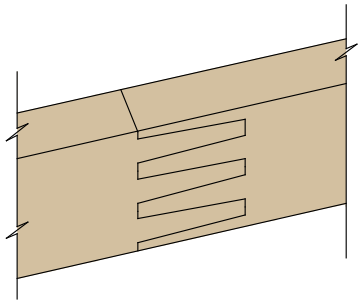
Half Lap Joint
Figure: RG-105



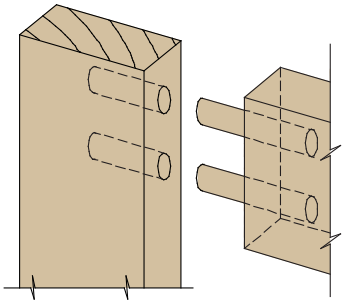
Half Lap Joint
Figure: RG-106



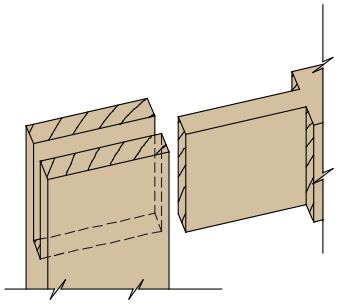
Scarf Joint
Figure: RG-107



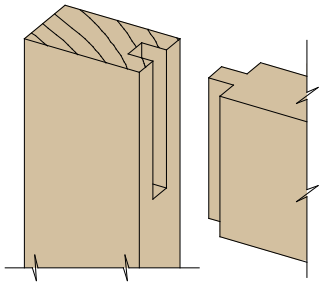
Finger Joint
Figure: RG-108



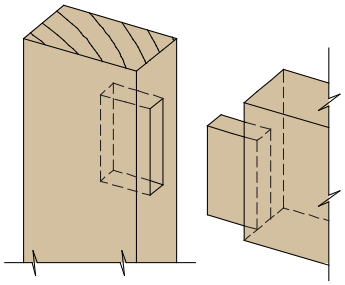
Doweled Joint
Figure: RG-109



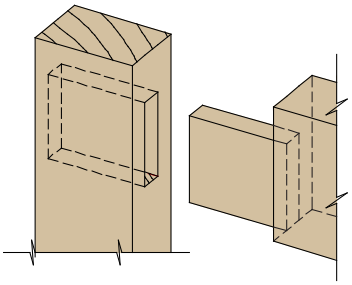
Slotted Mortise & Tenon (Bridle) Joint
Figure: RG-110



Stub Mortise & Tenon Joint
Figure: RG-111

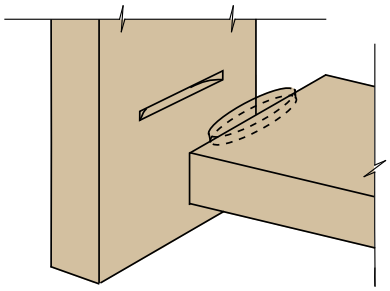


Blind Mortise & Tenon Joint
Figure: RG-112

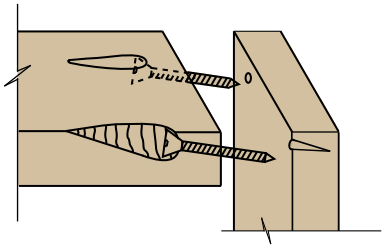


Through Mortise & Tenon Joint
Figure: RG-113

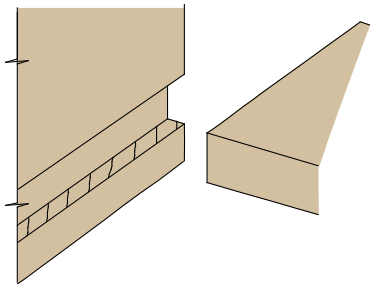
JOINERY DETAILS (continued)



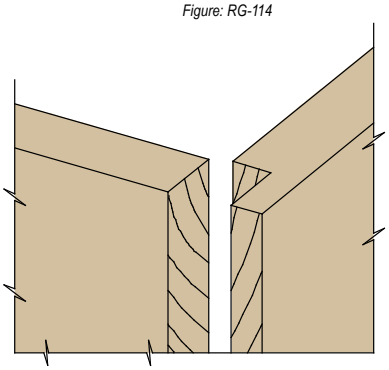
Biscuit Spline Joint
Figure: RG-114



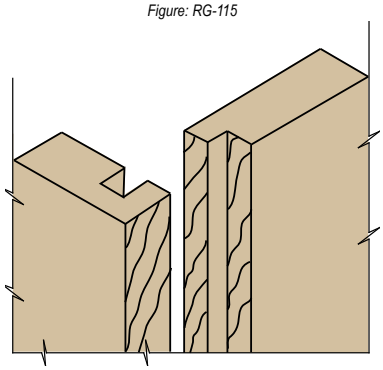
Pocket Screw Joint
Figure: RG-115



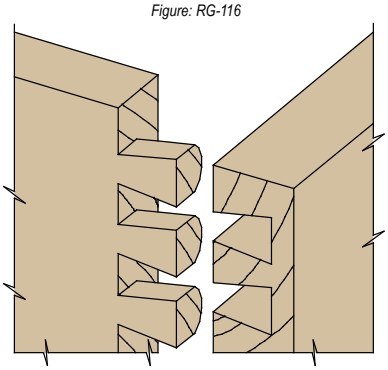
Plowed In Joint
Figure: RG-116



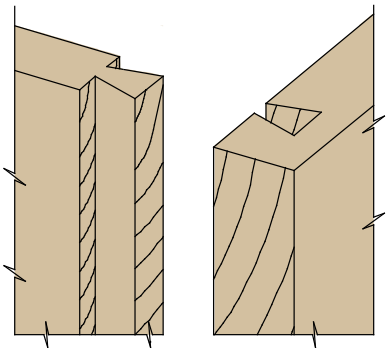
Rabbet Joint
Figure: RG-117



Lock Shoulder Joint
Figure: RG-118

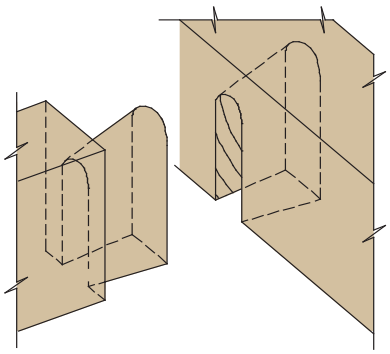


Dovetail Joint
Figure: RG-119

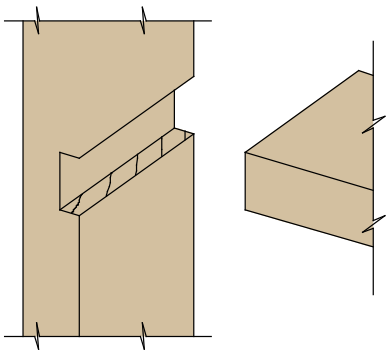


Dovetail (French) Dado Joint
Figure: RG-120

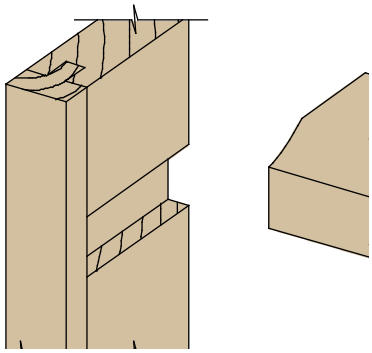
JOINERY DETAILS (continued)



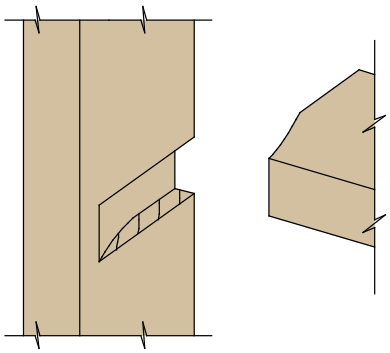
Blind Dovetail Joint
Figure: RG-121



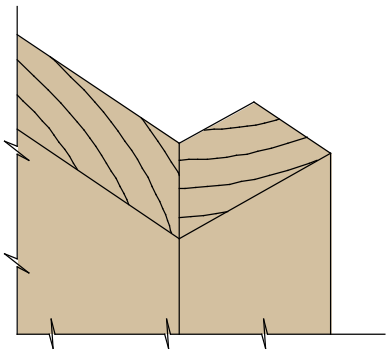
Dado Joint
Figure: RG-122



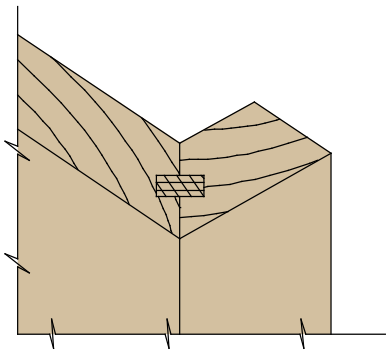
Dado, Blind Or Stopped Joint
Figure: RG-123



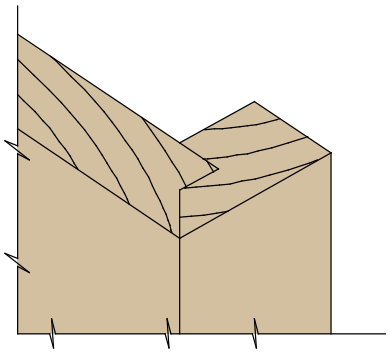
Dado, Blind Or Stopped Joint
Figure: RG-124



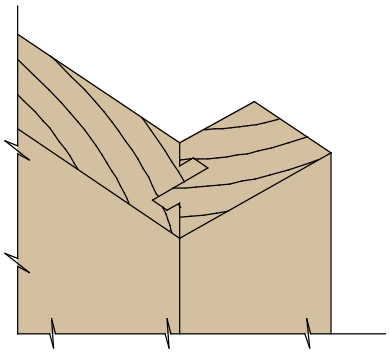
Miter Joint
Figure: RG-125



Splined Miter Joint
Figure: RG-1126



Shoulder Miter Joint
Figure: RG-127



Lock Miter Joint
Figure: RG-128

SUGGESTION

INTRODUCTION

Section 07 includes information on wood stairs, integral trim, handrails, and guardrails and their related parts.

DESIGN SUMMARY

This short summary is a collection of options and illustrations about the challenges of designing and building safe stairs. This Standard cannot and does not offer this data as advice on code compliance. Safe stairs and design and engineering to meet local codes remains the responsibility of the design professional.

CRITICAL STEPS IN STAIR DESIGN:

- Check local code.
- Consult with an experienced stair builder to double check your geometry.
- Pre clear your stair design with the local building officials.

CUSTOM DESIGNED STAIRS OFFER:

- **Design flexibility:** The use of custom designed stairs in a building allows the design professional freedom of expression while meeting the functional needs of the client.

  Since custom woodwork is normally produced by a specialty architectural woodwork firm, dimensions can easily be changed prior to actual fabrication, if required by job conditions. Special situations such as designing for the disabled can readily be accommodated by the custom architectural woodwork manufacturer.
- **Cost effective:** Custom woodwork competes favorably with mass produced architectural woodwork and offers practically limitless variations of design and material. Most woodwork lasts the life of the building, quality counts.
- **No restrictions:** Custom architectural woodwork permits complete freedom of selection of the numerous hardwoods and softwoods available for transparent or opaque finish. Other unique materials available from woodwork manufacturers require no further finishing at all, such as HPL and TFL. These materials can be fashioned into a wide variety of profiles, sizes, and configurations. The design professional has the best of both worlds, high quality and freedom of choice.

RUN and RISE DIMENSION POINTS

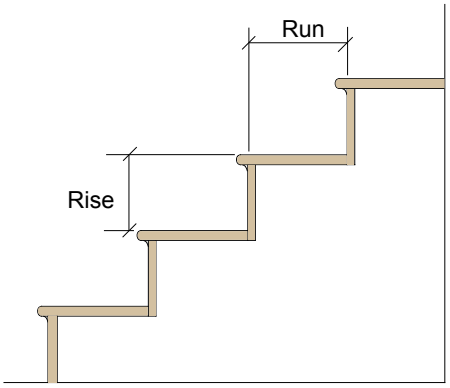


Figure: RG-129

TYPICAL STAIR RUNS

- **STRAIGHT**

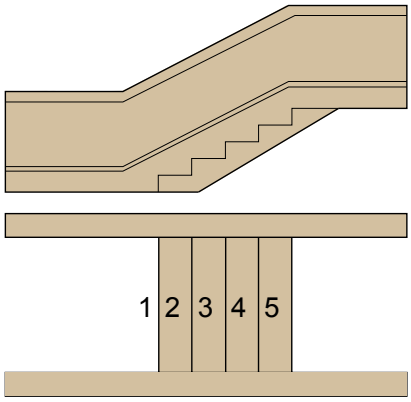


Figure: RG-130

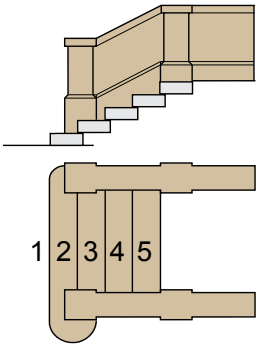


Figure: RG-131

STAIRWORK & RAILS (continued)

TYPICAL STAIR RUNS (continued)

- **TURNING**

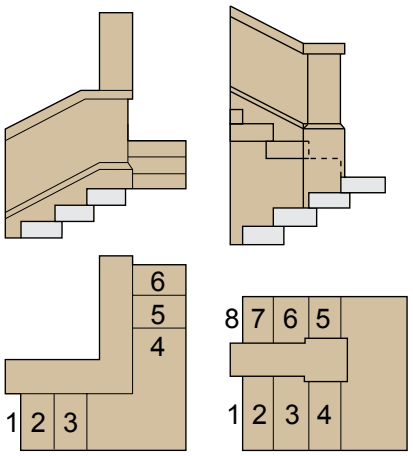


Figure: RG-132

- **WINDING**

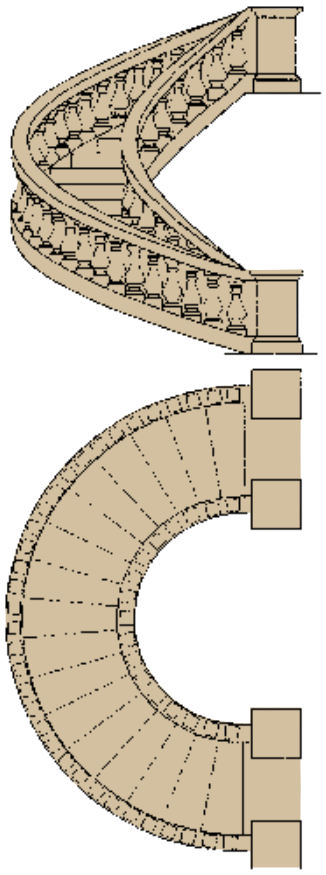


Figure: RG-133

STAIR and HANDRAIL / GUARDRAIL NOMENCLATURE

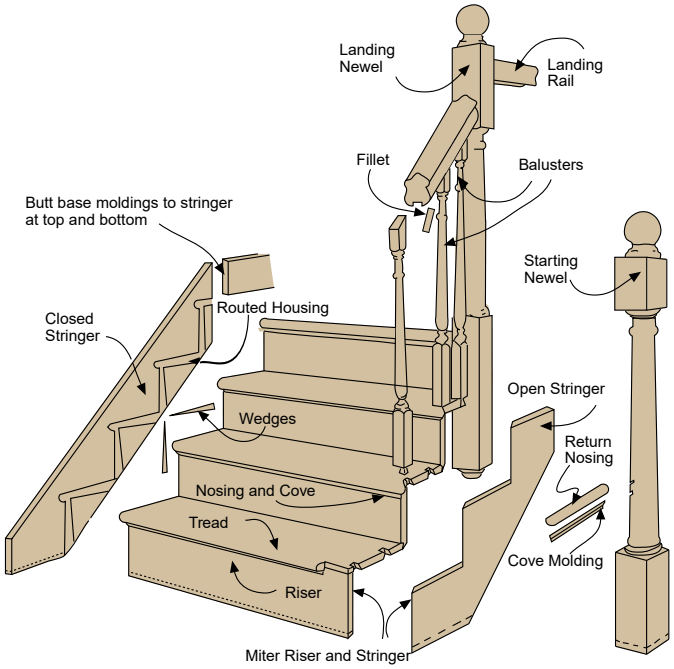


Figure: RG-134

SUGGESTION

HANDRAIL / GUARDRAIL COMPONENT NOMENCLATURE

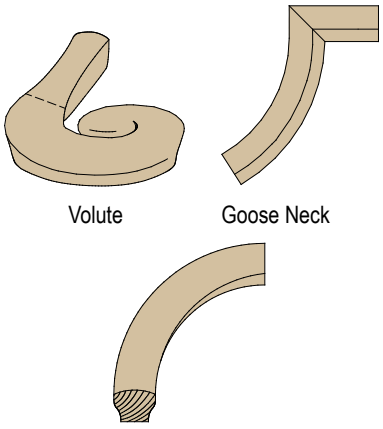


Figure: RG-135

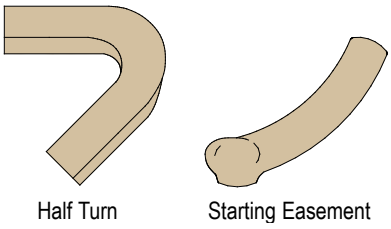


Figure: RG-136

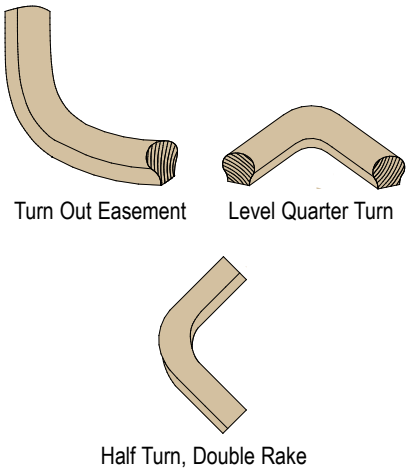


Figure: RG-137

HANDRAIL / GUARDRAIL FABRICATION

Large dimension rail fabrication techniques are typically the option of the manufacturer. Lamination on a radius depends on many factors:

Typical lamination orientations:

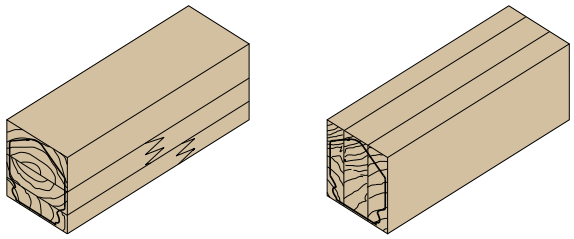


Figure: RG-138

HANDRAIL / GUARDRAIL JOINERY

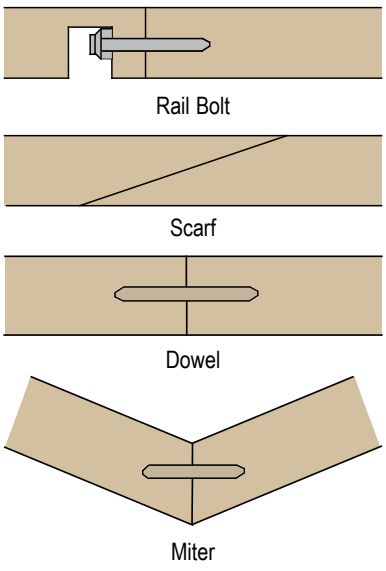


Figure: RG-139

GUARD / HANDRAIL ILLUSTRATIONS may not be compliant with current or applicable codes.

North American Architectural Woodwork Standards 4.0, Effective September 01, 2021, ©2021 AWMAC | Woodwork Institute, as updated by ERRATA through December 01, 2021 and may be furthe updated by errata at naaws.com

WALL / CEILING SURFACING & PARTITIONS

SUGGESTION

INTRODUCTION

Section 8 includes information on wood veneer, solid wood, stile and rail wood, decorative laminate, Solid Surface, CGS (Compact Laminate) and factory-built framing for wall, ceiling and partition surfacing.

MATERIAL SELECTIONS

OPAQUE finishes:

- **Medium Density Fiberboard (MDF)** is suggested for cost savings and an optimum paintable surface.
- **Medium Density Overlay (MDO),** which may be machined and detailed with little loss of quality surface characteristics, requires a seal coat prior to application of finish coats with no sheen limitation providing a paintable surface for panels. The thermosetting resin overlay is designed to take and hold paint. Opaque finish sheens above 40 Satin require special finishing procedures.
- **Close Grain Hardwood** - Although allowed, extra preparation may be required by the finisher as there may be grain show-through, split veneer joints, and other wood characteristics.
- **Manufacturers' option** - Face materials are determined by the manufacturer.

TRANSPARENT finishes:

- **Selection** starts by looking at "hand samples," pieces of veneer or lumber representing a particular species, but not necessarily a particular tree or log.
- **Wood** is a natural material (unlike a manufactured product), which varies from tree to tree in its color and texture. Rather than simply choosing an appropriate wood for its color, consider the size and availability of the species.
- **Species** that grows in smaller diameter, with shorter logs, lends itself to furniture and smaller projects, whereas an abundant species that grows in large diameter lends itself more to larger public spaces. Many projects have run into difficulties because the species availability was not compatible with the project's needs.

SOLID SURFACING:

- Solid surface panel products are a durable, non-porous solution for wall surfacing offering impact and scuff resistance, ease of cleaning, and homogenous appearance. However, many solid surfaces offer random patterns and veining that mimic stone or other materials. In many cases, such materials cannot be pattern matched to the degree HPL or wood veneer can, and care must be exercised when specifying such products. Material Supplier's recommendations and documentation will govern over maximum sizes, joint and seam locations and sizes; allowable mismatch, and installation requirements.

VARIATIONS in NATURAL WOOD PRODUCTS

Wood is a natural material, with variations in color, texture, and figure. These variations are influenced by the natural growing process and are uncontrollable by the manufacturer. The color of wood within a tree varies between the "sapwood" (the outer layers of the tree which continue to transport sap), which is usually lighter in color than the "heartwood" (the inner layers in which the cells have become filled with natural deposits). Various species produce different grain patterns (figures), which influence the selection process. There will be variations of grain patterns within selected species. The architectural woodwork manufacturer cannot select solid lumber cuttings within a species by grain and color in the same manner in which veneers may be selected. Color, texture, and grain variations will occur in architectural woodworking.

WALL / CEILING SURFACING & PARTITIONS (continued)

SUGGESTION

FLITCH SELECTION

The design professional may choose to see samples of veneer flitches to evaluate color and grain characteristics for other than pre-manufactured sets. This must be specified. Unless specified, layup is determined by the manufacturer.

When it is determined that the use of pre-manufactured panel sets is not adequate for the scope of the project, then selecting specific veneer flitches is an option to consider.

When sliced from a log, the individual pieces of veneer are referred to as leaves. These leaves are kept in order as they are sliced and then dried. As the leaves come out of the dryer, the log is literally reassembled. This sliced, dried and reassembled log or partial log is called a flitch. The flitch is given a number and the gross square footage of the flitch is tallied.

To select specific veneer flitches for a project:

- Determine the net square footage of face veneer required for the project. This should include paneling, casework, built-in furniture, and flush doors items when specifying a blueprint sequenced project.
- Multiply the net square footage times three (this is the average ratio. Some species require a higher multiplier).

  Example: 5,000 (net square feet) x 3 = 15,000 square feet; this is the gross square footage that should be sampled for this project.

  While this may sound like a daunting quantity of veneer to look through, there is an established process that simplifies the task. When a numbered flitch is sampled, typically, three leaves of veneer are removed from the flitch and numbered sequentially. Starting from the top of the flitch, a leaf is removed from one-quarter of the way down, then from one-half, and from three quarters in the flitch. These three sequentially numbered leaves of veneer form a representative sample of that flitch.
- Since it will take at least 6 flitches, with a gross square footage of 2,500 square feet each to meet the project needs, give careful consideration to the following key criteria:
  - **Length** - Is the length adequate for the requirements? The flitch needs to be at least 6" (152 mm) longer than the panel requirements.
  - **Width** - What will the net yield for width be from each flitch?
  - **Gross square footage of each flitch** - total yield must be 15,000 square feet.
  - **Color and grain compatibility** - While exact matching is not possible, from flitch to flitch, this is the opportunity to select the range of color and grain compatibility that will enhance the visual continuity of the entire project.

    The reality of this process is that the square footage of individual flitches of veneer will probably range from 1,200 square feet up to 3,000 square feet. This means that one may end up selecting 9 or 10 flitches, instead of just 6. But the goal remains the same as in the example: selecting flitches that will satisfy the aesthetic needs, while fulfilling the face veneer requirements for the project.

    It is recommended that specifications be written with the foregoing objective in mind. Then, when the project has been awarded to a qualified manufacturer, talk directly to the manufacturer and be involved in one of the most exciting aspects of bringing the design concepts to reality.

FINISHING

Site conditions and air quality regulations for finishing are rarely conducive to good results. Poor lighting, dust-laden air, and techniques available are limiting factors. Depending upon local practice, many manufacturers will factory finish, yielding better results than can be achieved from field finishing. Unless specified in the Contract Documents, the manufacturer is not responsible for the appearance of field finished panels or doors.

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WALL / CEILING SURFACING & PARTITIONS (continued)

STANDING and RUNNING TRIM

Site-applied cornice, chair rail, base, trim, and moldings are governed by the areas of NAAWS covering Standing and Running Trim.

SMOOTHNESS of FLAT and MOLDED SURFACES

- **Planers and Molders:** The smoothness of surfaces that have been machine planed or molded is determined by the closeness of the knife cuts. The closer the cuts to each other (i.e., the more knife cuts per inch [KCPI]), the closer the ridges, and therefore the smoother the resulting appearance.
- **Sanding and Abrasives:** Surfaces can be further smoothed by sanding. Sandpapers come in grits from coarse to fine and are assigned ascending grit numbers. The coarser the grit, the faster the stock removal. The surface will show the striations caused by the grit. Sanding with finer grit papers will produce smoother surfaces.

FIRE RETARDANCE and TREATMENT

The natural fire-retardant qualities and acceptability of treatments vary among the species. Where certain items of architectural woodwork are required to have a flame spread classification to meet applicable building and safety codes, the choice of lumber species must be a consideration. Additional data on various species may be available from U.S. Department of Agriculture Forest Service, usda.gov, Fire Safety of Wood Products Work Unit at (608) 231-9265.

- **Flame Spread Classification:** This is the generally accepted measurement for flame spread rating of materials. It compares the rate of flame spread on a particular species with the rate of flame spread on untreated Oak. Most authorities accept the following classes for flame spread:
  - Class A 0-25
  - Class B 26-75
  - Class C 76-200
- **Fire Retardant Treatments:** Some species may be treated with chemicals to reduce flammability and retard the spread of flame over the surface. This usually involves impregnating the wood, under pressure, with salts suspended in a liquid. The treated wood must be re-dried prior to fabrication. Consult with a material supplier about the appearance and availability of treated woods prior to specification.

  The sizes and species currently being treated (flame spread less than 25), are very limited, and not available in all markets. Fire-retardant treatment does affect the color and finishing characteristics of the wood.

  Subject to the authority having jurisdiction, untreated wood and wood products may be used. The location and quantity to be determined by the design professional.
- **Intumescent Coatings for Wood:** It is possible to reduce flammability by using intumescent coatings in either opaque or transparent finishes. These are formulated to expand or foam when exposed to high heat and create an insulating effect that reduces the speed of spread of flame. Improvements are continually being made on these coatings. Consequently, the specifier must ascertain whether they will be permitted under the code governing the project, the relative durability of the finish, and the effect of the coating on the desired color of the finished product.
- **Finishing Of Fire Retardant Treated Lumber:** Fire-retardant treatments may affect the finishes intended to be used on the wood, particularly if transparent finishes are planned. The compatibility of finishes should be tested before they are applied.

WALL / CEILING SURFACING & PARTITIONS (continued)

FIRE RETARDANT PANEL PRODUCTS

- **Core** - The flame spread rating of the core material determines the rating of the assembled panel. Fire-retardant veneered panels must have a fire-retardant core. Particleboard core is available with a Class A rating. Veneer core and MDF (Medium Density Fiberboard) cores are available with a flame spread rating in some markets.
- **Face** - The International Codes, except where locally amended, provide that facing materials less than 0.036" (0.9 mm) or thinner and applied directly to the surface of the walls or ceilings are not required to be tested.

  If a Class A panel assembly is specified with a decorative laminate face, the decorative laminate and the laminate balancing sheet must be applied to a Class A core material, with the laminate material supplier's recommended adhesive. It is the responsibility of the specifier to indicate what flame spread rating, if any, is required for the paneling. In the absence of such a specified rating, the manufacturer shall supply un-rated paneling.

INSTALLATION

The methods and skill involved in the installation of paneling and doors in large measure determine the final appearance of the project. The design, detailing, and fabrication should be directed toward achieving installation with a minimum of exposed face fastening. The use of interlocking wood cleats or metal hanging clips combined with accurate furring and shimming will accomplish this. Such hanging of panels has the additional advantage of permitting panel movement that results from humidity changes or building movement. Depending upon local practice, many manufacturers will perform the wall preparation and installation of the paneling and related doors.

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SUGGESTION

PANEL SEQUENCING

- **Running Match** (cannot be end matched) - Each panel face is assembled from as many veneer leaves as necessary. This often results in a non-symmetrical appearance, with some veneer leaves of unequal width. Often the most economical method at the expense of aesthetics.

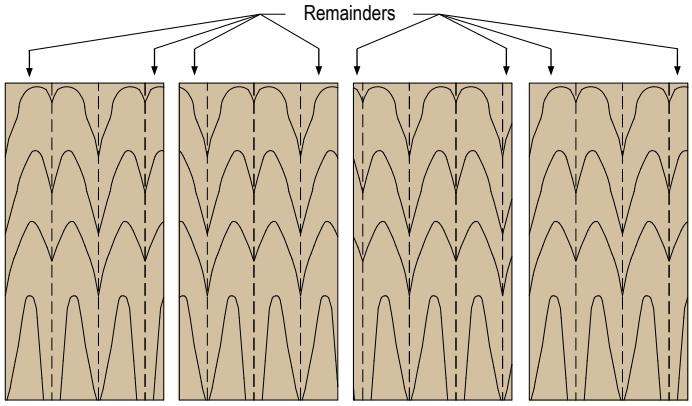


Figure: RG-140

- **Balance Match** - Each panel face is assembled from veneer leaves of uniform width before edge trimming. Panels may contain an even (balance and center) or odd (balanced) number of leaves and may change from panel to panel within a sequenced set.

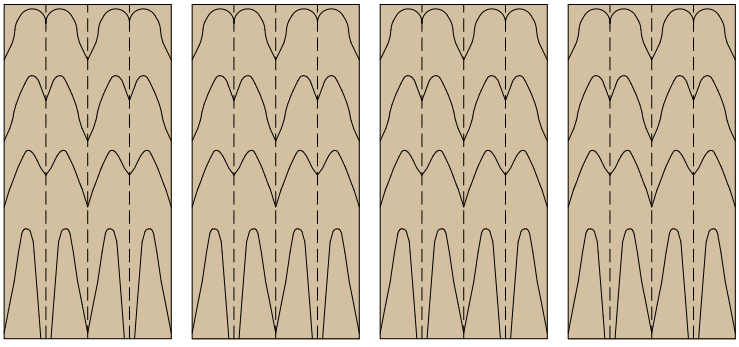


Figure: RG-141

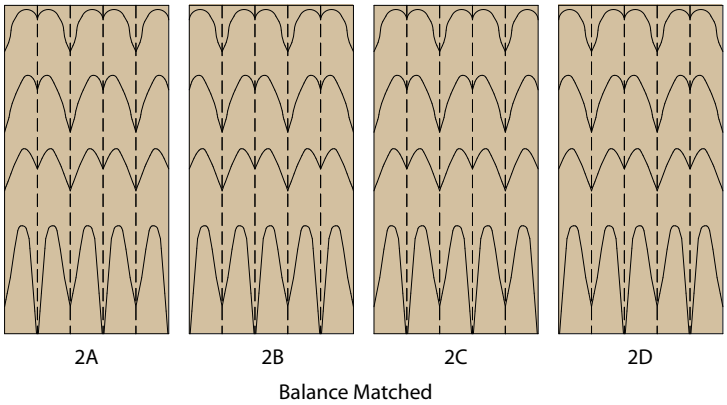
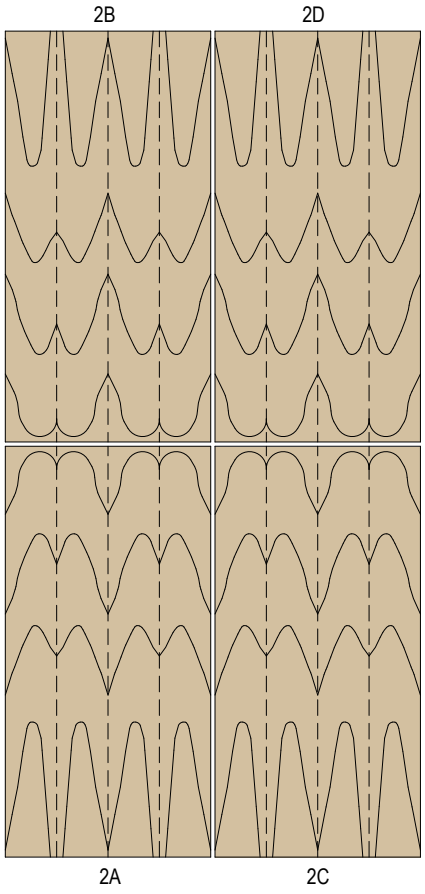


Figure: RG-142

SUGGESTION

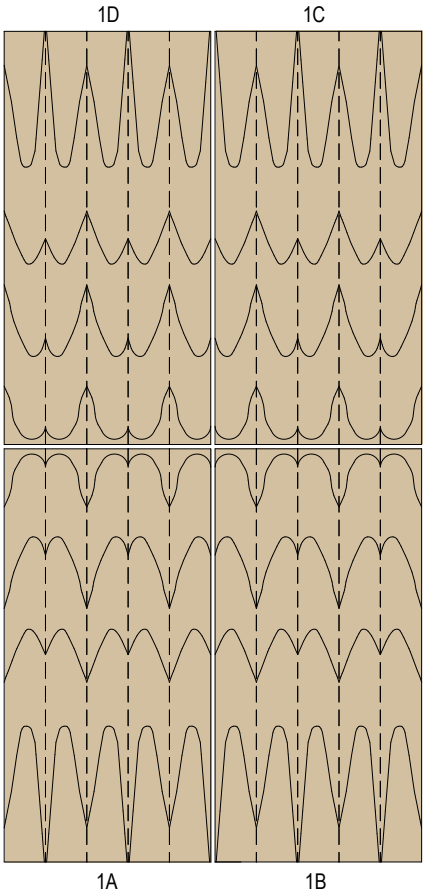
SEQUENCING of PANELS WITHIN A ROOM

- **Balanced End Match**



Balance and Center Matched,
Requires Multiple of 2

Figure: RG-143



Balance Matched,
Requires Multiple of 4

Figure: RG-144

SEQUENCING of PANELS WITHIN A ROOM:

Selections include: no sequence, pre-manufactured sets - full width, pre-manufactured sets - selectively reduced in width (equally sized), sequenced uniform size set(s), or blueprint sequenced panels and components. Although many panel distributors maintain a panel inventory of pre-manufactured sets of different species and grades, only a limited quantity of species, cut and grades will be available.

Sequenced custom sized and blueprint sequenced panels offer variables of veneer leaf match and panel width, therefore pre-manufactured sets shall not be used for sequenced custom sized and blueprint sequenced panels.

Sequenced panels and examples of their room layout are as follows:

SUGGESTION

SEQUENCING of PANELS WITHIN A ROOM (continued)

- **PRE-MANUFACTURED SEQUENCED SETS**

Full width utilization is composed of a specific quantity of sequenced and numbered panels based on a per room basis for net footage selected from available inventory. They are usually only available in 48" x 96" or 120" (1220 mm x 2440 mm or 3048 mm) sheets in sets varying from 06-12 panels. If more than one set is required, sequencing between sets cannot be expected. Similarly, doors or components cannot be fabricated from the same set.

- **FULL WIDTH PANEL UTILIZATION** with running matched panels.

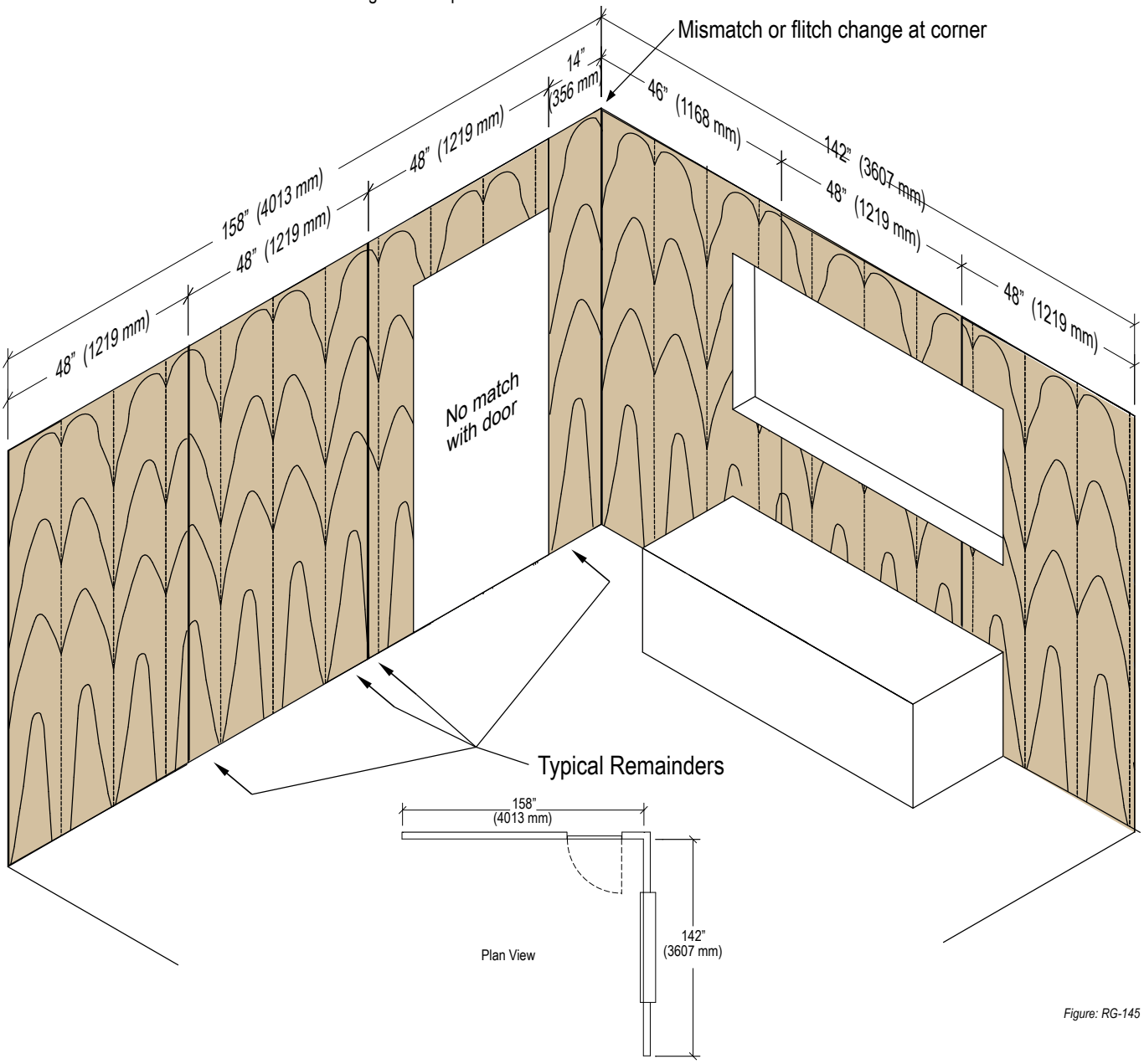


Figure: RG-145

SUGGESTION

SEQUENCING of PANELS WITHIN A ROOM (continued)

- **PRE-MANUFACTURED SEQUENCED SETS** (continued)
  - **FULL WIDTH PANEL UTILIZATION** with balanced matched panels.

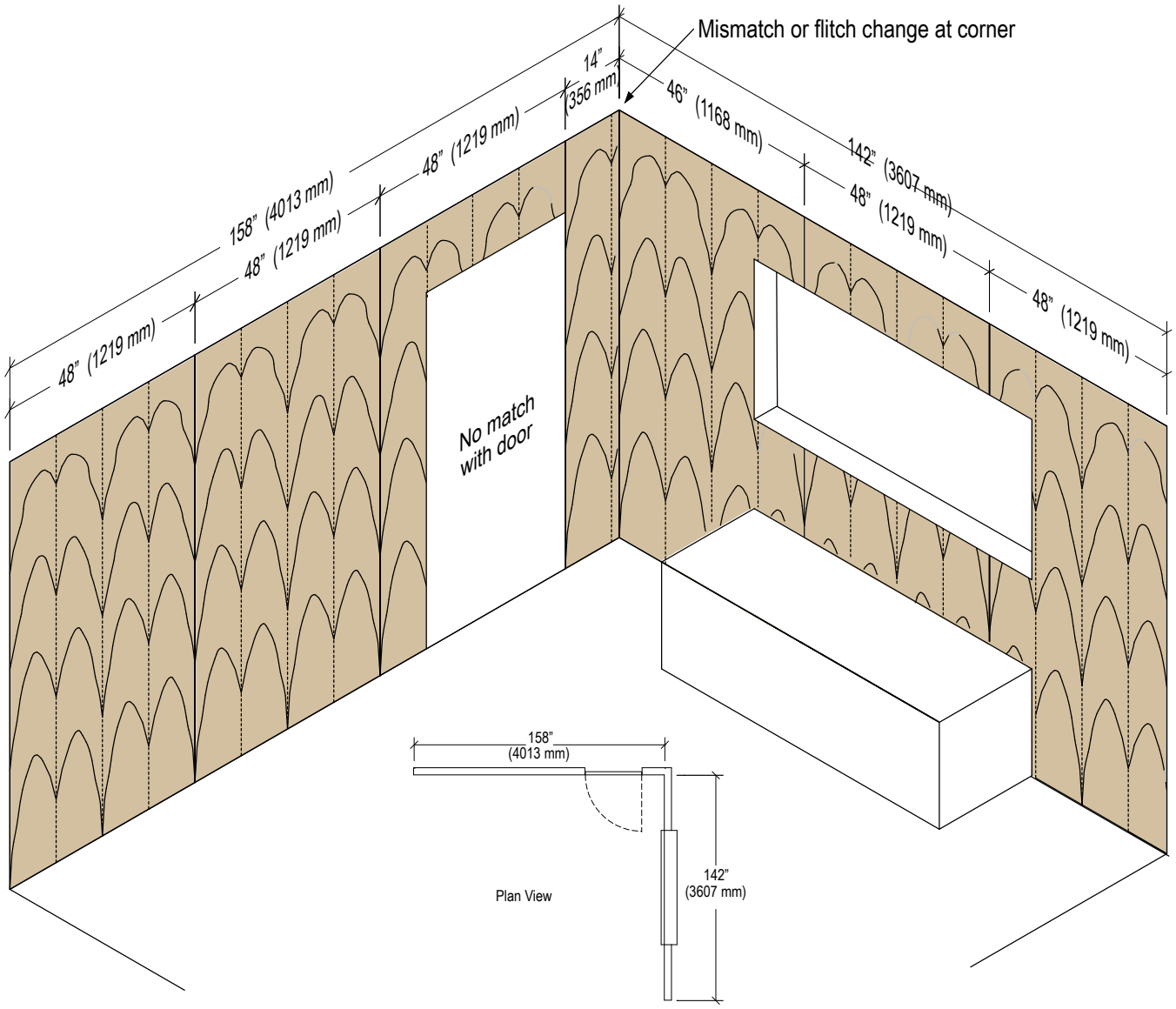


Figure: RG-146

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SUGGESTION

SEQUENCING of PANELS WITHIN A ROOM (continued)

- **PRE-MANUFACTURED SEQUENCED SETS** (continued)
  - **SELECTIVELY REDUCED PANEL UTILIZATION** with balanced matched panels.

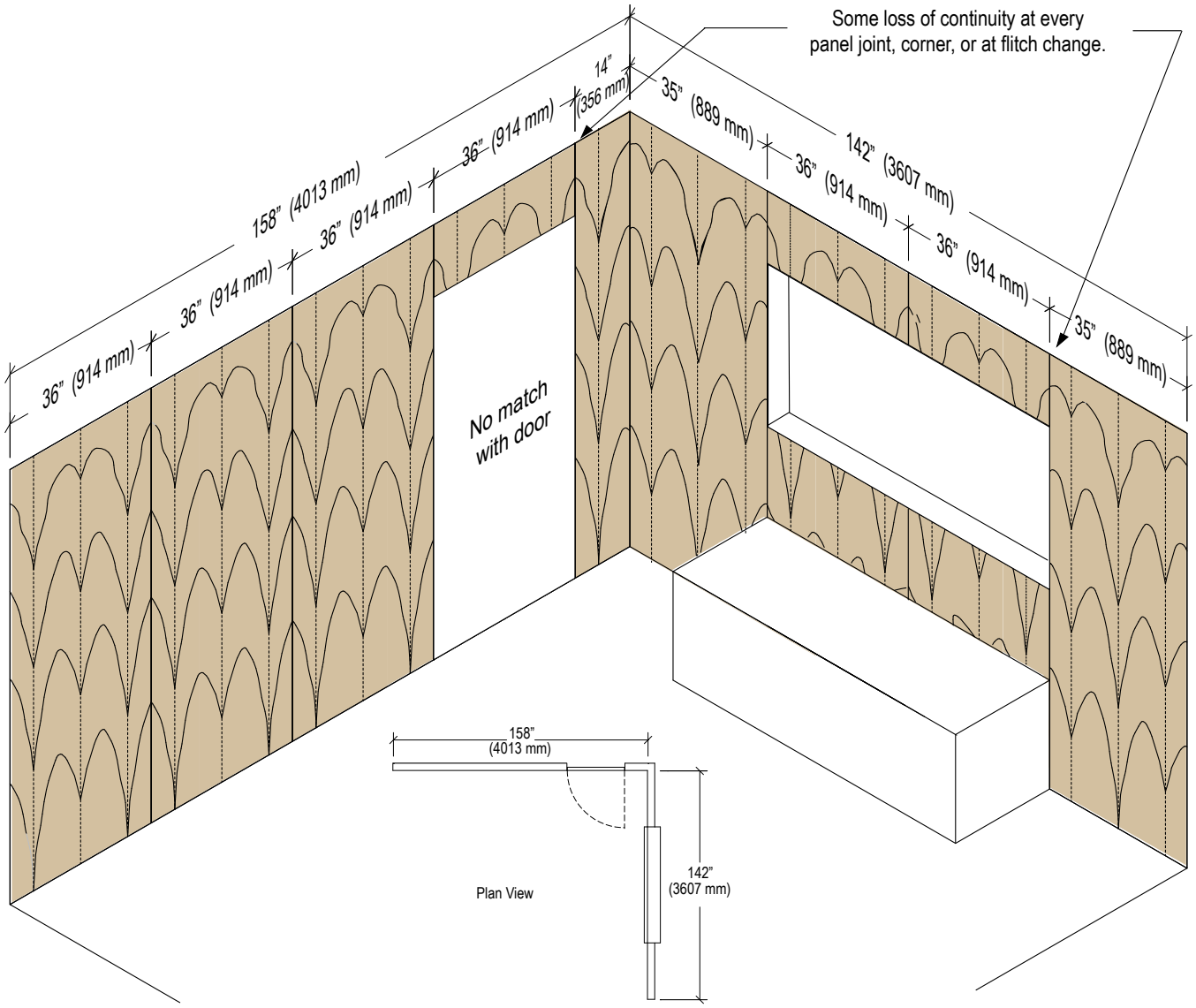

Figure: RG-147

SUGGESTION

SEQUENCING of PANELS WITHIN A ROOM (continued)

- **MADE TO ORDER SEQUENCED SETS** (must be specified). Balance matched or balance and center matched panels are manufactured to exact sizes based on the project's net footage and height requirements.

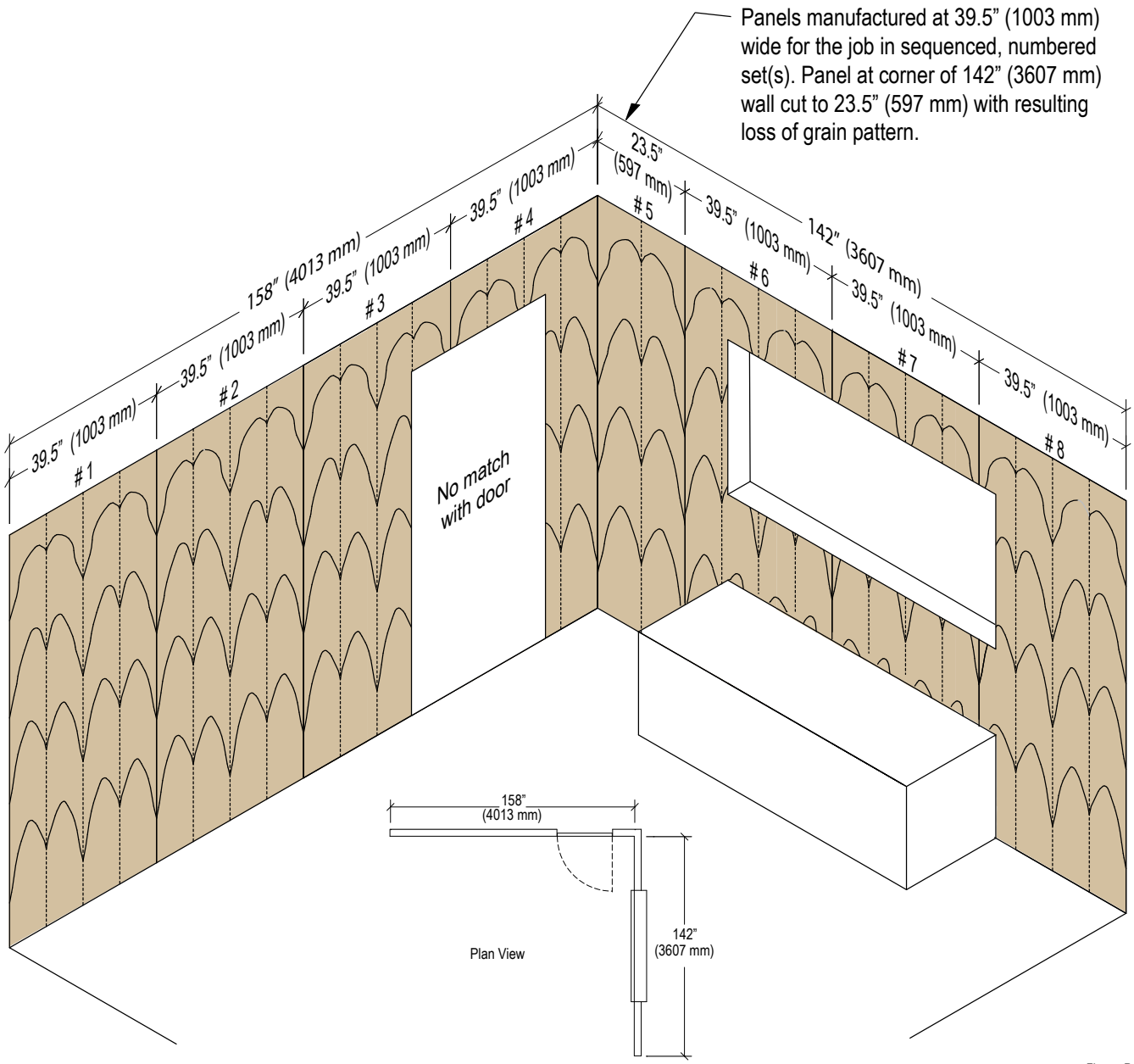

Figure: RG-148

WALL / CEILING SURFACING & PARTITIONS (continued)

SEQUENCING of PANELS WITHIN A ROOM (continued)

- **MADE TO ORDER SEQUENCED BLUEPRINT SETS** and **COMPONENTS** (must be specified). Balance matched and balance and center matched panels are manufactured to the exact sizes the manufacturer determines from the contract drawings, clipping and matching each individual face to the project's specific needs. Each face will be in sequence with adjacent panels, doors, transoms, and cabinet faces as needed for continuity.
- Components such as doors, windows, openings and cabinets plus overall room dimensions are the variables that determine panel width. Either balance and/or balance and center matched panels may be used in conjunction with one another to achieve a blueprint sequence. Therefore, grain continuity is maximized, which enhances the overall aesthetics.

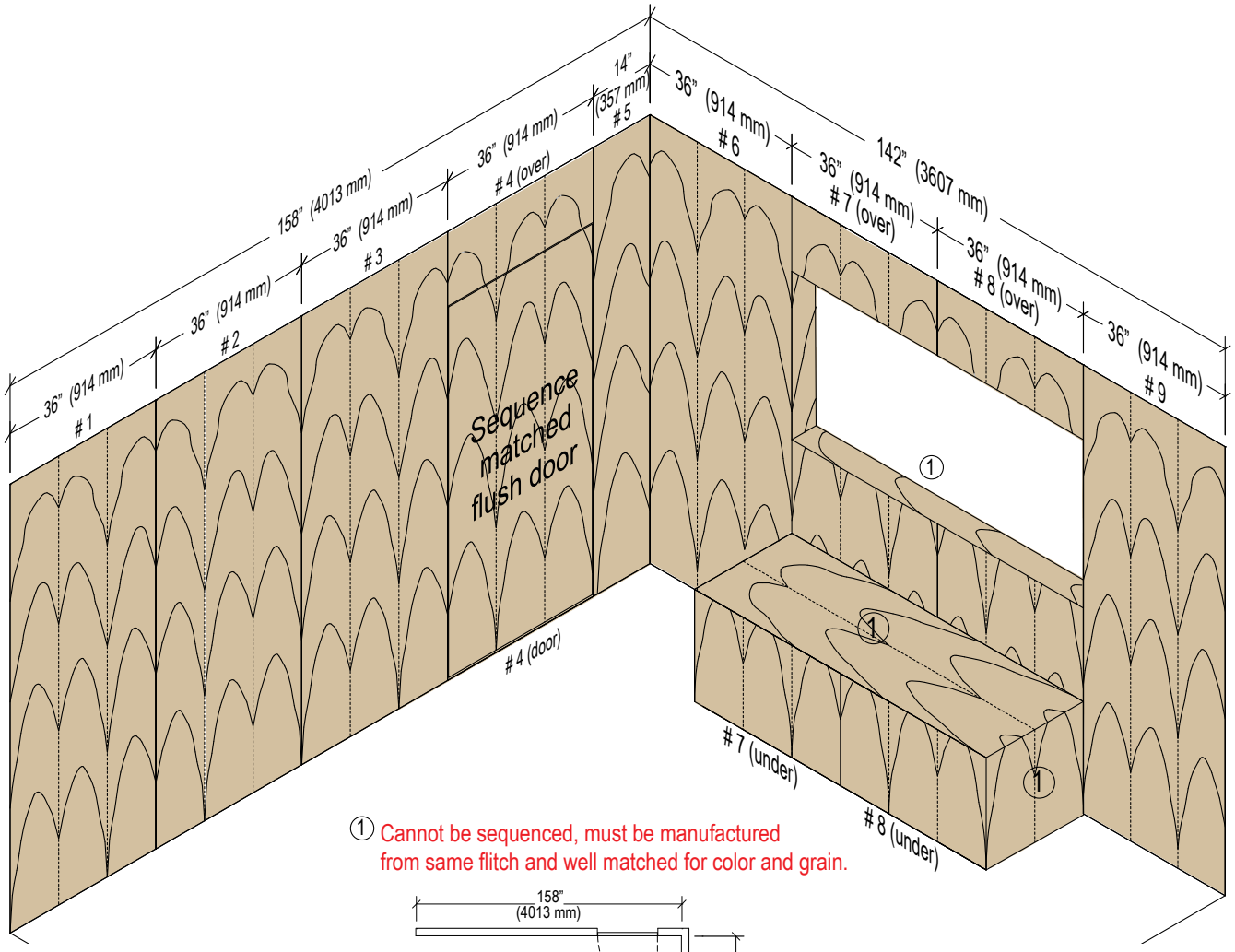

Figure: RG-149

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WALL / CEILING SURFACING & PARTITIONS (continued)

EDGEBANDING EXAMPLES

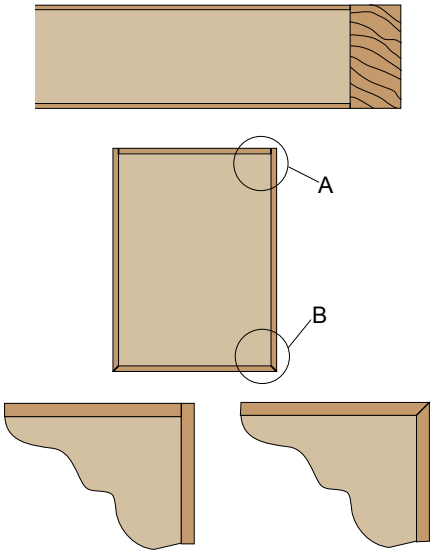
Veneer edgebanded

Figure: RG-150

Inset Solid Wood edgebanding

Figure: RG-151

Applied Solid Wood with corner joint options



A - Lapped B - Mitered

Figure: RG-152

For durability, the bottom edge of wall surfacing is edgebanded.

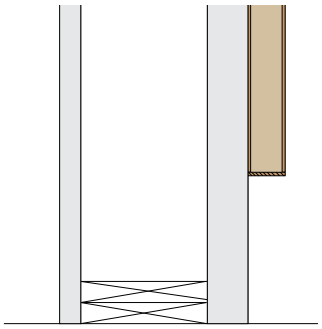


Figure: RG-153

FIELD-CUT CORNER and TRANSITION EXAMPLES

Butt - Outside Corner

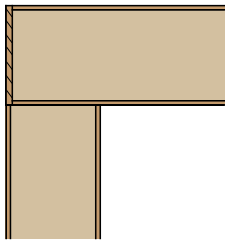


Figure: RG-154

Mitered - Outside Corner

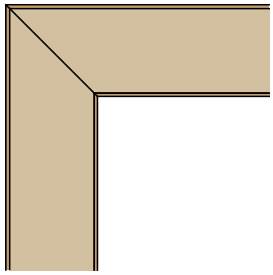


Figure: RG-155

Solid Wood - Outside Corner

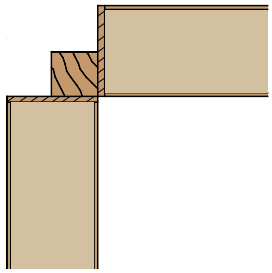


Figure: RG-156

Butt - Inside Corner

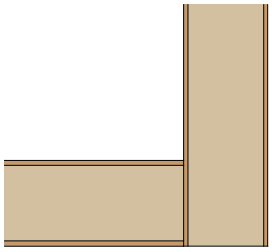


Figure: RG-157

Non-reveal - Transition

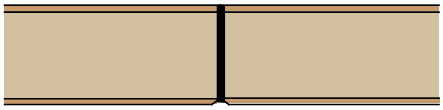


Figure: RG-158

SUGGESTION

REVEALS and REVEAL JOINT EXAMPLES

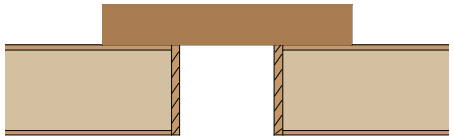


Figure: RG-159

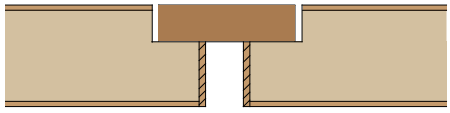


Figure: RG-160

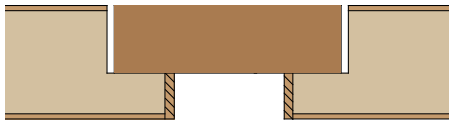


Figure: RG-161

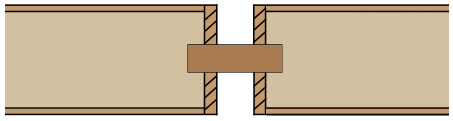


Figure: RG-162

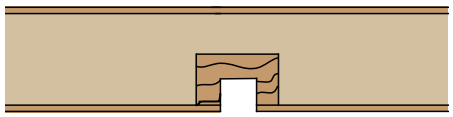


Figure: RG-163

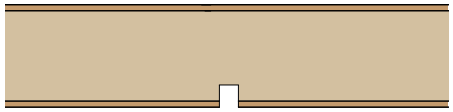


Figure: RG-164

Figure: RG-165

To PREVENT TELEGRAPHING, inset solid wood edging when used must have similar moisture content as panel core, be glued securely and calibrated with panel core thickness prior to being laminated with a wood veneer on both faces.

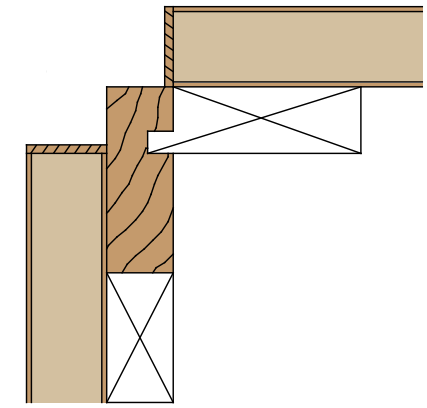


Figure: RG-166

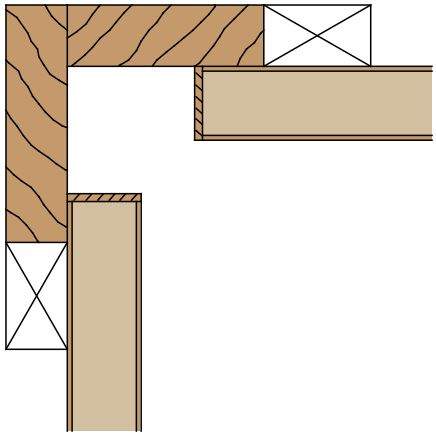


Figure: RG-167

WALL / CEILING SURFACING & PARTITIONS (continued)

SUGGESTION

FACTORY-PREPARED CORNER and TRANSITION EXAMPLES

Lock Mitered - Outside Corner

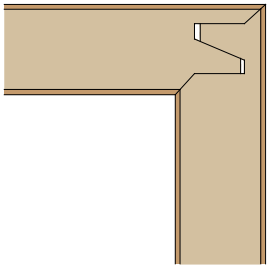


Figure: RG-168

Splined - Outside Corner

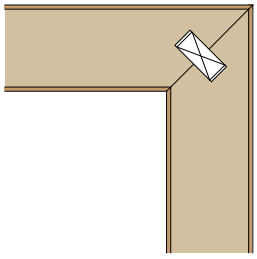


Figure: RG-169

Miter Fold - Outside Corner

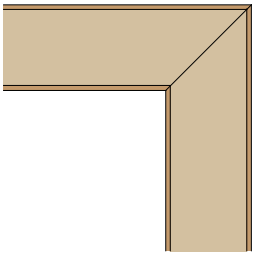


Figure: RG-170

Solid Wood - Outside Corner

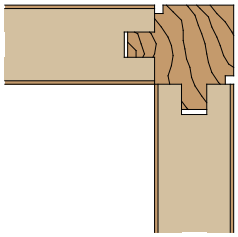


Figure: RG-171

Solid Wood - Outside Corner

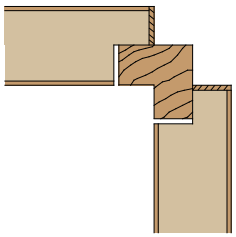


Figure: RG-172

Non-reveal Transition

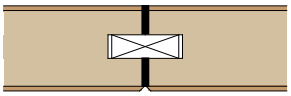


Figure: RG-0173

FACTORY PREPARED TRANSITION EXAMPLE OF BUILT-UP SECTION

Loose joint fit in plant and sanded flush

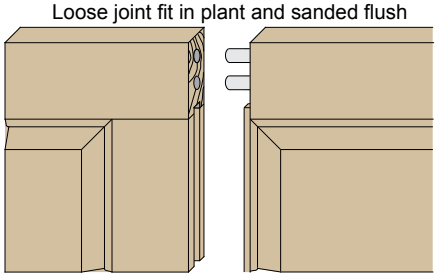
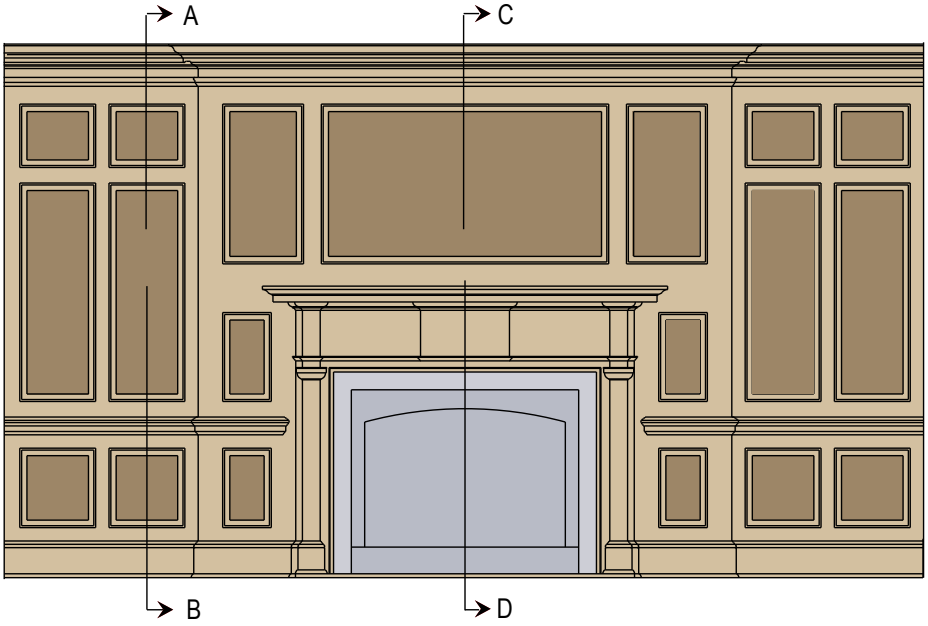


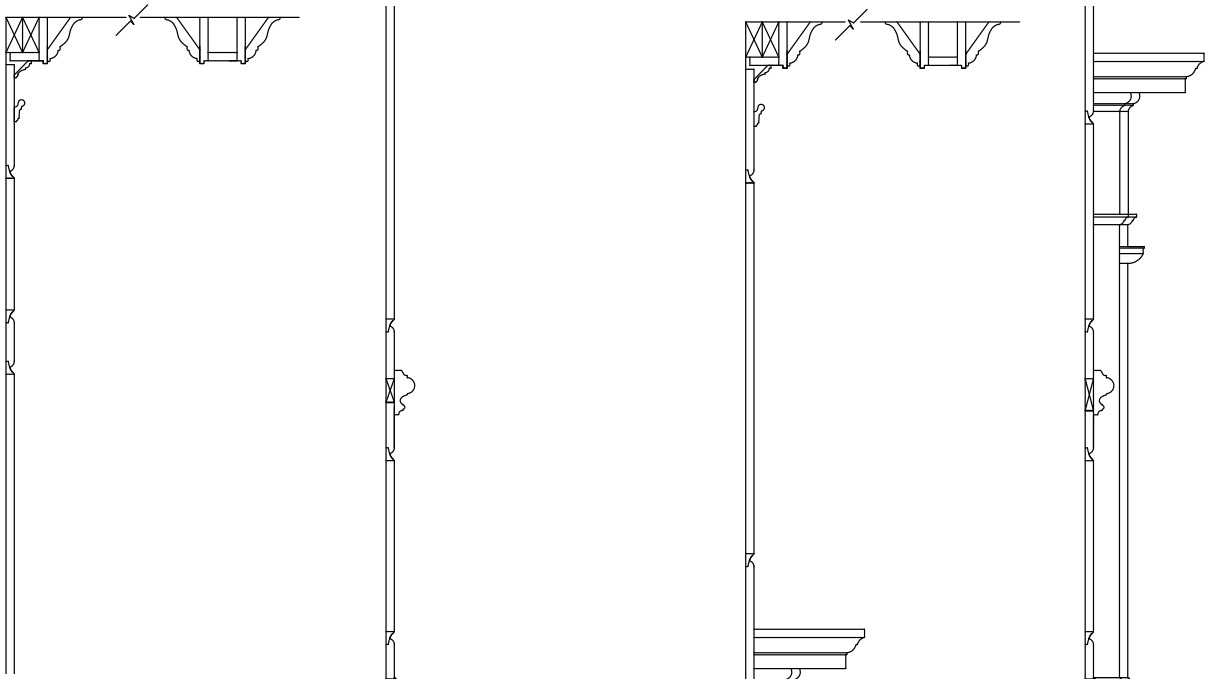
Figure: RG-174

SUGGESTION

STILE and RAIL PANELING

Flat or raised panels with wood veneer faces or of solid lumber, combined with stiles and rails. Design may encompass face application of moldings. Joints between panels, stiles, rails, and other members to be as designed for functional or decorative purposes.





Section A | Section B | Section C | Section D

Figure: RG-175

WALL / CEILING SURFACING & PARTITIONS (continued)

EXAMPLES of STILE and RAIL PANELING (continued)

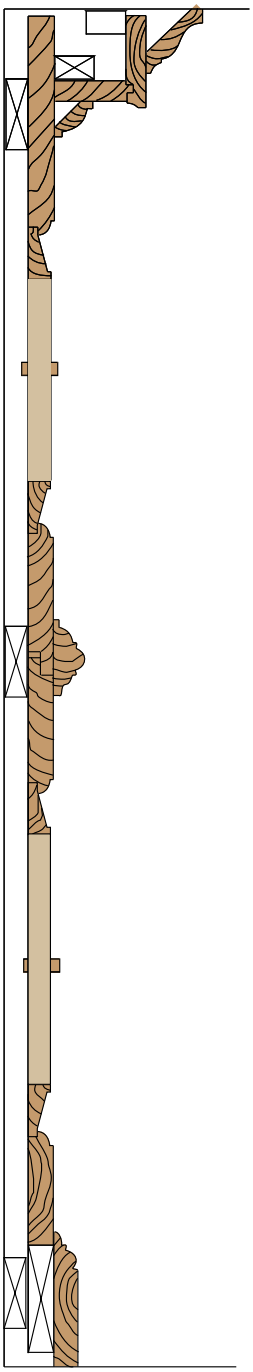
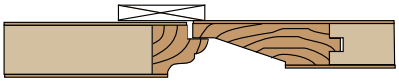


Figure: RG-176

Veneered stile and rail with concealed* stile and rail edges and panel rim



* Likely to cause telegraphing through face veneer

Figure: RG-177

Solid lumber stile and rail with panel products and solid rims

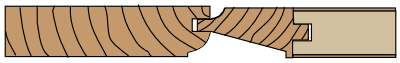


Figure: RG-178

Solid stile and rail with lip moulding and panel product with solid rim

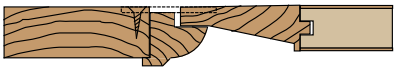


Figure: RG-179

Medium density fiberboard (MDF) for stiles, rails and panels

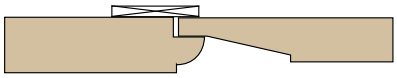
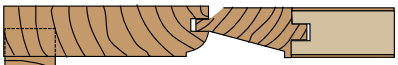


Figure: RG-180

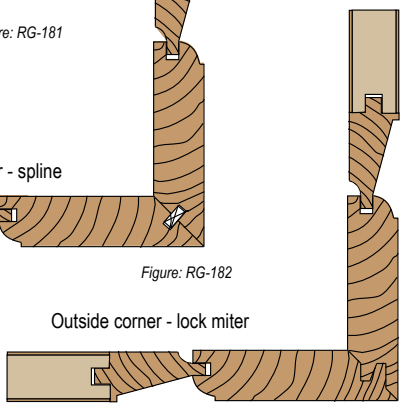


Inside corner

Figure: RG-181

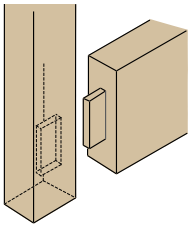
Outside corner - spline

Figure: RG-182



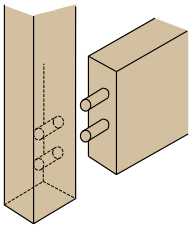
Outside corner - lock miter

Figure: RG-185



Mortise and Tenon construction

Figure: RG-183



Doweled construction

Figure: RG-184

SUGGESTION

WALL / CEILING SURFACING & PARTITIONS (continued)

SUGGESTION

EXAMPLE of FLAT PANELING WITH REVEALS WITHIN a NICHE

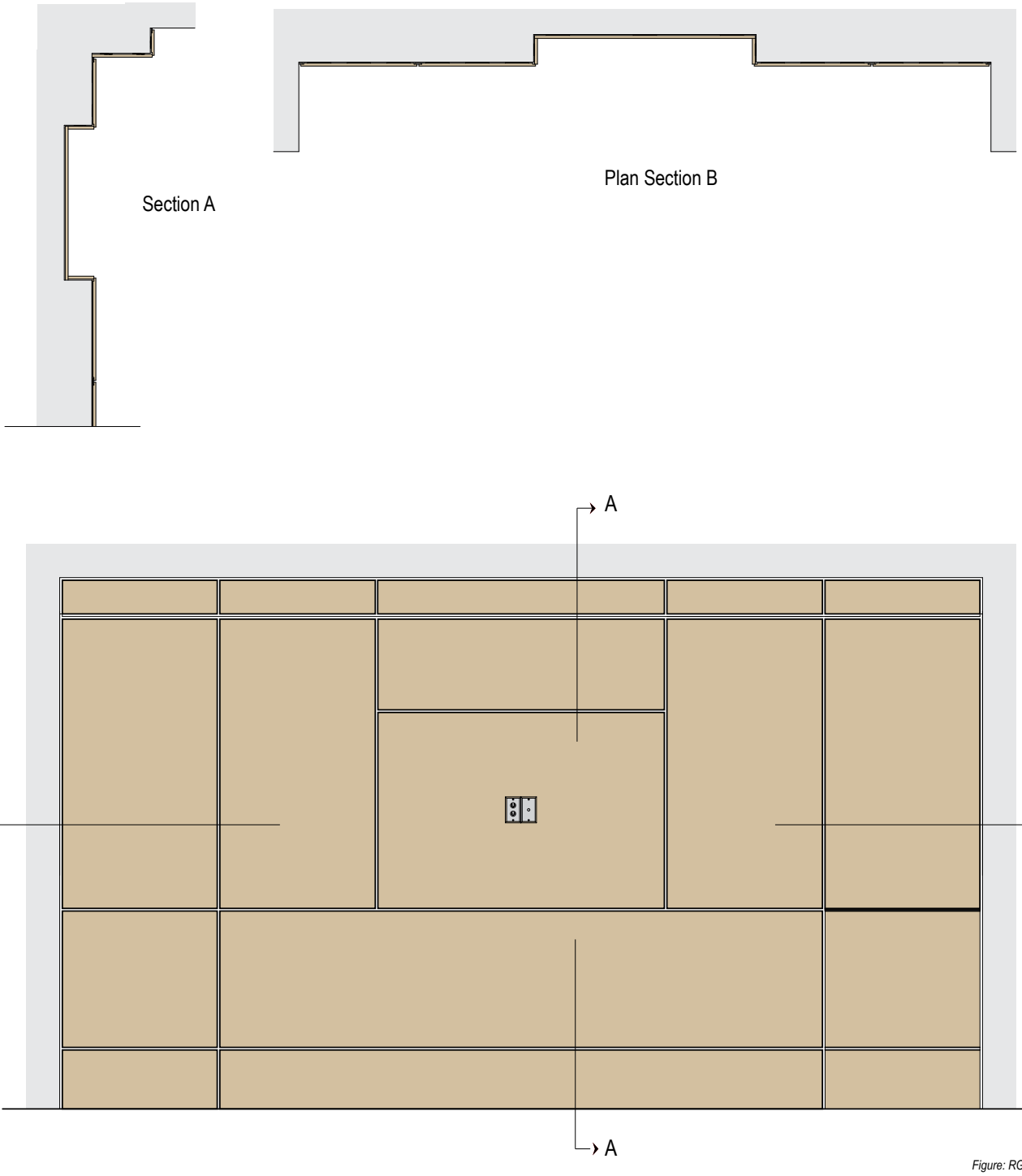
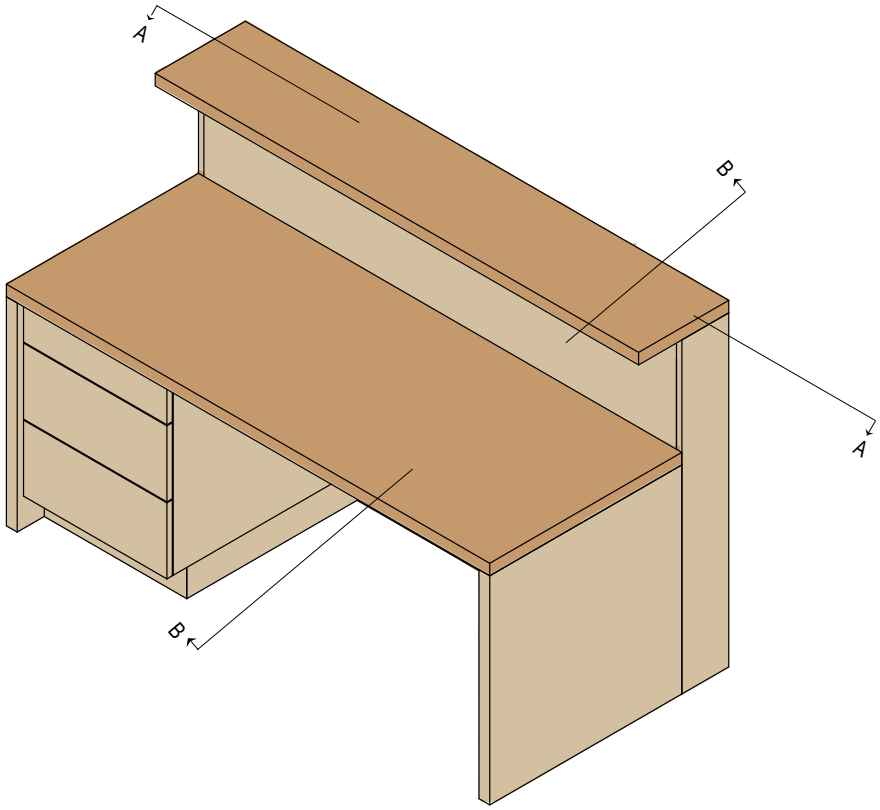
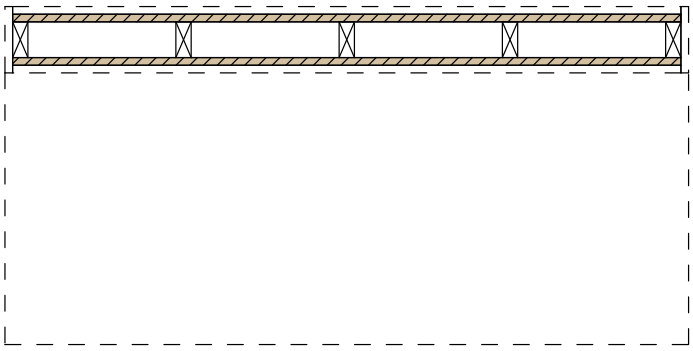


Figure: RG-186

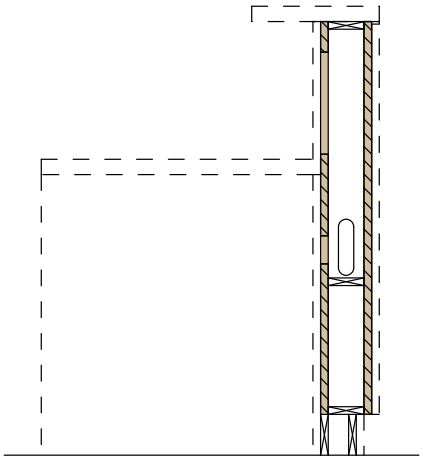
SUGGESTION

EXAMPLE of PANELING FOR RECEPTION WALLS WITH FACTORY BUILT STRUCTURES





Plan Section A



Section B

Figure: RG-187

PASSAGE DOORS

SUGGESTION

INTRODUCTION

Section 09 includes information on doors using flush and stile & rail construction with wood or HPL faces and their related parts.

In the past material suppliers have relied on the natural strength of hardwood lumber and veneer to assure long term performance. Many new engineered wood products are now replacing traditional hardwoods; allowing cost reductions, improved production efficiency and allowing the material suppliers the ability to provide better doors.

However, there is a risk some nonconforming products will not perform as well. The materials and construction methods used determine how well a door will resist high use and abuse. With the introduction of engineered wood products this becomes more important. Wood products, whether natural or engineered, have a wide range of strength characteristics and it is important that the door material and construction method meets the performance criteria of the project requirements.

CONSTRUCTION DEFINITIONS

- **Wood Face:**
  - **5-Ply** consists of a center core on which is applied to each side a wood veneer or composite cross band with a face veneer applied over the cross band.
  - **7-Ply** consists of a center core on which is applied to each side 3-ply face skins.
- **HPL Face:**
  - **3-Ply** consists of a core with a HPL face applied over both sides of the core.
  - **5-Ply** consists of a wood veneer or composite cross band applied over the core before application of the face laminate.

DOOR CONSTRUCTION CUTAWAY EXAMPLES

Illustrations of grain direction is only applicable to wood veneer.

- **WOOD VENEER FACE** with particleboard, MDF, or agrifiber core (PC-5 /PC-7):

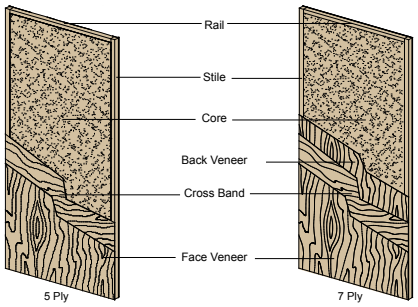


Figure: RG-188

- **HPL FACE** with particleboard, MDF, or agrifiber core (PC-HPL-3 / PC-HPL-5):

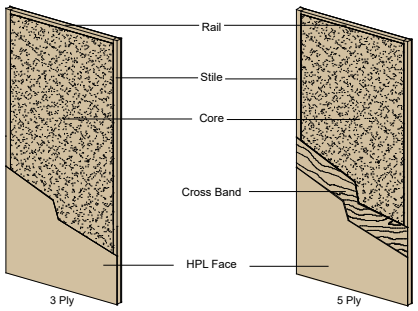


Figure: RG-189

- **WOOD VENEER FACE** with staved lumber core (SLC- / SLC-7):

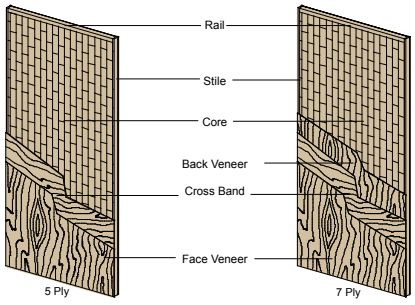


Figure: RG-190

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PASSAGE DOORS (continued)

DOOR CONSTRUCTION CUTAWAY EXAMPLES (continued)

- **WOOD VENEER FACE** with structural composite lumber (SCL) core (SCLC-5 / SCLC-7):

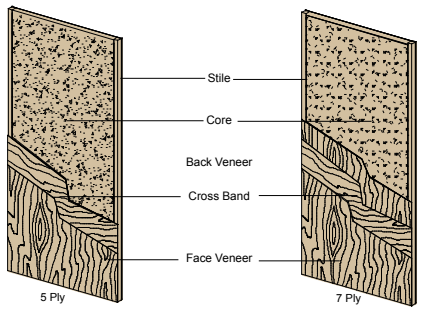

Figure: RG-191

- **WOOD VENEER FACE** with fire resistant composite core (FD-5 / FD-7):

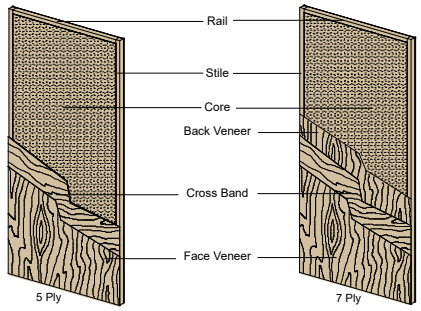

Figure: RG-192

- **HPL** with fire resistant composite core (FD-HPL):

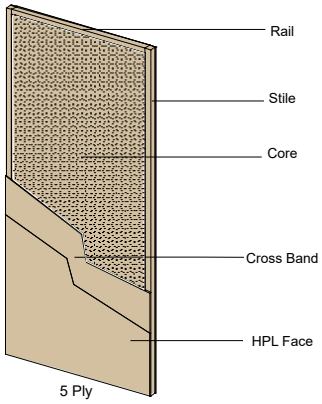

Figure: RG-193

- **WOOD VENEER / HPL FACE** with hollow core (HC-7):

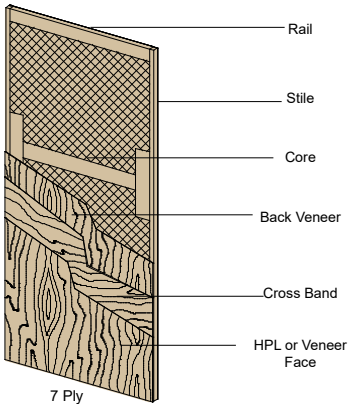

Figure: RG-194

SUGGESTION

PASSAGE DOORS (continued)

DOOR SYMBOLS and ABBREVIATIONS

Your door material supplier is the best source of specific guidance when writing door specifications. The following short list of abbreviations applies to some door companies:

- **ME = Matching edges**; i.e., vertical edges same as decorative faces.
- **CE = Compatible edges**; i.e., vertical edges selected for compatibility with decorative faces.
- **PC = Particleboard, MDF, or agrifiber core**, solid core door with stiles and rails bonded to the core and abrasive planed flat prior to the application of the faces, including:
  - **PC-5** = Core with 2 layers on each side.
  - **PC-7** = Core with 3 layers on each side.
  - **PC-HPL-3** = Core with laminate to each side.
  - **PC-HPL-5** = Core with cross band and laminate each side.
- **SCLC** = Structural composite lumber core, solid core door with stiles and rails bonded to the core and abrasive planed flat prior to the application of the faces, including:
  - **SCLC-5** = Core with 2 layers on each side.
  - **SCLC-7** = Core with 3 layers on each side.
  - **SCLC-HPL-5** = Core with cross band and laminate each side.
- **SLC** = Staved lumber core, solid core door with stiles and rails bonded to the core and abrasive planed flat prior to the application of the faces.
  - **SLC-5** = Core with 2 layers on each side.
  - **SLC-7** = Core with 3 layers on each side.
  - **SLC-HPL-5** = Core with cross band and laminate each side.
- **FPC** = Floating particleboard core, solid core placed within a stile and rail frame, bonded together by the faces, including:
  - **FPC-5** = Core with 2 layers on each side.
  - **FPC-7** = Core with 3 layers on each side.
- **FSLC** = Floating staved lumber core, solid core placed within a stile and rail frame, bonded together by the faces, including:
  - **FSLC-7** = Core with 3 layers on each side.
- **FD** = Fire resistant core, fire resistant materials assembled to stiles and rails according to methods prescribed by the testing agency based on rigorous smoke, flame, and pressure tests. Labeled fire doors are specified by their resistance ratings:
  - **FD-5** = Core with 2 layers on each side.
  - **FD-7** = Core with 3 layers on each side.
  - **FD-HPL-3** = Core with laminate to each side.
  - **FD-HPL-5** = Core with cross band and laminate each side.
- **IHC-7** = Institutional hollow core, honeycomb, ladder, or grid type cores inside stiles and rails, bonded together by the faces.
- **SHC-7** = Standard hollow core, honeycomb, ladder, or grid type cores inside stiles and rails, bonded together by the faces.
- **SR** = Sound retardant doors, specified by their performance characteristics.
- **LL** = Lead lined doors, designed to resist penetration by radiation of various types, and specified by their performance.
- **ES** = Electrostatic shielded doors.
- **BR** = Ballistic resistant doors.

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PASSAGE DOORS (continued)

SUGGESTION

BASIC CORE TYPES

The design professional or specification writer has the opportunity to select the door core type. In the absence of specification, PC shall be furnished, complying with particleboard standard ANSI A208.1 Particleboard, Grade LD-1 or LD-2 as published by the Composite Panel Association, compositepanel.org.

The five most common core types are PC, SLC, SCLC, HC, and fire-resistant door core, conforming to the minimum requirements of WDMA - I.S. 1-A (latest edition).

Specify one, or a combination of, solid core, hollow core, or fire-resistant core, and acoustical, ballistic resistant, or lead lining where and when required. The requirements for each core type are illustrated in Section 9. In the absence of clear specifications, the core shall be of the manufacturer's choice. SCLC may be specified in any Grade, for:

- **SOLID CORE,** specify one of the following: PC, SLC, or SCLC. When the weight of the door is a design factor, consult the door manufacturer to determine the differences between PC, SLC, and SCLC core types.
- **HOLLOW CORE**, specify the honey comb, with the minimum cell size required, grid core, or ladder construction.
- **FIRE RESISTANT CORE**, required beyond the 20 minute label level, consult your door manufacturer for code compliant core types, blocking options, metal edges, cut outs, and astragals.
- The use of **SCLC** for top and/or bottom rails, and blocking is acceptable. SCLC is proving to have excellent performance characteristics as a replacement for stave core, as it often minimizes or eliminates telegraphing of the lumber blocks through the face veneers or overlays.

When the edge of an SCL core door will be visible after installation, design professionals may wish to specify a fill and paint treatment, or the application of a veneer edgeband to conceal the coarse texture of the edge of the SCL material. It is the responsibility of the design professional to make a selection in the best interests of the client.

SPECIALITY CORES

Such as fire rated, sound resistant, x-ray, bullet resistant, or electrostatic shielded doors shall be properly specified, including the fire rating, sound class, lead thickness, and/or protection rating:

- At **FIRE RATED** doors, the type of construction, core type, thickness, edgebands, moldings, blocking, and use of intumescent coatings shall be the standard of the door material supplier, conforming to the labeling authority granted to them by their labeling agency.
- At **SOUND RESISTANT** doors, the type of construction, thickness, edgebanding, applied moldings, special stops, stop adjusters, gaskets, and automatic threshold closing devices shall be the standard of the door material supplier conforming to the STC (Sound Transmission Class) specified when tested as an opening unit (rather than sealed in place).
- At **X-RAY DOORS**, construction, thickness, edgebands, and moldings shall be of the material supplier's standard.
- At **BULLET RESISTANT** doors, the type of construction, thickness, edgebands, and moldings shall be of the material supplier's standard.
- At **ELECTROSTATIC SHIELDED** doors, the type of construction, thickness, edgebands, and moldings shall be of the material supplier's standard.

Cores other than those enumerated herein are manufactured to individual specifications and are not dealt with in these standards for that reason.

PASSAGE DOORS (continued)

SUGGESTION

CORE TO EDGE ASSEMBLY

These standards provide for multiple types of assembly between the core and the vertical and horizontal edges in doors:

- Stiles and rails securely bonded to core, prior to application of faces.
- Stiles and rails **NOT** bonded to core prior to application of faces.
- Stiles and rails placed (not bonded) around hollow core inserts.

FIRE RATINGS

The Model Codes have established a fire door rating and operating classification system for use in protecting door openings in fire rated wall constructions. Fire doors must meet certain requirements and bear certifying labels of an independent testing agency approved by the building official.

SPECIAL FUNCTION DOORS

Sound retardant (acoustical), lead lined (X-ray), ballistic resistant, and electrostatic shield doors are manufactured by some companies to meet these special needs. Refer to material supplier's literature for details.

Transom panels and special function doors are available and should be specified carefully, with particular attention to the meeting edge details, operational functions and accessories, and veneer match options. In the absence of clear and complete specifications, fabrication details will be of the material supplier's choice.

VENEER FACES

At stand-alone doors with face species of Anigre, Ash, Beech, Birch, Cherry, Hickory, African Mahogany, American Mahogany, Makore, Maple, Red Oak, White Oak, Pecan, Poplar, or Walnut shall conform to the HPVA Door Skin Face tables included within the Materials portion of this section. Doors of a species not listed above shall conform to the HPVA Door Skin Faces as agreed on between buyer and seller.

- Doors adjacent to or that become a component of other architectural woodwork shall conform to the applicable requirements of Section 04.
- Stand alone, Center Balanced Matched doors, shall not have the width of outer leaves after trimming exceed 1" (25.4 mm) less than its adjoining leaf for Custom Grade, or 1/2" (12.7 mm) less than its adjoining leaf for Premium Grade.
- Before specifying, check with the door material supplier for availability.

SPECIAL MATCHING SHALL BE SO SPECIFIED, SUCH AS:

- All doors on the same project are to be manufactured using the same or similar flitches.
- Sequence matched face veneers required at pairs or sets of doors and adjacent panels.

VENEER FACE GRADE SUMMARY

Refer to Section 4 HPVA Panel Grades and Section 9 HPVA Door Skin Grades for the complete description of veneer face grades.

When veneers are specified as "natural," they may contain any amount or combination of sapwood and heartwood, with the resultant contrast in color in many species.

The industry recognizes that cost is an important factor and having lower veneer standards can result in some savings. Specifying Architectural Woodwork Standards Custom Grade meets that need. However, when doors are a part of an overall design scheme and/or are adjacent to other architectural woodwork specified under these standards, the level of quality of those doors must be consistent with other architectural woodwork components.

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PASSAGE DOORS (continued)

SUGGESTION

ANSI/WDMA PERFORMANCE DUTY LEVELS

ANSI/WDMA HEAVY DUTY PERFORMANCE DUTY LEVEL is required within NAAWS for both Flush and Stile and Rail doors, and if a higher Extra Heavy Duty or lower Standard Duty Performance Duty Level is required, it will be specified.

- **DUTY LEVEL** performance requirements are spelled out within the Machine / Assembly Requirements. Duty Levels other than those required herein, will be so specified from the following:
  - **HEAVY DUTY LEVEL** typically involves doors for moderate usage and requires intermediate minimum performance standards. Typical usage examples include:

Assisted living room entry	Storage
Office - Interior passage stairwell	Apartment / condo entry
Mechanical service	X-ray
Hallway	Acoustic
Medical exam room	Stairwell

  - **EXTRA HEAVY-DUTY** level typically involves doors where use is considered heavy and frequent, and requires the highest minimum performance standards. Typical usage examples include:

Classrooms	Detention / correctional
Patient rooms	Bullet-resistant
Bathrooms - Public	Gym / locker rooms
Dorm rooms	Surgical entry
Assembly areas	Trauma centers
Auditorium entry	Hotel / motel room entry

  - **STANDARD DUTY** level typically involves doors where frequency of use is low and requires the lowest minimum performance. Typical usage examples include:

Closet	Bath - Private
Wardrobe	Small, low-usage office

VENEER USAGE GUIDELINES

The panel face veneer standards of the Decorative Hardwoods Association's ANSI/HPVA HP-1 (latest edition) is adopted as the minimum standard for face veneers. Specifiers need to determine and specify the following:

VENEERS FOR TRANSPARENT FINISHES

- **Species** - There are numerous foreign and domestic species available. Involve your manufacturer early in the design and selection process.
- **Matching** - Many different visual effects can be obtained by face veneer matching:
  - Appearance and layout of individual pieces of veneer.
  - Matching between pieces (leaves) of veneer.
  - Orientation of spliced veneer on a door face.
  - Appearance of doors in pairs or sets.
  - Appearance of doors with transoms.

MATERIALS FOR OPAQUE FINISHES

- **Medium Density Overlay, MDF or Hardboard -** These provide the optimum paintable surface for architectural doors.
- **Close Grain Hardwood -** Extra preparation will be required by the finisher as there will be grain show through, open appearing veneer joints, and other wood characteristics when using this product for a painted finish.
- **Manufacturers' option -** Face materials are determined by the manufacturer.

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PASSAGE DOORS (continued)

VENEER USAGE GUIDELINES (continued)

DOORS IN PAIRS OR SETS

- **Pair Match -** Two doors hung adjacent may be (and in some Grades, must be) specified as a Pair Match. Note to specifying authority: Specifying Pair Matched only means the two doors are to be considered Pair Matched as per the Grade specified, it does not mean the veneer is sequenced, nor does it designate the veneer cut or layup. The Grade specified will determine the type of Match required. Sequencing, veneer cut and layup if different from the Grade Rules must be specified. The illustration shows flat or plain cut, book matched, center matched faces.

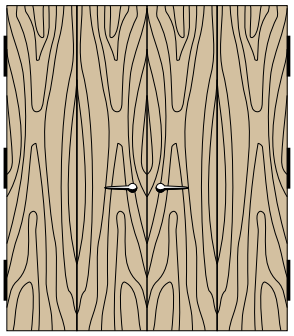

Figure: RG-195

- **Set Match -** Three or more doors or two or more Pair Matched doors hung adjacent may be (and in some Grades, must be) specified as a Set Match. Note to specifying authority: Specifying Set Matched only means the three or more doors are to be considered Set Matched as per the Grade specified, it does not mean the veneer is sequenced, nor does it designate the veneer cut or layup. The Grade specified will determine the type of Match required. Sequencing, veneer cut and layup if different from the Grade Rules must be specified. The illustration in shows flat or plain cut, book matched, center matched faces.

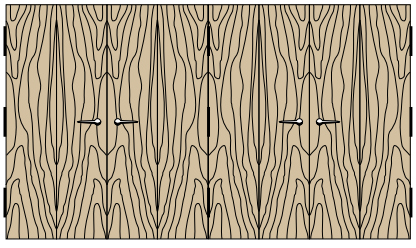

Figure: RG-196

- **Doors with Transoms**

  The use of the transom increases the apparent height of the door and often enhances the appearance of the opening. The type of match should be specified, and a slight misalignment of veneer grain may occur between the transom and the door. Industry practice allows a variation in grain alignment from side to side. If tighter tolerances are desired, they must be specified.

  Grain pattern alignment between the door and transom, even when cut from the same panel, will vary to some extent. This is due to the natural progression of the annual rings which create the figure in the wood. Misalignment will be more apparent in doors veneered with open grain species than with close grain.

  - **Continuous Match -** Provides optimum veneer utilization as each single piece of veneer extends from the top of the transom to the bottom of the door. Available veneer length in the species may limit this option.

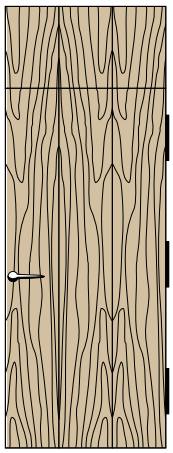

Figure: RG-197

SUGGESTION

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PASSAGE DOORS (continued)

VENEER USAGE GUIDELINES (continued)

- **Doors with Transoms** (continued)
  - **End Match -** A single piece of veneer extends from the bottom to the top of the door with a mirror image at the transom.

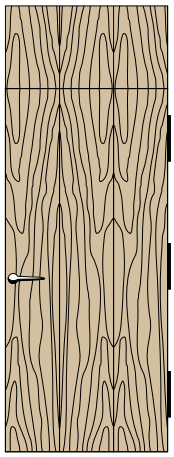

Figure: RG-198

  - **No Match**

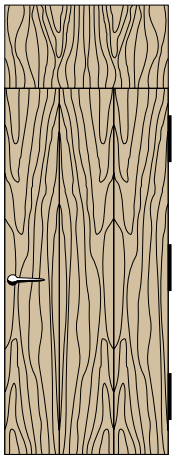

Figure: RG-199

DOOR EDGE CONSTRUCTION and TYPES

Edge construction is the manufacturer's choice unless specified otherwise.

To **PREVENT TELEGRAPHING**, inset solid wood edging when used must have similar moisture content as panel core, be glued securely and calibrated with panel core thickness prior to being laminated with a wood veneer on both faces.

- **Type - A** - Solid Wood edgeband, face, and cross band edges show.

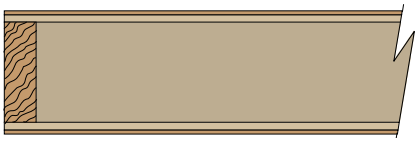

Figure: RG-200

- **Type - B** - Wood Veneer edgeband, face, and cross band edges covered.

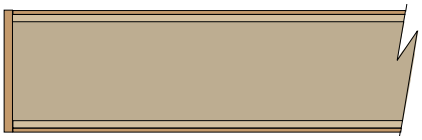

Figure: RG-201

- **Type - C** - HPL or PVC edgeband, face, and cross band edges covered.

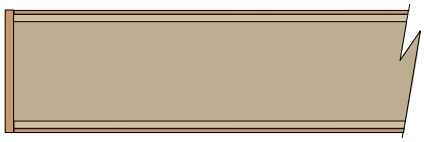

Figure: RG-202

- **Type - D** - Solid Wood edgeband, veneer face edge shows.

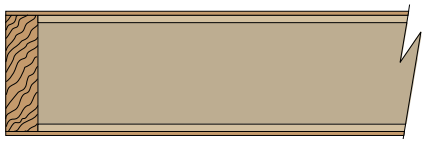

Figure: RG-203

- **Type - E** - Solid Wood edgeband, veneer face edge shows.

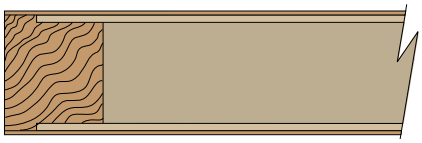

Figure: RG-204

- **Type - F** - Solid Wood edgeband, face, and cross band edges covered.

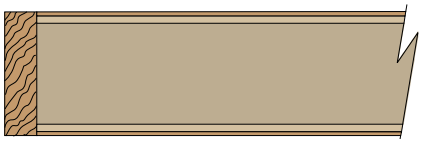

Figure: RG-205

SUGGESTION

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PASSAGE DOORS (continued)

CONSTRUCTION DETAILS

- **GENERAL MOLDING REQUIREMENTS:**
  - **SPECIES** shall match or be compatible with face veneer or laminate.
  - **SPECIFY** transparent or opaque finish.
  - **FREE** of open defects, shake, splits, or doze.
  - **SMOOTH** and **FREE** of visible knife, saw, or sanding marks.
- **HORIZONTAL** or **TRANSOM MEETING EDGE OPTIONS**

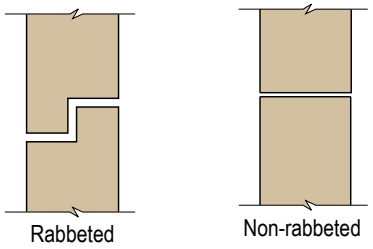

Figure: RG-206

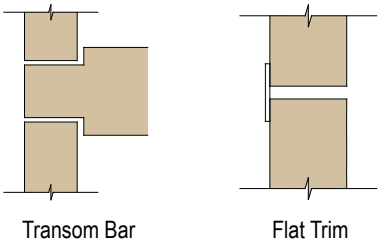

Figure: RG-207

- **MEETING EDGE OPTIONS**

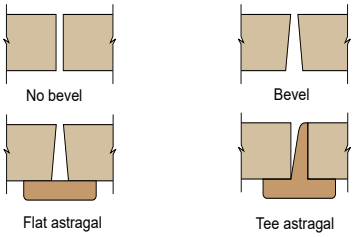

Figure: RG-208

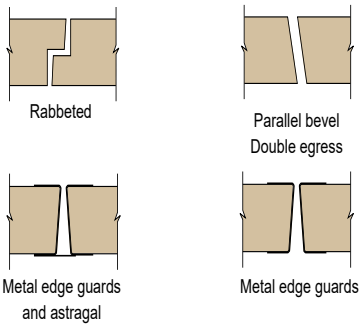

Figure: RG-209

- **GLAZING OPTIONS**

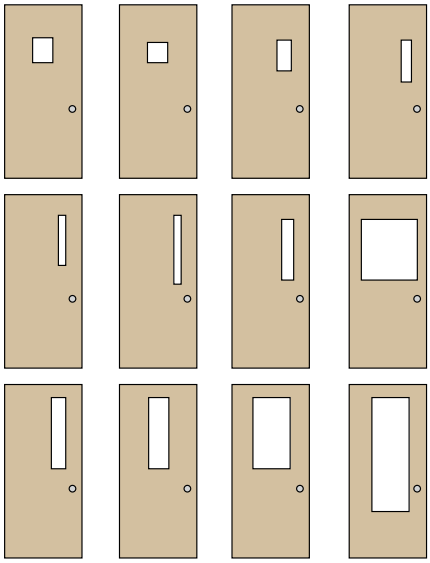

Figure: RG-210

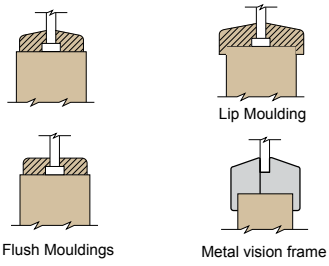

Figure: RG-211

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PASSAGE DOORS (continued)

CONSTRUCTION DETAILS (continued)

- **LOUVER OPTIONS**

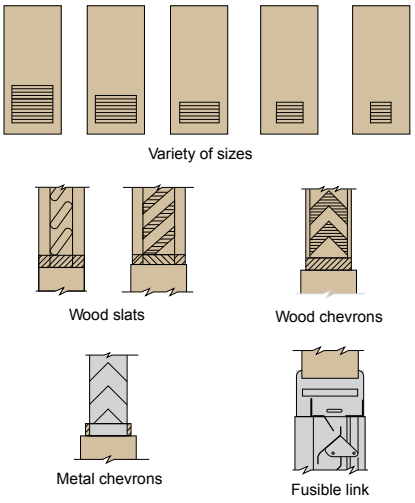

Figure: RG-212

- **FLASHING OPTIONS**

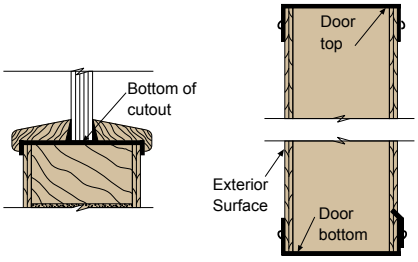

Figure: RG-213

If the manufacturer is to flash the top of the door or the bottom edge of cutouts for exterior doors, it must be specified.

- **DUTCH DOOR OPTIONS**

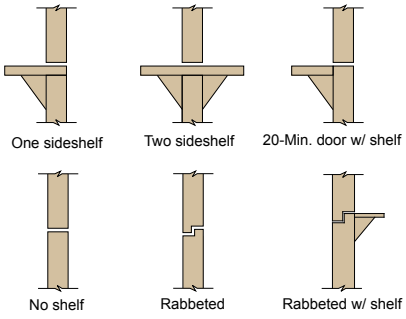

Figure: RG-214

- **BLOCKING OPTIONS**

For undercutting flexibility and specialized hardware applications, a number of internal blocking options are available from most material suppliers. When blocking is required it is typically at particle core and fire-resistant core doors. There are many options available, consult your manufacturer early in the design process to determine your requirements.

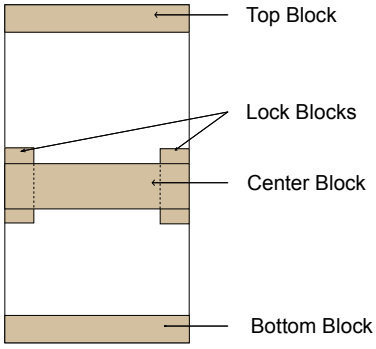

Figure: RG-215

Hardware Blocking, if desired, shall be specified from the following typical options:

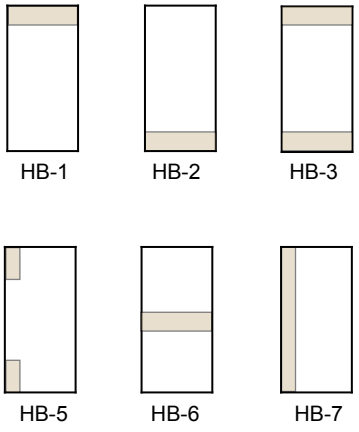

Figure: RG-216

Figure: RG-117

Top Blocking may be full or partial width as required by its application.

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PASSAGE DOORS (continued)

SUGGESTION

HAND and BEVEL OF DOORS

The "hand" of a door is always determined from the outside. The outside of an exterior door is the street or entrance (key) side. The outside of an interior room or auditorium door is the corridor or hall (key or imaginary key) side. The outside of a closet door is the side opposite the closet; the room, corridor or hall side. The outside of a single communicating door is the side from which the butts are invisible when the door is closed. The outside of twin communicating doors is the space between the two doors.

Standard handed doors push away from the person standing on the outside / key side. Reverse handed doors pull toward the person standing on the outside / key side.

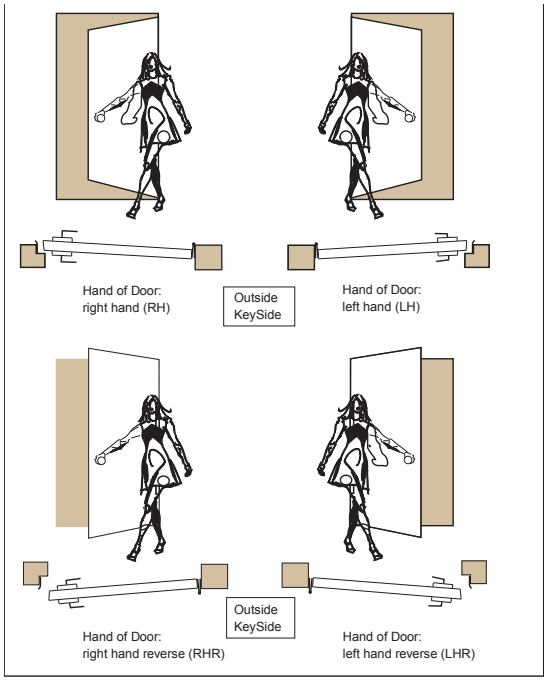

Figure: RG-218

FACTORY FINISHING (when specified)

Firms differ in the variety of factory finishes offered. Some finishes may not be available from all material suppliers. Finishes protect wood from moisture, handling, or harsh chemicals. The sooner moisture is restricted from entering or leaving, the longer wood lasts and the finer it looks. Transparent finishes without stain provide a protective coating for the wood, maintaining its natural look. Transparent finishes with stain provide the architect or designer an opportunity to create a striking visual effect by modifying color, texture, and sheen.

Section 05 defines the finishing systems and performance characteristics.

Carefully studying Section 05 with your manufacturer early in the design phase can result in both high quality and cost savings.

Factory finishing is generally specified when a project requires high quality performance and superior appearance.

Factory finishing offers many benefits, including:

- State of the art equipment in a well-lighted, dust free environment (conditions normally not available in the field), which provides uniform color, texture, and sheen.
- Proper sanding prior to the application of stains and finishes. Field conditions often hinder surface preparation resulting in a lack of clarity and uniformity in finish and color.
- Protection from unfavorable relative humidity conditions at the earliest possible time.
- Cost savings (in most cases) over the total cost of field applied finishes by a separate contractor.
- Shorter installation time on the job site, resulting in faster project completion.

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PASSAGE DOORS (continued)

SUGGESTION

STILE and RAIL DOOR COMPONENTS

- **STILES** - are the vertical outside members. They may be solid wood or veneered. Stiles usually have solid sticking (solid stuck, solid molded). Sticking is usually of three profiles: "ovolo", "ogee" or "quarter round". Other profiles may be used. The stiles are ploughed or grooved along the edge to receive the panels, rails, and/or glass. If the door is to be assembled by dowelled construction, the stiles are bored to receive the dowels. If the door is to be assembled by lag screw construction, the stiles shall be solid hardwood lumber. The stiles will contain much of the hardware for the door and must be sized and fabricated to fit the intended hardware, locks, and latches.
- **RAILS** - are the cross or horizontal members of the door. They may be solid wood or veneered. Rails are coped on both ends to fit the sticking of the stile. Tenons or dowels are machined into the rails to fit mortises or dowel boring in the stiles.
  - **Top** and **bottom rails** are required, with the addition of intermediate cross rails or lock rails as appropriate. The bottom rail is usually the widest of the members, made of edge glued lumber or veneered, depending on the door construction. The top rail is often the same face dimension as the stiles.
  - **Lock rail**, if there is one, is usually a wide member located at lock height. In the case of narrow stiles or large hardware, this rail serves to house the lock and latch mechanisms.
- **MULLIONS** - an upright or vertical member between panels. It is similar to a cross rail in the way it is fit and machined.
- **PANELS** - are either solid lumber or panel products that fill the frame formed by the stiles, rails, and mullions. When the figure of the wood is visible in the finished product, the grain direction of the panels usually runs vertically.
- **MUNTINS** and **BARS** - Stile and rail door with glass panels often utilize muntins and bars, which are smaller in section than mullions. A bar is a rabbeted molding, which extends the total height or width of the glass opening. A muntin is a short bar, either horizontal or vertical, extending from a full bar to a stile, rail, or another bar. Muntins and bars are traditionally coped and mortised joinery.

STILE and RAIL DOOR DESIGN

Custom stile and rail door design offer many opportunities for creativity and choice. Some of the variables include:

- Panel layout, grain patterns and relationships.
- Stile and rail and/or Panel construction.
- Molding details, Joinery techniques.

Selection among these variables requires some knowledge of their relative performance characteristics. The following drawings illustrate some of the options. Many manufacturers feel veneered and laminated constructions offer the lowest risk of warp for most species of wood. Consult your manufacturer early in the design process for assistance in making selections.

The strength of a stile and rail door is primarily dependent on the shoulders and joints between the stiles and rails. A wide bottom rail will increase significantly the strength and stability of a door far beyond that of a narrow rail.

Care should be taken to ensure that the design of a door's stiles and rails is large enough to structurally accommodate the intended hardware, provide a strong and stable door, and accommodate the usage and size of the opening.

Door panels of either flush / flat or raised design are typically of the same species as the stiles and rails.

TEMPORARY DISTORTIONS (warp) will usually disappear when humidity is equalized, and doors seldom need to be replaced.

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PASSAGE DOORS (continued)

STILE and RAIL DOOR JOINERY EXAMPLES

- **Haunched Mortise and Tenon**

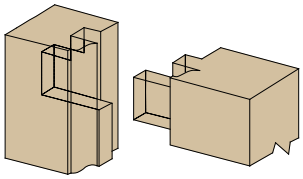

Figure: RG-219

- **Slot Mortise and Tenon**

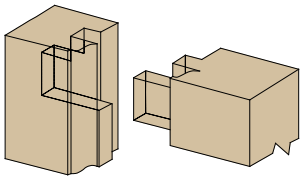

Figure: RG-220

- **Loose Tenon**

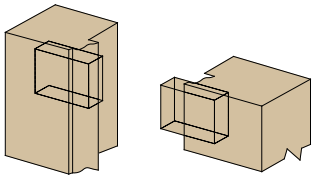

Figure: RG-221

- **Dowel**

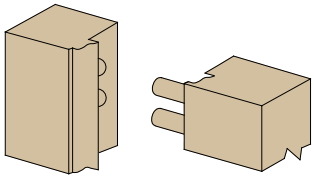

Figure: RG-222

STICKING PROFILES EXAMPLE

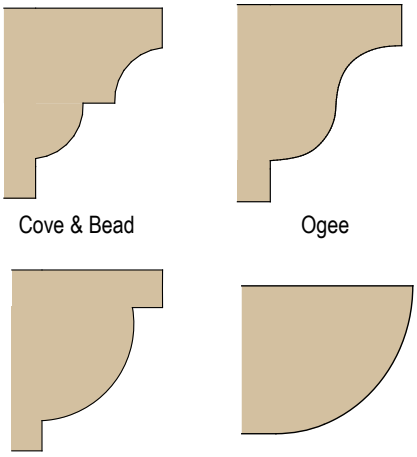

Figure: RG-223

THICKNESS

Stile and rail doors are usually 1-3/4" (44.5 mm) thick. For doors over 42" (1067 mm) in width or 96" (2440 mm) in height, it is recommended they be 2 1/4" (57.2 mm) minimum thickness.

GRAIN DIRECTION and LAYOUT

Traditionally, the grain direction flows with the longest dimension of the stile or rail. Panel grain typically runs vertical: however, it can be altered for design purposes. If raised panels are to be rim raised veneered construction, the grain of the rims will flow around the panel with the long dimension of the rim material.

There are a variety of methods of stile and rail fabrication. It is possible to fabricate stile and rail doors that will perform within the tests established in this Standard using any of the illustrated techniques and others. The illustrations are intended as guidelines for the design professional and should not limit the potential for creative solutions. Glass cannot always be centered on stiles and rails, depending on the thickness. Moldings and stop are usually applied with small brads or finish nails.

PASSAGE DOORS (continued)

STILE and RAIL DOOR PANEL LAYOUT and GRAIN PATTERN EXAMPLES

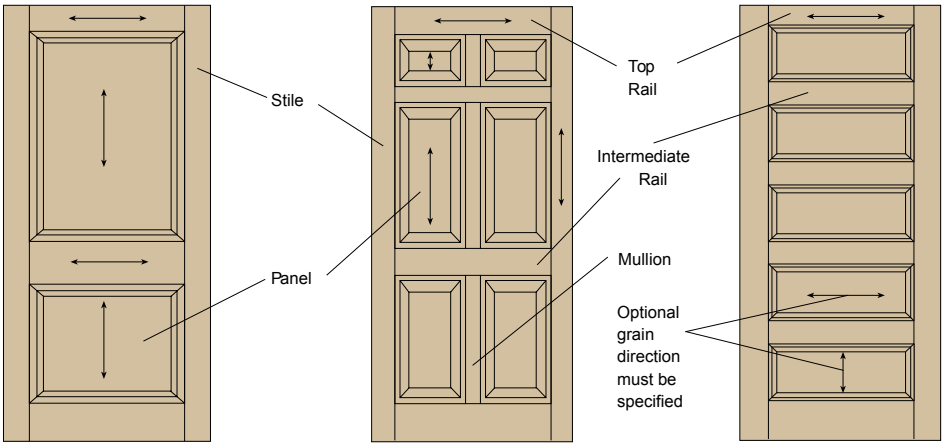

Figure: RG-224

STILE and RAIL DOOR CONSTRUCTION EXAMPLES

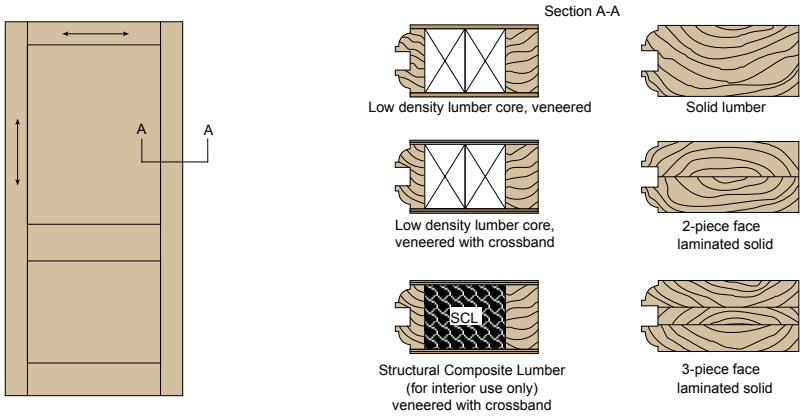

Figure: RG-225

STILE and RAIL PANEL CONSTRUCTION EXAMPLES

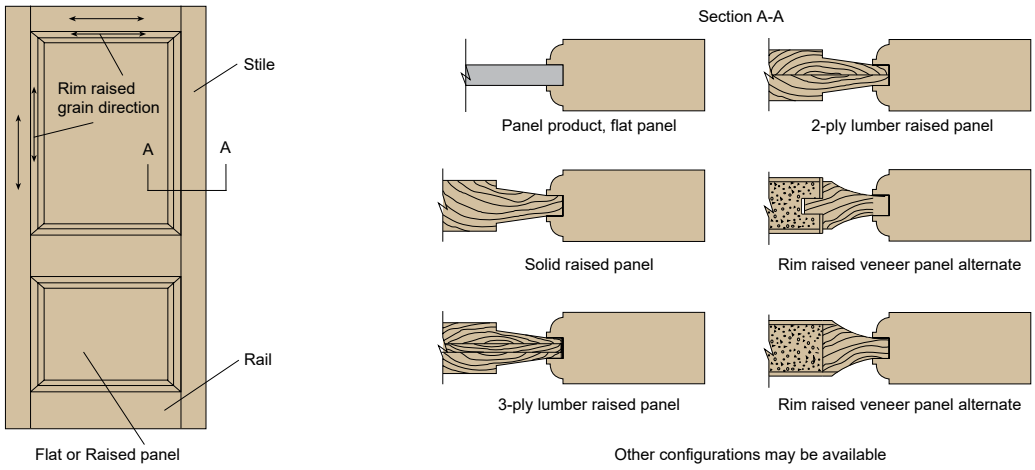

Figure: RG-226

STILE and RAIL PANEL and GLASS RETENTION EXAMPLES

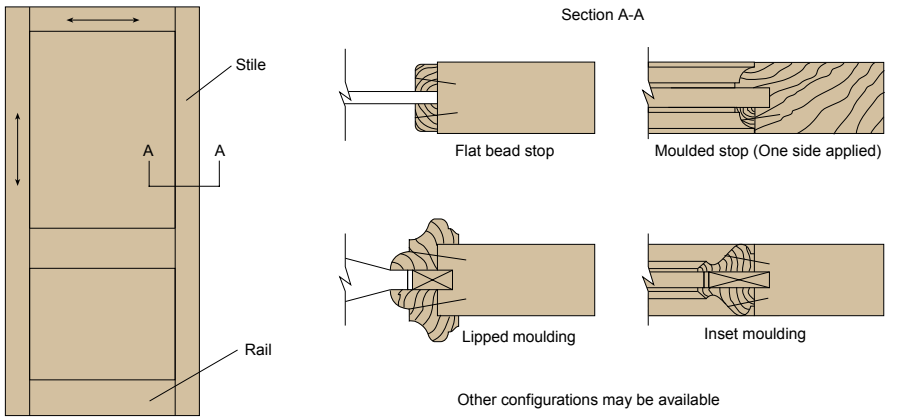

Figure: RG-227

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CASEWORK

INTRODUCTION

Section 10 includes information on Wood, Decorative Laminate, and CGS (Compact Laminate) Faced Casework and their related parts.

SURFACE TERMINOLOGIES

Cabinet surfaces are defined in four distinct categories, three for exposed surfaces with very specific minimum surface requirements and one for concealed surfaces subject to manufacturer's choice, as follows:

- **EXPOSED EXTERIOR SURFACES**, defined as all exterior surfaces exposed to view, including:
  - All surfaces visible when doors and drawers are closed, including knee spaces.
  - Underside of cabinet bottoms over 42" (1067 mm) above the finished floor, including cabinet bottoms behind light valances and the bottom edge of light valances.
  - Cabinet tops under 80" (2032 mm) above the finished floor, or if 80" (2032 mm) and over and visible from an upper building level or floor.
  - Front edgeband of stretchers, ends, divisions, partitions, fixed shelves, tops, and bottoms.
  - Front edgeband of adjustable shelves exposed to view in open casework or behind transparent doors.
  - Sloping tops of cabinets that are visible.
- **EXPOSED INTERIOR SURFACES,** defined as all interior surfaces exposed to view in open casework or behind transparent doors, include:
  - Interior faces of shelves (both fixed and adjustable), divisions and partitions (edgeband is an Exposed Exterior Surface).
  - Interior face of ends (sides), backs, and bottoms (including pull outs).
  - Interior face of cabinet top members 36" (914 mm) or more above the finished floor.
  - Interior face of doors and applied drawer fronts.

SURFACE TERMINOLOGY BY ILLUSTRATION

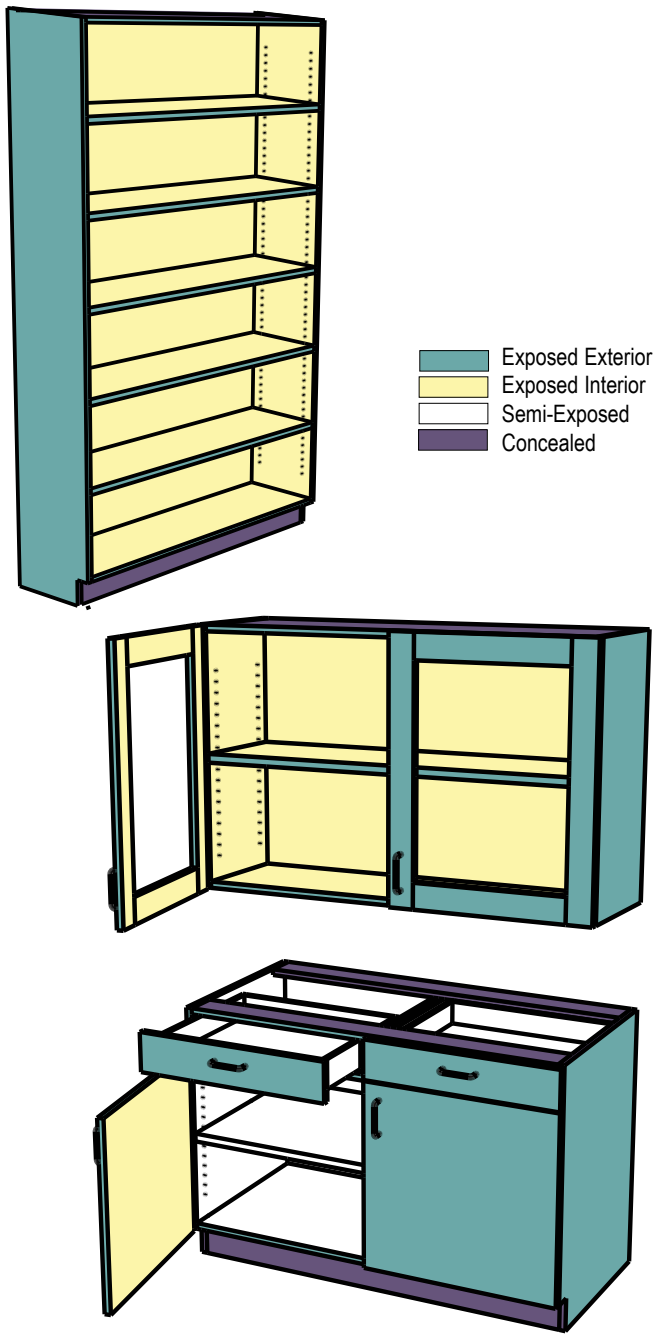

Figure: RG-228

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CASEWORK (continued)

SURFACE TERMINOLOGIES (continued)

- **SEMI-EXPOSED SURFACES**, defined as those interior surfaces only exposed to view when doors or drawers are opened, include:
  - Interior faces and edgeband of adjustable shelves, except at Premium Grade where edgeband will match Exposed Exterior surface.
  - Divisions and partitions (edgeband is an Exposed Exterior Surface).
  - Interior face of ends (sides), backs, and bottoms (including a bank of drawers).
  - Interior face of cabinet top members 36" (914 mm) or more above the finished floor.
  - Drawer box sides, sub fronts, backs, edgebanding, and bottoms.
  - The underside of cabinet bottoms between 24" (610 mm) and 42" (1067 mm) above the finished floor.
  - Security and dust panels or drawer stretchers.
- **CONCEALED SURFACES**, defined as those exterior or interior surfaces that are covered or not normally exposed to view including:
  - Toe space unless otherwise specified.
  - Sleepers, stretchers, and solid sub tops.
  - The underside of cabinet bottoms less than 24" (610 mm) above the finished floor.
  - The underside of countertops, knee spaces, and drawer aprons.
  - The flat tops of cabinets 80" (2032 mm) or more above the finished floor, except if visible from an upper floor or building level.
  - The three non-visible edges of adjustable shelves.
  - The underside of countertops, knee spaces, aprons and drawer boxes that are less than 36" (914 mm) above the finished floor.
  - The faces of cabinet ends of adjoining units that butt together.

SURFACE FINISH REQUIREMENTS

- **EXPOSED EXTERIOR SURFACES** for:
  - **WOOD** casework requires:
    - For **TRANSPARENT** finish, wood of specified species, cut, and match.
    - For **OPAQUE** finish at:
      - **CUSTOM GRADE**, MDF, MDO, close grain hardwood plywood, or solid stock.
      - **PREMIUM GRADE**, MDF and MDO.
  - **DECORATIVE LAMINATE** casework requires at:
    - **CUSTOM** and **PREMIUM GRADE**, HPL of specified color or pattern.
  - **CGS** (Compact Laminate) casework requires for **PREMIUM GRADE**, CGS of specified color or pattern.
- **EXPOSED INTERIOR SURFACES** for:
  - **CUSTOM GRADE** at:
    - **WOOD** casework requires:
      - For **TRANSPARENT** finish, wood of the same species as the exposed exterior surface.
      - For **OPAQUE** finish at, MDF, MDO, close grain hardwood plywood, or solid stock of manufacturer's choice.
    - **DECORATIVE LAMINATE** casework requires HPL or TFL compatible to exposed exterior surface in color, grain, or pattern of manufacturer's choice.
  - **PREMIUM GRADE** at:
    - **WOOD** casework requires:
      - For **TRANSPARENT** finish, wood of same the species and cut as the exposed exterior surface.
      - For **OPAQUE** finish, use of MDF and MDO of manufacturer's choice.
    - **DECORATIVE LAMINATE** casework requires, HPL, the same as the exposed exterior surface.
    - **CGS** (Compact Laminate) casework requires, CGS, the same as the exposed exterior surface.

SUGGESTION

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CASEWORK (continued)

SUGGESTION

SURFACE FINISH REQUIREMENTS

- **SEMI-EXPOSED SURFACES** for:
  - **WOOD** casework requires for both **TRANSPARENT** and **OPAQUE** finish at:
    - **CUSTOM GRADE**, wood of the manufacturer's choice of species, or TFL of the manufacturer's choice of color.
    - **PREMIUM GRADE**, wood of a compatible species to the exposed.
  - **DECORATIVE LAMINATE** casework at all grades requires, TFL of the manufacturer's choice of color.
  - **CGS** (Compact Laminate) casework requires, CGS of the manufacturer's choice of color.
- **CONCEALED SURFACES** for all grades at, decorative laminate, wood, and CGS (Compact Laminate) casework require the manufacturer's choice.

CABINET CONSTRUCTION TERMINOLOGY / OPTIONS

FRAMELESS construction where the front edge of the cabinet body components are edgebanded.

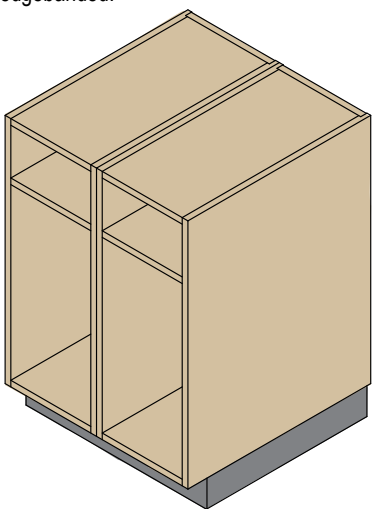

Figure: RG-229

FACE FRAME construction where the front edge of the cabinet body components are overlaid with a frame.

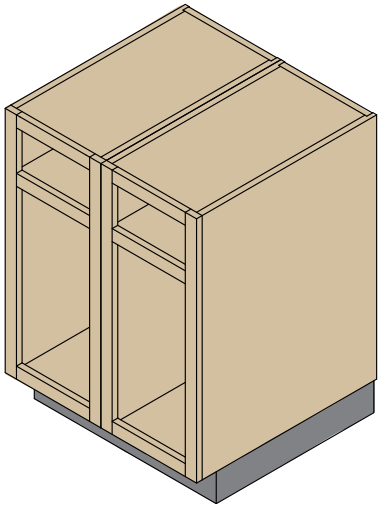

Figure: RG-230

SELECTION shall be manufacturer's choice, unless specified otherwise.

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CASEWORK (continued)

CABINET and DOOR INTERFACE TERMINOLOGY / OPTIONS

FRAMELESS construction options include:

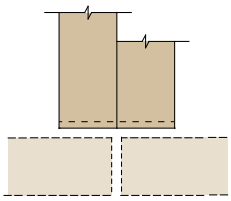

Figure: RG-231

Flush Overlay

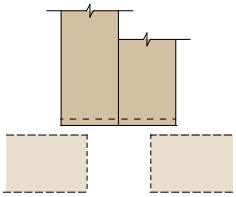

Figure: RG-232

Reveal Overlay

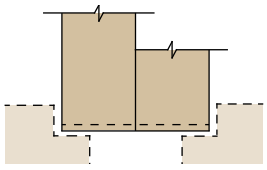

Figure: RG-233

Lipped

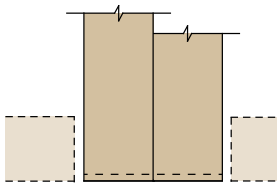

Figure: RG-234

Flush Inset

FACE FRAME construction options include:

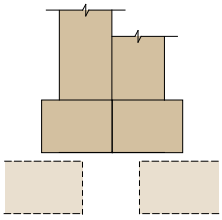

Figure: RG-235

Reveal Overlay

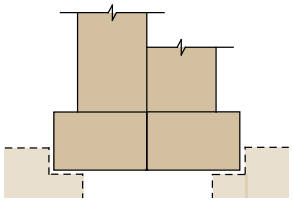

Figure: RG-236

Lipped

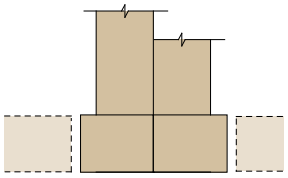

Figure: RG-237

Flush Inset

SUGGESTION

LAYOUT REQUIREMENTS OF GRAINED OR PATTERNED FACES BY GRADE

- **STILE** and **RAIL** doors and drawer fronts for all Grades, drawer fronts shall run either vertically or horizontally at the manufacturer's choice for the entire project. Doors shall be vertical.

Figure: RG-238

Figure: RG-239

- **FLUSH PANEL** doors and drawer fronts:
  - **CUSTOM GRADE** - doors, drawer fronts, and false fronts shall run and match vertically within each cabinet unit.

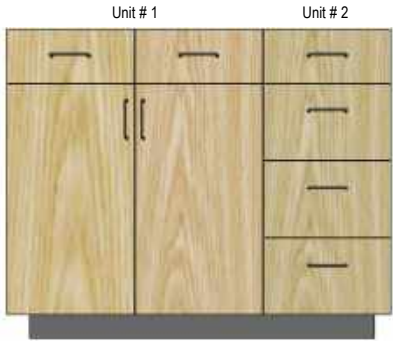

Figure: RG-240

  - **PREMIUM GRADE** - doors, drawer fronts, and false fronts shall run and match vertically and be sequenced horizontally within each cabinet unit; and at cathedral grain, the crown shall be pointing up and run in the same direction for the entire project. Doors, drawer fronts, and false fronts shall be well matched for color and grain across multiple cabinet faces in one elevation. Requirement for blueprint or sequencing between cabinet units must be so specified.

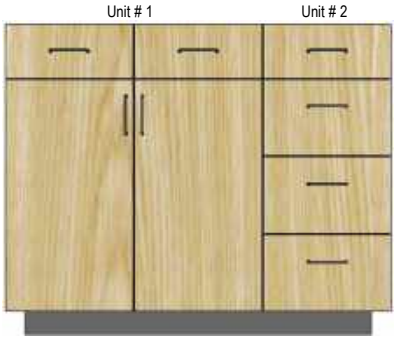

Figure: RG-241

SUGGESTION

CASEWORK JOINERY REQUIREMENTS

TESTING - All methods of casework and drawer joinery provided for within NAAWS 4.0 have been tested and proven compliant to the unique NAAWS requirements outlined in the **APPENDIX**. These tests are unique to NAAWS and were created specifically for the needs of architectural woodwork casework, and drawers. The test procedures and their success establish the minimum acceptable level of integrity and performance for casework / drawer joinery and in wall blocking requirements incorporated within NAAWS 4.0.

These testing requirements meet or exceed the highest and most demanding performance levels of ANSI/AWI 0641-2019.

CASEWORK DIMENSION RANGES

These ranges have developed over time with consideration of materials, ergonomics, construction techniques, and general intended usage. The following are guidelines from historical experience. It is the responsibility of the design professional to coordinate accessibility requirements, appliance and equipment sizes, and/or storage requirements with the casework manufacturer and adjust their required dimensions accordingly. Please note that illustrations are not to scale and are provided only to show dimension reference point:

- **BASE**:
  - **HEIGHT** - from the finished floor to the top of the countertop deck ranges from:
    - **34" (864 mm) to 36" (914 mm)** at stand-up counters.
    - **31" (787 mm) to 38" (965 mm)** at vanities.
    - **28" (711 mm) to 32" (812 mm)** at sit down counters, providing a clear knee space height of 24-1/2" (622 mm).
    - **25-1/4" (641 mm) to 28" (711 mm)** at keyboard recesses, providing a clear knee space height of 24-1/2" (622 mm).
  - **DEPTH** - from the front of the cabinet door / drawer to the face of the wall ranges from 22" (559 mm) to 30" (762 mm).

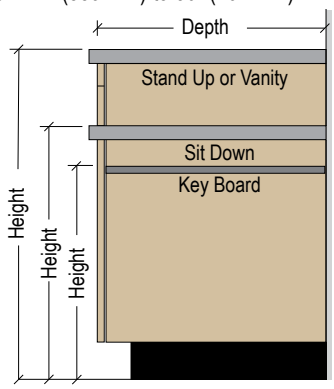

Figure: RG-242

SUGGESTION

CASEWORK DIMENSION RANGES (continued)

- **WALL HUNG:**
  - **HEIGHT** - including the light apron ranges from 12" (305 mm) to 48" (1220 mm).
  - **DEPTH** - from the front of the cabinet door to the face of the wall ranges from 12-1/2" (318 mm) to 14" (356 mm).

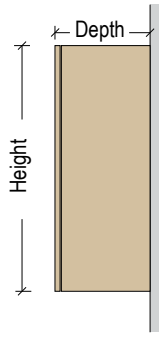

Figure: RG-243

- **TALL STORAGE:**
  - **HEIGHT** - from the finished floor to the cabinet top ranges from 72" (1829 mm) to 96" (2440 mm).
  - **DEPTH** - from the front of the cabinet door to the face of the wall ranges from 12-1/2" (318 mm) to 30" (762 mm).

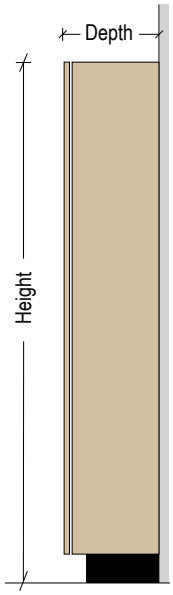

Figure: RG-244

- **RECEPTION COUNTER:**
  - **HEIGHT** - from the finished floor to the top of the countertop deck ranges from:
    - **34" (864 mm) to 42" (1067 mm)** at the standing side.
    - **28" (711 mm) to 32" (812 mm)** at the sit down-side, providing a clear knee space height of 24-1/2" (622 mm).
    - **25-1/4" (641 mm) to 28" (711 mm)** at the sit-down keyboard recesses, providing a clear knee space height of 24-1/2" (622 mm).
  - **DEPTH**:
    - **24" (610 mm) to 30" (762 mm)** overall countertop on the sit down-side, plus an additional 8" (203 mm) of countertop at the stand-up side.

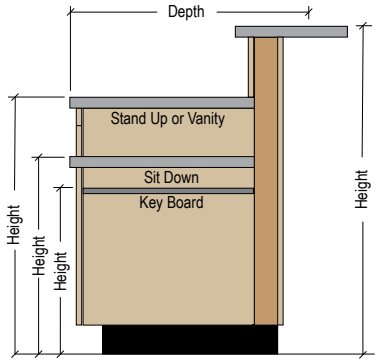

Figure: RG-245

- **TELLER COUNTER:**
  - **HEIGHT** - from the finished floor ranges from:
    - **50" (1270 mm) to 54" (1372 mm)** on the customer side at the security hood.
    - **40" (1016 mm) to 42" (1067 mm)** on the teller's side transaction countertop.
  - **DEPTH**:
    - **24" (610 mm) to 32" (813 mm)** at the countertop on the teller side, plus an additional 8" (203 mm) of countertop at the customer side.

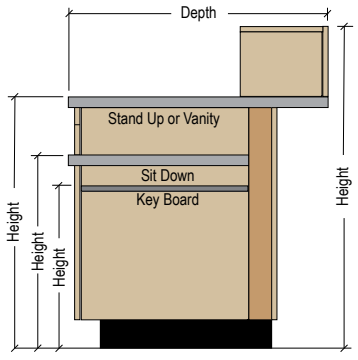

Figure: RG-246

SUGGESTION

DOOR AND APPLIED DRAWER FRONT PROFILES

For illustration purposes only and are not intended to be duplicated exactly:

- Common **EDGE PROFILES:**
  - Square edge with thin applied edgeband.

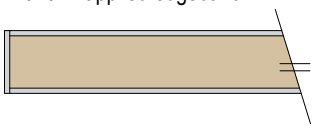

Figure: RG-247

  - Radius edge with thick applied edgeband.

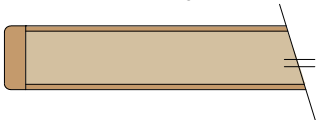

Figure: RG-248

  - Square edge with thick applied edgeband.

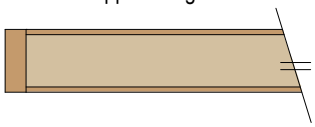

Figure: RG-249

  - Square edge with inset edgeband.

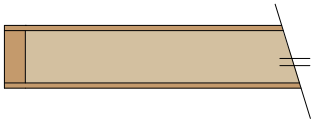

Figure: RG-250

  - Lipped edge with inset edgeband:

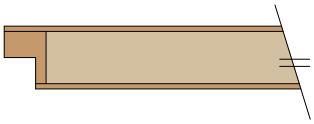

Figure: RG-251

To **PREVENT TELEGRAPHING**, inset solid wood edging when used must have similar moisture content as panel core, be glued securely and calibrated with panel core thickness prior to being laminated with a wood veneer on both faces.

- Common **RETENTION PROFILES**:
  - Fixed panel.

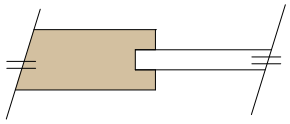

Figure: RG-252

  - Removable stop.

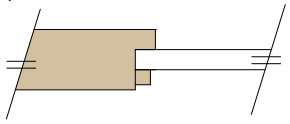

Figure: RG-253

  - Removable stop at HPL face.

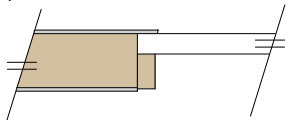

Figure: RG-254

  - Removable stop, synthetic.

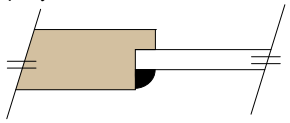

Figure: RG-255

  - Removable retainer, synthetic.

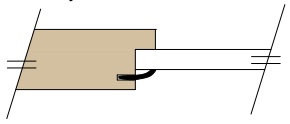

Figure: RG-256

  - Removable clips.

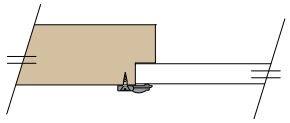

Figure: RG-257

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CASEWORK (continued)

CABINET DESIGN SERIES (CDS)

Details were developed by the industry and represent a series of numbered cabinet designs that are available for ease of specification and drawing. A numerical / elevation key to the CDS may be found in the **APPENDIX.** CAD details are available in both Autodesk Revit Families and AutoCAD ".dwg / .dxf" files and may be found at naaws.com.

These cabinets may be specified by number to a specific size requirement on the plan view drawings without having to draw elevations. They are drawn as Frameless Construction, flush overlay Interface', with integral finished ends and scribes at wall to wall installations not exceeding 1-1/2" (38.1 mm) in width.

CASEWORK INTEGRITY

These standards have adopted several requirements methods of testing and acceptable results as the minimum acceptable level of integrity for casework, as found in the **APPENDIX**.

CABINET HARDWARE

These standards have adopted ANSI/BHMA Standards (latest editions) buildershardware.com, Grade 2, as the basic minimum requirement. For more specific details, see the **PRODUCT** portion of this Section. Choice of product should be based on utility, aesthetics, security objectives, and the end use desired. As a general guide:

- **GRADE 1** is the highest and is suitable for most institutional applications.
- **GRADE 2** is used in most other applications.

DRAWER SLIDE SELECTION GUIDE

The following serves as both a checklist and a starting point for the discussion of a wide variety of drawer slide systems. While by no means exhaustive, the characteristics described below are often considered the most important by the client, the design professional, and the woodwork manufacturer. The selection of the slide characteristics will affect the usefulness of the cabinets. Careful consideration should be given to avoid "over specifying" for the purpose intended:

- **DEGREE OF EXTENSION:**
  - **Standard Extension**, all but 4" - 6" (102 - 152 mm) of drawer body extends out of the cabinet.
  - **Full Extension**, entire drawer body extends out to the face of cabinet.
  - **Full Extension** with over travel, entire drawer body extends beyond the face of cabinet.
- **STATIC LOAD CAPACITY**:
  - **50 pounds - R**esidential and light commercial.
  - **75 pounds** - Commercial.
  - **100 pounds** - Heavy duty.
  - **Over 100 pounds** - Special conditions, extra heavy duty.
- **DYNAMIC LOAD CAPACITY**:
  - **30 pounds/35,000 cycles** - Residential and light commercial.
  - **50 pounds/50,000 cycles** - Commercial.
  - **75 pounds/100,000 cycles** - Heavy duty.
- **REMOVAL:**
  - **Passive disconnect** - A means of drawer removal that does not require active disconnecting.
  - **Positive disconnect** - A means of removing a drawer that requires active disconnection or removal of hardware.
- **CLOSING:**
  - **Self-closing / stay closed** - Drawer slides will self-close with the related dynamic load when the drawer is 2" (50.8 mm) from the fully closed position and not bounce open when properly adjusted.
- **METAL SIDED DRAWER SYSTEMS** must be specified and should require:
  - **Positive stop** - Drawer must stop within itself and not rely on the drawer front to stop it.
  - **Pullout strength** - System must demonstrate sufficient strength of attachment of front to sides, design professional should evaluate and approve individually.

SUGGESTION

HINGE SELECTION GUIDE

Architectural cabinet hinges will usually be furnished from the manufacturer's stock unless otherwise specified. The three most common hinge types are illustrated below.

European hinges with the screws set in synthetic inserts are an established industry standard. These hinges have been found to be cost effective alternatives to the more traditional hinges shown below. Follow hinge material suppliers' recommendations on number and spacing of hinges. There are conditions, however, in which the use of butt or wraparound hinges will continue to be the best solution. Pivot hinges often require a cut in center hinge. Consult material supplier's recommendations:

- **European style hinge**, typically used in conventional flush without face frame and reveal or flush overlay application offering moderate strength, full concealment, moderate cost, ease of installation and adjustment.

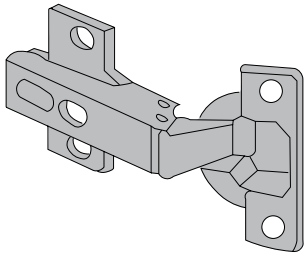


Figure: RG-258

- **Wraparound hinge (3 & 5 knuckle)**, typically used in flush and reveal overlay applications offering very high strength; however, can require mortising and shows an exposed knuckle and hinge body. Field adjustment is difficult.

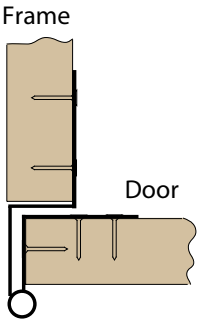


Figure: RG-259

- **Butt hinge**, typically used in conventional flush with face frame application, offering high strength, low cost, moderate ease of installation and adjustment; however, can require mortising and shows an exposed knuckle.

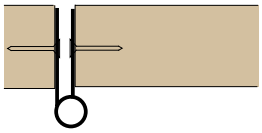


Figure: RG-260

ADJUSTABLE SHELF LOADING and DEFLECTION

Proper specification can balance aesthetic needs with load requirements.

Load is the total applied weight, uniformly dispersed on an individual shelf, not to exceed 200 lbs. (90.7 Kg) on any one shelf. These standards have adopted the following load capacities:

- **50 lbs. per sq. ft (244.1 kg/m2)** - School, hospital, library or book shelving.
- **40 lbs. per sq. ft (195.3 kg/m2)** - All other shelving.

Shelving specification requires consideration of deflection, the measured distance from a straight line that a shelf will deflect under load. L/144 (the length of the shelf divided by 144) is the industry standard for the maximum acceptable deflection of a shelf, which permits 1/4" (6.4 mm) deflection in a 36" (914 mm) shelf.

Creep is the increase in deflection over time, which fluctuates with temperature, humidity, and load stress. Creep is not considered a defect; if it is a concern, it can be reduced by:

- Reduced loading of shelves.
- Use of material with a higher (stiffer) modulus of elasticity (MOE).
- Use of alternate construction (support) techniques.
- Use of a decreased factor of acceptable deflection.

SUGGESTION

CONSTRUCTION DETAIL NOMENCLATURE

Familiarity with the labeled details on this and following pages will facilitate communication between architects, designers, specifiers, and woodwork manufacturers by establishing common technical language:

- **Stub Tenon** - Joinery method for assembling stile and rail type frames that are additionally supported, such as web or skeleton case frames.

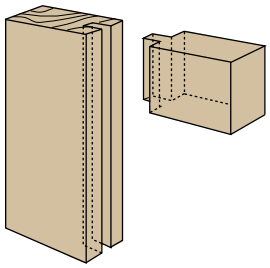


Figure: RG-261

- **Haunch Mortise and Tenon Joint** - Joinery method for assembling paneled doors or stile and rail type paneling.

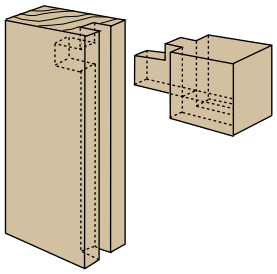


Figure: RG-262

- **Conventional Mortise and Tenon Joint -** Joinery method for assembling square edged surfaces such as case face frames.

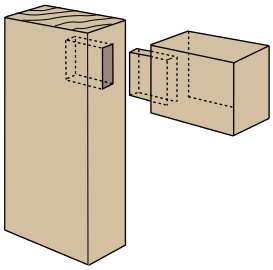


Figure: RG-263

- **Dowel Joint** - Alternative joinery method serving same function as Conventional Mortise and Tenon.

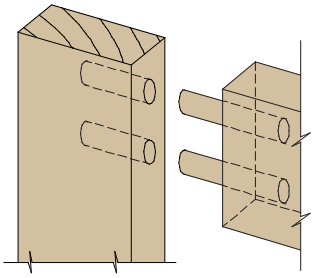


Figure: RG-264

- **French Dovetail Joint** - Method for joining drawer sides to fronts when fronts conceal metal extension slides or overlay the case faces.

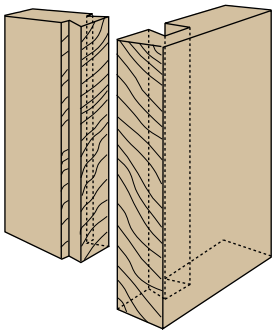


Figure: RG-265

- **Conventional Dovetail Joint -** Traditional method for joining drawer sides to fronts or backs. Usually limited to flush or lipped type drawers.

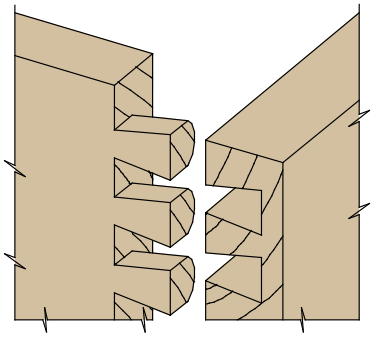


Figure: RG-266

SUGGESTION

CONSTRUCTION DETAIL NOMENCLATURE (continued)

- **Drawer Lock Joint** - Another joinery method for joining drawer sides to fronts. Usually used for flush type installation but can be adapted to lip or overlay type drawers.

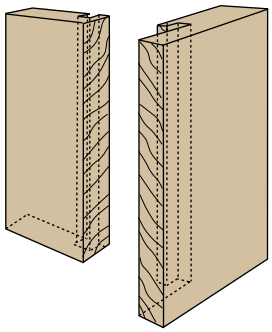


Figure: RG-267

- **Exposed End Details** - Illustrates attachment of finished end of case body to front frame using:
  - **Butt Joint**

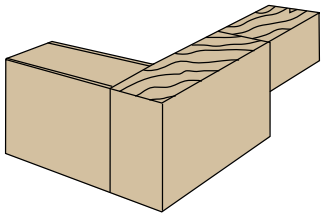


Figure: RG-268

  - **Shoulder mitered joint.**

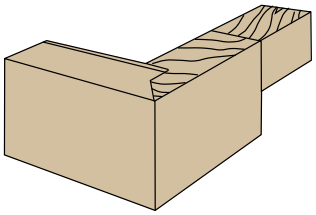


Figure: RG-269

- **Pocket Screw Joint.**

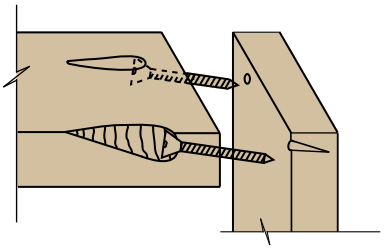


Figure: RG-270

- **Through Dado -** Conventional joint used for assembly of case body members. Dado not concealed by application of case face frame.

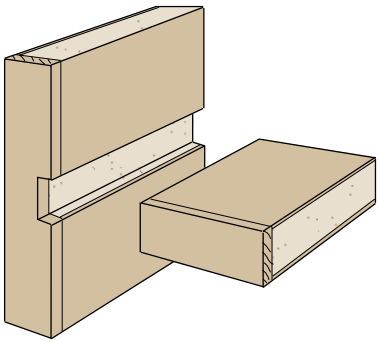


Figure: RG-271

- **Blind Dado** - Variation of Through Dado with applied edge "stopping" or concealing dado groove.

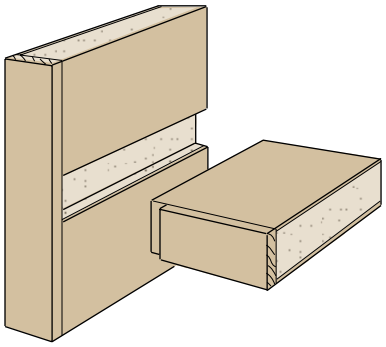


Figure: RG-272

- **Stop Dado** - Another method of concealing dado exposure. Applicable when veneer edging or solid lumber is used. Exposed end detail illustrates attachment of finished end of case body to front frame using butt joint.

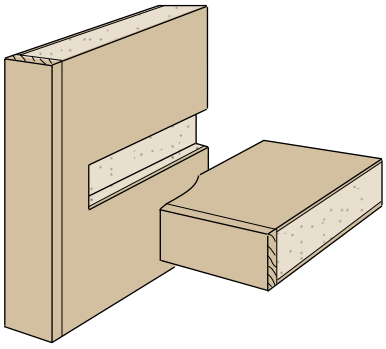


Figure: RG-273

SUGGESTION

CONSTRUCTION DETAIL NOMENCLATURE (continued)

- **Dowel Joint** - An established industry standard assembly method, this versatile joinery technique is often based on 1-1/4" (31.8 mm) spacing of dowels.

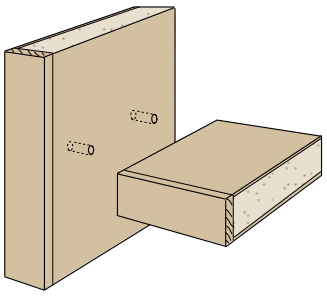


Figure: RG-274

- **Dowel Screw Joint -** An alternative to the dowel joint above.

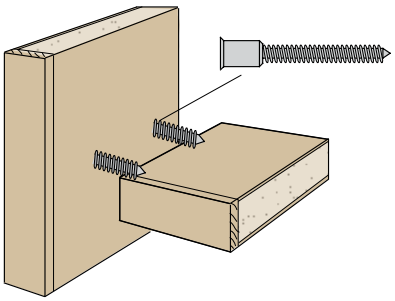


Figure: RG-275

- **Edgebanding** - Method of concealing plies or inner cores of plywood or particleboard when edges are exposed. Thickness or configuration will vary with manufacturers' practices.

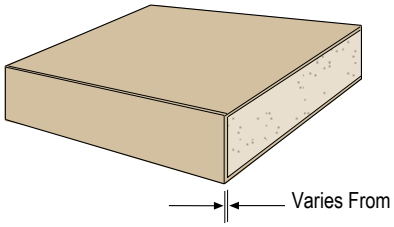


Figure: RG-276

- **Miter / Miter Fold Joint.**

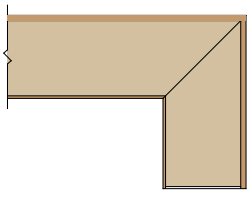


Figure: RG-277

- **Spline Joint:** Used to strengthen and align faces when gluing panels in width or length, including items requiring site assembly.

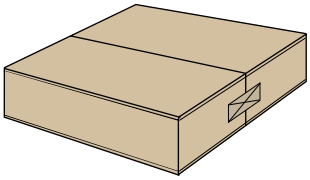


Figure: RG-278

- **Paneled Door Details** - Joinery techniques when paneled effect is desired. Profiles are optional as is the use of flat or raised panels. Solid lumber raised panels may be used when width does not exceed Custom Grade standard. Rim raised panels are required for Premium Grade or when widths exceed Custom Grade or when transparent finish is used.

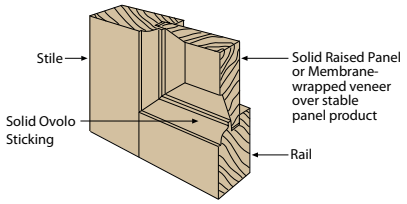


Figure: RG-279

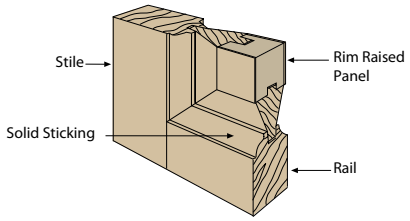


Figure: RG-280

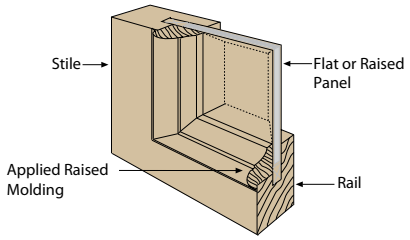


Figure: RG-281

North American Architectural Woodwork Standards 4.0, Effective September 01, 2021, ©2021 AWMAC | Woodwork Institute, as updated by ERRATA through December 01, 2021 and may be furthe updated by errata at naaws.com

CASEWORK REFURBISHING

SUGGESTION

RE-FINISH, RE-FACE or RE-FURBISH IN GENERAL

THIS TYPE OF WORK IS TYPICALLY REQUIRED TO BE DONE IN THE FIELD AND WITHOUT SPECIFIC CONTRACT DOCUMENT REQUIREMENTS TO THE CONTRARY:

- Will not update any seismic fabrication and/or installation deficiencies.
- Lead and/or toxic material abatement will not be the responsibility of the woodwork manufacturer / installer.

SPECIFICATIONS

Shall clearly indicate whether refinishing, refacing, refurbishing, or a combination thereof is required.

ARCHITECTURAL PLANS

Shall clearly indicate all casework to be refinished, refaced, and/or refurbished. The casework elevations shall also indicate any unusual or special requirements (such as structural repair or component replacement).

It is the design professional's responsibility to specify any and all modifications required for code compliance.

Including the means, methods, and materials required to retrofit casework for IBC Title 24 or other national compliance code(s).

The requirement for reinstallation of existing casework (if needed to be removed), in a manner other than the original, shall be so specified.

If new or additional wall blocking is required, it shall be so specified and be the responsibility of the contractor.

All refinishing, refacing, and/or refurbishing of casework governed by these standards shall generally be in accordance with these standards as applicable, with the following exception:

- Repair or modification of existing casework shall be in compliance with accepted methods of joinery as contained in these standards.

The method of repair used shall be optional with the manufacturer / installer.

REFINISHING

Can be as simple as the application of a new finish over the existing cabinet surfaces or as extensive as the removal of the existing finish, repair or patch of all physical defects, and the application of a new finish; however: does not include the replacement of hardware, unless so specified.

REFACING

Is usually more involved and very field labor intensive. Exposed surfaces to be refaced include doors, drawer fronts, cabinet face, and finished ends:

- **IF HPL**, shall be removed with any damaged core areas repaired and core surface suitably prepared for proper adhesion of the new surface material. Or resurfaced with a laminate with a peel and stick adhesive especially formulated for resurfacing existing HPL or TFL surfaces.
- **IF PAINT**, shall be stripped to the original surface with any damaged areas repaired and resurfaced with the specified material.

Does not include the refacing of cabinet interiors (semi-exposed surfaces) or replacement of hardware, unless so specified.

REFURBISHING

Includes either the refinishing or refacing of the exterior cabinet body, replacement of the cabinet doors and drawer fronts, and replacement of all exposed cabinet hardware, including hinges, pulls, catches, and locks; however:

- It does not include the repair or replacement of interior components such as shelves, drawer boxes, or drawer slides unless so specified.

New components, such as doors, drawer fronts, drawer boxes, and shelves, shall be compliant to these standards.

Gaps and tolerances shall match that of the existing casework within an elevation and within a room.

Hardware replacement for refurbished casework, or when specified to be included with refinishing or refacing, shall include door hinges, door and drawer pulls, and locks (keying requirement to be as specified).

Drawer slide replacement is not included unless specifically required in the contract documents.

Match of existing hardware is contingent on the availability of such from a manufacturer's current stock.

The method of repair or patching of tear outs used for proper hardware replacement shall be optional with the manufacturer / installer.

SUGGESTION

INTRODUCTION

Section 11 includes information on Countertops and Windowsills manufactured of Wood, HPL, Solid Surface, Engineered Stone, Epoxy Resin, CGS (Compact Laminate) and Natural Stone Products and their related parts.

TYPICAL COUNTERTOP CONFIGURATIONS

- **HPL edged HPL** - This type of top consists of HPL over a stable core, with an applied HPL edge.

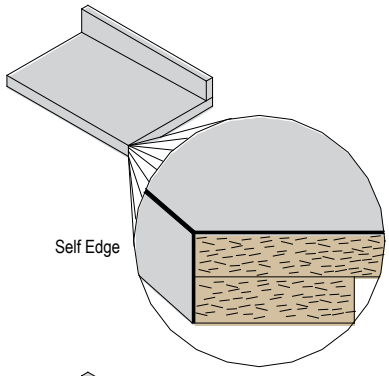


Figure: RG-282

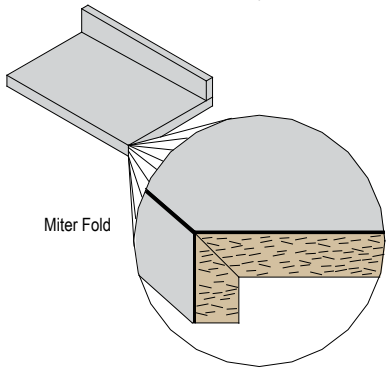


Figure: RG-283

- **Post formed HPL** - This type of top consists of HPL formed with heat and pressure over a stable core typically with a coved integral backsplash and must be specified.

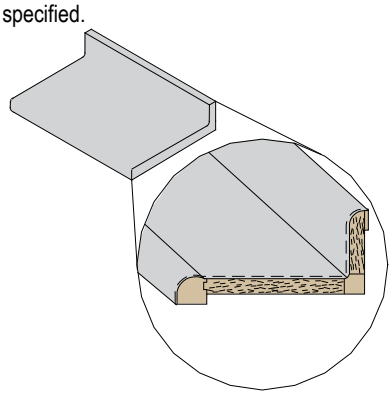


Figure: RG-284

- **Mixed Material** - This type of top may consist of a mixture of materials, such as wood, HPL, inlays, etc.

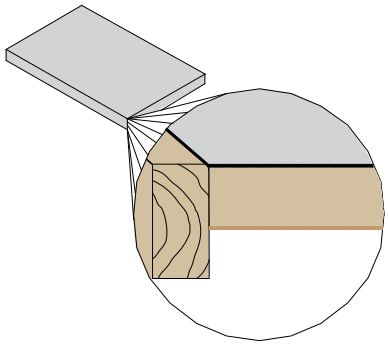


Figure: RG-285

- **Solid Surface** - This type of top requires special fabrication techniques, depending upon the composition of the product: however, its ability to produce inconspicuous seams allows for a variety of edge detail and thicknesses. Veined / swirled solid surface may have random patterns that cannot be matched at seams. Pattern breaks, changes and color variations may occur, and will not be considered a defect in materials or workmanship. Many manufacturers fabricate and install the product which must be specified by brand name, color / pattern and thickness. Typically, only available in 1/2" (12.7 mm) nominal thickness.

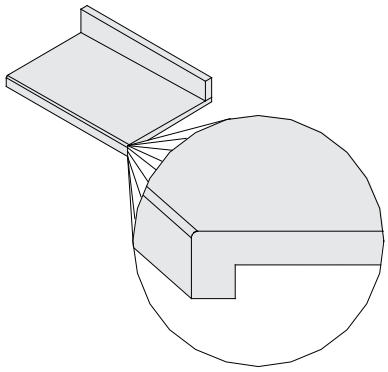


Figure: RG-286

TYPICAL COUNTERTOP CONFIGURATIONS (continued)

- **CGS (Compact Laminate) -** This type of top is a thick HPL, typically 1/4" to 1" in thickness, CGS features higher impact, moisture, scratch and abrasion resistance. Brand, color/pattern, and thickness must be specified.

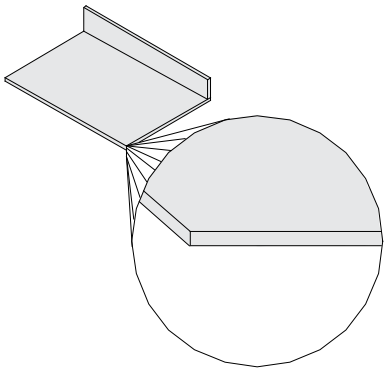


Figure: RG-287

- **Stone** - This type of top requires special fabrication techniques, depending upon the composition of the product. **Veined / swirled** stone may have random patterns that cannot be matched at seams. Pattern breaks, changes and color variations may occur, and will not be considered a defect in materials or workmanship. Many manufacturers fabricate and install the product which must be specified by brand name, color / pattern and thickness.
  - **Engineered** stone (Quartz) - Is non-porous and does not typically require sealing.
  - **Natural** stone - Is porous and requires sealing.

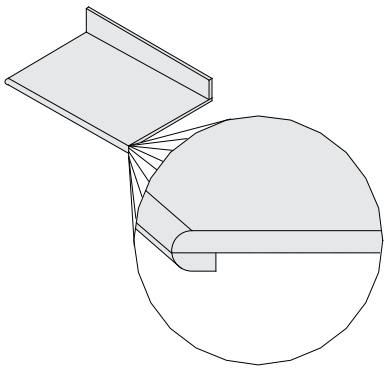


Figure: RG-288

- **Solid Laminated Wood** - This type of top consists of narrow strips of wood, face glued together, like "butcher block," but custom manufactured to contract documents.

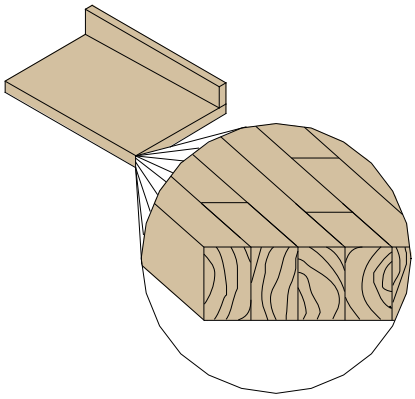


Figure: RG-289

- **Solid Wood** - This type of top consists of boards edge glued to a desired width. In this kind of top there is no assurance of matching grain or color at the edges or individual ends of the boards.

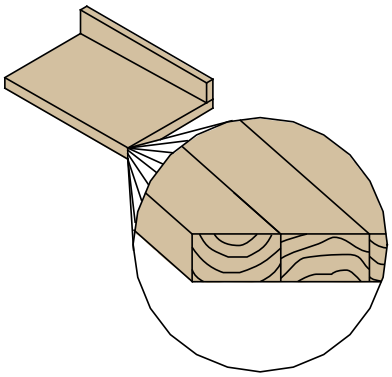


Figure: RG-290

SUGGESTION

TYPICAL COUNTERTOP CONFIGURATIONS (continued)

- **Wood Veneer** - This type of top consists of wood veneer laid up over a stable core, veneer edged, solid wood edged or with an applied decorative edge of another material as specified.

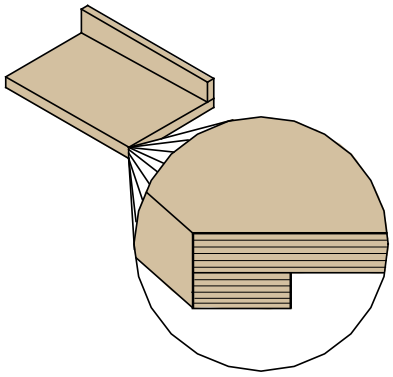


Figure: RG-291

- **Epoxy Resin** - Specially formulated resin tops designed to resist harsh chemicals. Must be specified by brand name and material supplier.

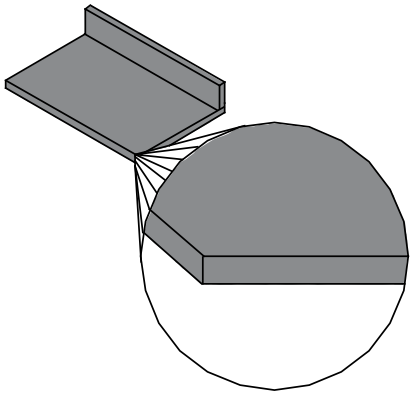
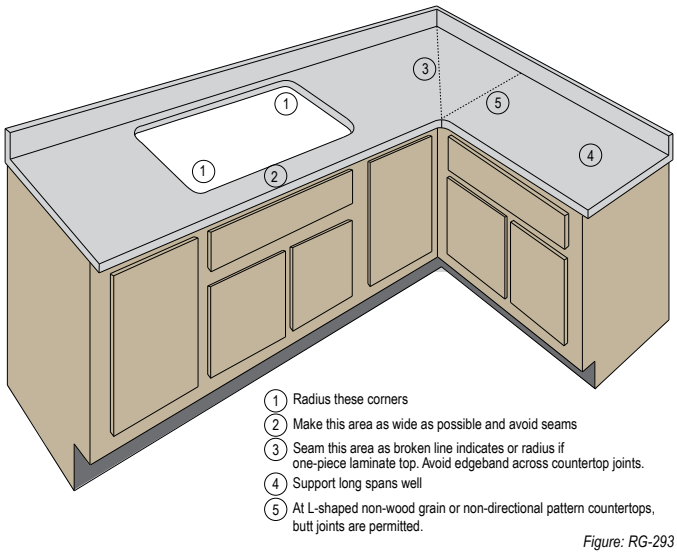


Figure: RG-292

GUIDELINES FOR FABRICATION / INSTALLATION OF HPL COUNTERTOPS

The following was taken in part from the National Electrical Manufacturers Association (NEMA), nema.org.

- When making a cutout (as for electrical receptacles, ranges, sinks, grills, windows, chopping blocks, L shaped counter tops, and so forth), inside corners should be smoothly rounded using a minimum comer radius of 1/8" (3.2 mm). A router is an ideal tool for making cutouts.
- When removing large areas from a sheet of laminate (e.g., a sink cutout), the connecting strips between the remaining areas should be left as wide as possible.
- Factory-trimmed sheet edges and saw-cut edges should be routed and filed. Original edges on factory cut laminates are not finished edges since oversized laminates are supplied to allow for proper fabrication.



1. Radius these corners
2. Make this area as wide as possible and avoid seams
3. Seam this area as broken line indicates or radius if one-piece laminate top. Avoid edgeband across countertop joints.
4. Support long spans well
5. At L-shaped non-wood grain or non-directional pattern countertops, butt joints are permitted.

Figure: RG-293

- All chips, saw marks, and hairline cracks should be removed from cuts by filing, sanding, or routing.
- Backsplash seam areas on countertops which are exposed to spilled water or other fluids should be sealed with caulking to ensure a tight seal.
- When laminate is bonded to a core, precaution should be taken to prevent warping of the assembly. Laminates used on shelves or in long unsupported spans should make use of a backer. A thick backer (approximately the same thickness as the face sheet), can provide more stability than a thin backer. Thicker laminates can offer better dimensional stability and resistance to stress (corner) cracking.
- Paint, varnish, vinyl film, and fiber backers will not balance HPL.
- Before using nails or screws, oversized holes should be drilled through the laminate with a sharp drill bit.

SUGGESTION

TYPICAL PROBLEMS AT HPL COUNTERTOPS - CAUSES AND PREVENTION

Some of the problems that may arise after laminates have been fabricated and installed are the following:

- **Cracking of the laminate at corners and around cutouts** may be caused by improper climate control, improper bonding and, sometimes, poor planning, or combination of these reasons. Cracking may be caused by shrinkage; proper climate control helps to prevent it. Rough edges, inside corners that have not been rounded, binding and/or forced fits can contribute to cracking. If the seams are properly placed in the layout of the laminate, stresses can be minimized.

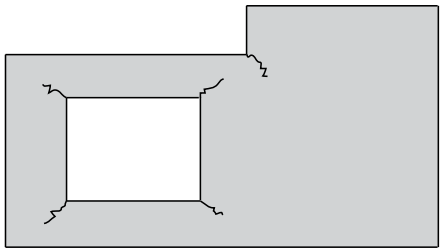


Figure: RG-294

- **Separation of the laminate** from the core may generally be caused by a poor adhesive bond. The bonding procedure should be reviewed with close attention to uniform glue line, uniform pressure and cleanliness of mating surfaces. If the edges fail to bond, extra adhesive may be applied and the product re-clamped.

  Some cleaning agents, excess heat, and moisture can contribute to bond failure at joints and edges.

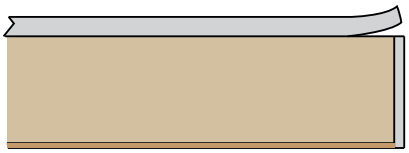


Figure: RG-295

- **Warping of the assembly** may be generally caused by unbalanced construction or unbalanced glue lines. Proper HPL backer sheets should be chosen and aligned so that their grain direction is parallel to that of the face laminate. Proper gluing is also important. If the core is secured to a framework, the framework should be designed to hold the assembly to a flat plane. Conditioning is also helpful.

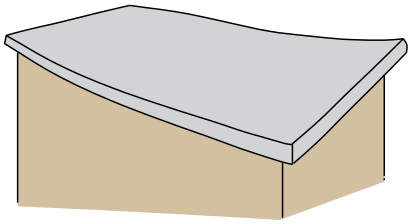


Figure: RG-296

- **Blistering or Bubbling** of the laminate surface away from the core can be caused by excessive heat, starved glue line, improper conditioning, and inadequate pressure or drying. Use of a PVA glue line and pressure over clean, conditioned laminates and core might have prevented the problem.

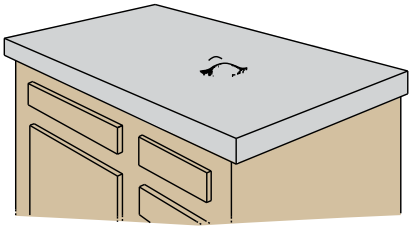


Figure: RG-297

  The forming of a blister or bubble over a small area, often accompanied by a darkening of the laminate can be caused by continual exposure to a source of heat. Electrical appliances which produce heat and light bulbs should not be placed in contact with or close proximity to laminate surfaces.

- **Repeated Heating** may cause the laminate and adhesive to react and finally deteriorate after continual exposure to temperatures above 150˚ F (66° C).

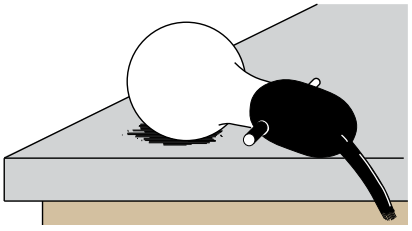


Figure: RG-298

SUGGESTION

TYPICAL PROBLEMS AT HPL COUNTERTOPS - CAUSES AND PREVENTION (continued)

- **Cracking of the laminate in the center of the sheet** may be caused by flexing of the core when it covers a wide span or by spot gluing. Wide spans call for sturdy framework, and special attention should be given to the uniformity of glue lines and gluing pressures. Also, care should be taken to avoid trapping foreign objects between the laminate and the core.

  Cantilevered overhangs should be designed with appropriate supports.

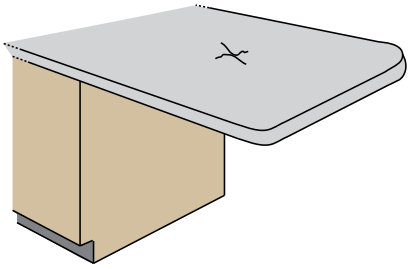


Figure: RG-299

  Long, unsupported spans should be avoided. A wide variety of engineering solutions are available.

CHEMICAL or STAIN RESISTANCE

Requirements must be specified. Consider the chemical and staining agents that might be used on or near the surfaces. Chemical and stain resistance is affected by concentration, time, temperature, humidity, housekeeping, and other factors; it is recommended that actual samples are tested in a similar environment with those agents. Common guidelines can be found by referring to:

- ISO 4586 (latest edition) for chemical resistance.
- ASTM D3023 and C1378 (latest editions) for stain resistance.
- SEFA #3 - Recommendations for work surfaces.
- SEFA #8 - PH, PL and W - Recommendations for CGS Compact Laminate, HPL and wood casework.

ABRASION RESISTANCE

Requirements must be specified. When abrasion resistance requirements are a concern, users should consider the abrasive elements that might be used on or near the countertop surfaces. Common guidelines can be found in:

- ASTM C501 (latest edition)
- ISO-4586 (latest edition)

CLEANING

For typical cleaning:

- Use a clean, damp, nonabrasive cotton cloth and a mild liquid detergent or household cleaner. Clean the soiled area using a rotating motion.
- Next, rinse with clean water, using a clean, non-abrasive cotton cloth. Please take care not to flood laminate, especially near seams, since water can penetrate and cause the substrate to swell.
- Dry the surface with a soft, clean, non-abrasive cotton cloth

Persistent or **tougher stains** may require a solvent or abrasive cleaner – consult the supplier's documentation specific to the surface to avoid damage.

SUGGESTION

HPL COUNTERTOPS

- **WHITE BACKGROUND PAPER** is utilized in some HPLs to achieve the high fidelity, contrast, and depth of color of their printed pattern, leaving a white line at exposed edges that is extremely noticeable with darker colors.
- **FLAME SPREAD RATED** - Class A Flame Spread Architectural HPL countertops are available. Countertops desired to be certified as a flame spread rated assembly (versus simply having been built with a flame spread rated laminate surface) shall be specified as a "Class A Flame spread Rated HPL Countertop."

  The term "Class A Flame spread Rated HPL Countertop" shall mean that the entire countertop assembly, including surface HPL, backer, core, and adhesive, has been tested and certified as to its Class A Flame spread Rating by an authorized organization, such as Underwriters Laboratories, and must be manufactured by an approved company of the certifying agency.

  Manufacturers of "Class A Flame Spread Rated Countertop Assemblies" require specific methods of installation and trimming in order to label and certify their product. Design professionals desiring to use a "Class A Flame Spread Countertop Assembly" should coordinate with an approved manufacturer during the design stage.

- **COUNTERTOP CONFIGURATION OPTIONS:**
  - **Matching Edge with No Splash**

Figure: RG-300

  - **Matching Edge with Butt Splash**

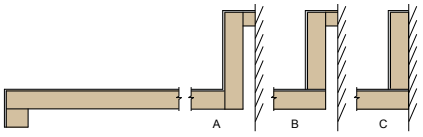


Figure: RG-301

  - **Matching Edge with Coved Splash**

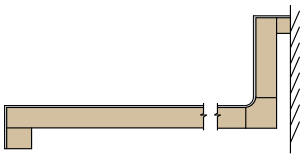


Figure: RG-302

  - **Post Formed Edge with No Splash**

Figure: RG-303

  - **Post Formed Edge with Butt Splash**

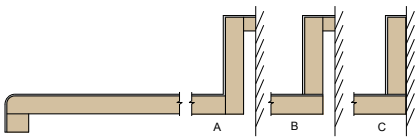


Figure: RG-304

  - **Post Formed Edge with Coved Splash**

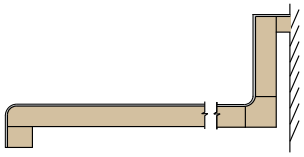


Figure: RG-305

  - **Fully Formed with Coved Splash**

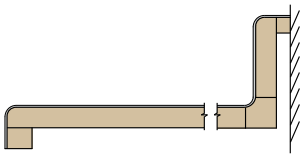


Figure: RG-306

  - **No-drip / Lipped Edge with Coved Splash**

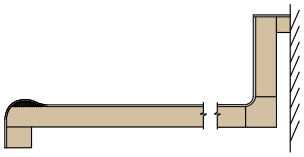


Figure: RG-307

  - **Wood Edge with No Splash**

Figure: RG-308

SUGGESTION

HPL COUNTERTOPS (continued)

- **OPTIONS AT TOP OF SPLASH:**
  - **Waterfall with Scribe**

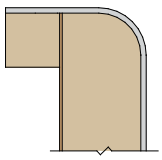


Figure: RG-309

  - **Square with Scribe**

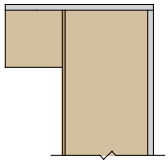


Figure: RG-310

  - **Square**

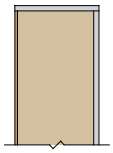


Figure: RG-311

- **DECK OPTIONS AT SPLASH:**
  - **Horizontal Butt**

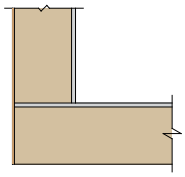


Figure: RG-312

  - **Vertical Butt**

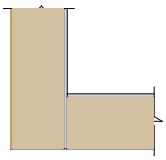


Figure: RG-313

  - **Coved**

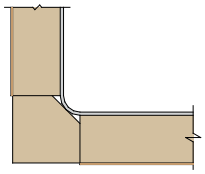


Figure: RG-314

- **FRONT EDGE OPTIONS:**
  - **Matching Edge with Wide Build Up**

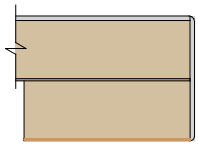


Figure: RG-315

  - **Matching Edge with Narrow Build Up**

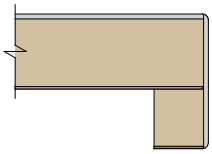


Figure: RG-316

  - **Matching Edge with Drip Groove**

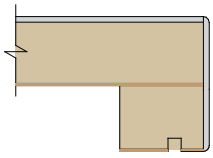


Figure: RG-317

  - **Waterfall**

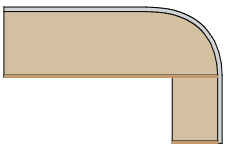


Figure: RG-318

  - **No Drip / Lipped Edge**

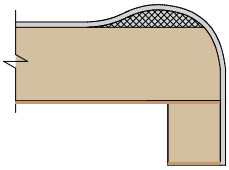


Figure: RG-319

  - **Full Round**

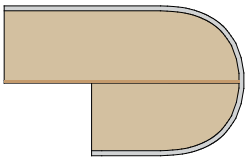


Figure: RG-320

HPL COUNTERTOPS (continued)

- **FRONT EDGE OPTIONS:**
  - **Solid Wood Edgeband w/ V Groove**

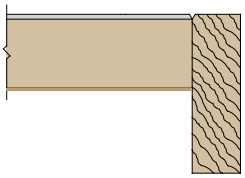


Figure: RG-321

- **Solid Wood Edgeband w/o V Groove**

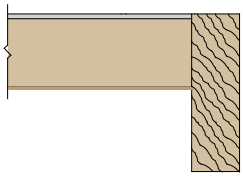


Figure: RG-322

  - **Solid Wood Edgeband with Overlaid Laminate**

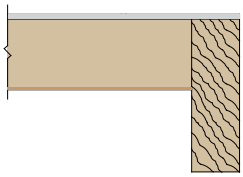


Figure: RG-323

  - **Miter Fold**

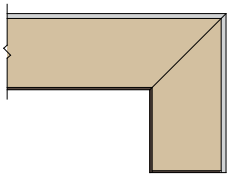


Figure: RG-324

  - **Thick PVC Edgeband**

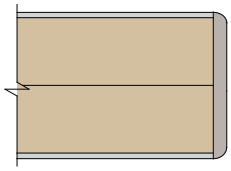


Figure: RG-325

  - **T Mold Edgeband**

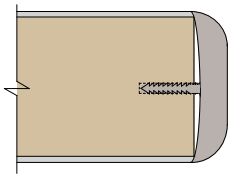


Figure: RG-326

- **TYPICAL MECHANICAL TIGHT JOINT FASTENER:**

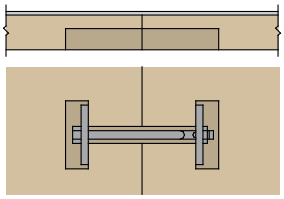


Figure: RG-327

SUGGESTION

SOLID SURFACE COUNTERTOPS

- **COLOR** and **PATTERN MATCH -** Some slight color variation may exist from sheet to sheet, sheet to bowl, or sink products. In sheet stock, use of the same batch material will reduce these variations.
- **REPAIRS -** When allowed, repairability varies from material to material and may be visible.
- **PRECAUTIONS -** Product dimensions are nominal. If tolerances are critical, review them with your manufacturer and/or installer.
- **MACHINABILITY**- is an issue with some materials and shall be taken into consideration on selection.
- **CONFIGURATION OPTIONS:**
  - **Built Up Edge**

Figure: RG-328

  - **Built Up Edge with Butt Splash**

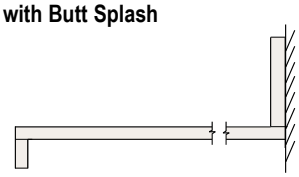


Figure: RG-329

  - **Built Up Edge with Coved Splash**

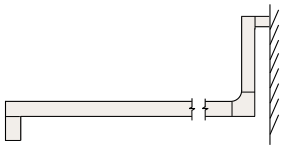


Figure: RG-330

- **TOP OPTIONS AT SPLASH:**
  - **Waterfall**

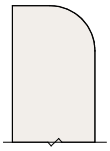


Figure: RG-331

  - **Square**

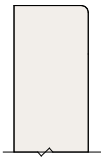


Figure: RG-332

- **DECK OPTIONS AT SPLASH:**
  - **Butt**

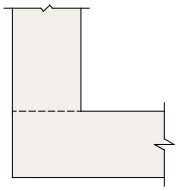


Figure: RG-333

  - **Coved**

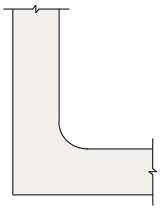


Figure: RG-334

- **EDGE OPTIONS:**
  - **Waterfall**

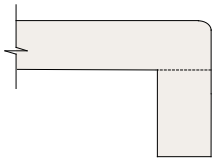


Figure: RG-335

  - **No-drip Lipped**

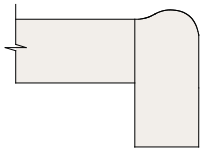


Figure: RG-336

  - **Build Up with Drip Groove**

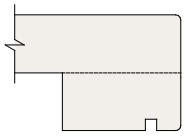


Figure: RG-337

SUGGESTION

CGS (Compact Laminate), EPOXY RESIN, AND NATURAL / ENGINEERED STONE COUNTERTOPS

- CONFIGURATION OPTIONS:
  - Butt Splash

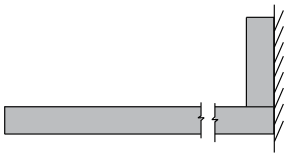


Figura: RG-338

  - Build Up

Figure: RG-339

  - Build Up with Butt Splash

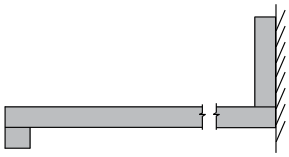


Figure: RG-340

- TOP AND DECK OPTIONS AT SPLASH:
  - Waterfall

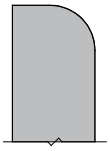


Figure: RG-341

  - Square

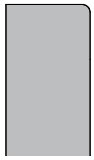


Figure: RG-342

  - Butt

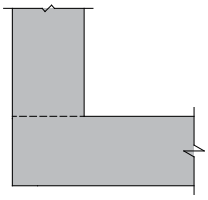


Figure: RG-343

  - Removable Ledge

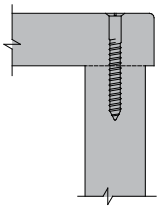


Figure: RG-344

- EDGE OPTIONS:
  - Drip Groove

Figure: RG-345

  - Marine Edge

Figure: RG-346

  - Waterfall

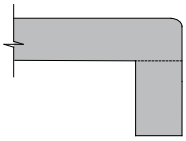


Figure: RG-346

  - Champher Edge

Figure: RG-348

  - Bull Nose Edge

Figure: RG-349

  - Build Up with Drip Groove

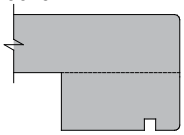


Figure: RG-350

North American Architectural Woodwork Standards 4.0, Effective September 01, 2021, ©2021 AWMAC | Woodwork Institute, as updated by ERRATA through December 01, 2021 and may be furthe updated by errata at naaws.com

WOOD COUNTERTOPS

- **CONFIGURATION OPTIONS:**
  - **Solid Butcher Block**

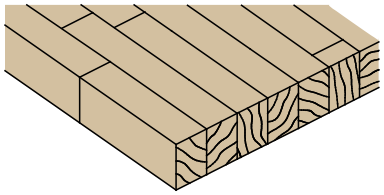


Figure: RG-351

  - **Solid Wide Width**

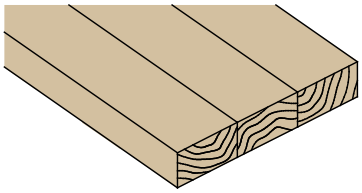


Figure: RG-352

  - **Solid, Splined Wide Width**

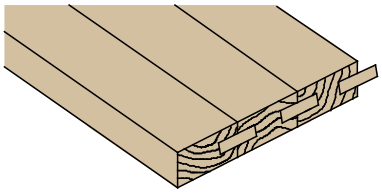


Figure: RG-353

  - **Veneer Edgebanded**

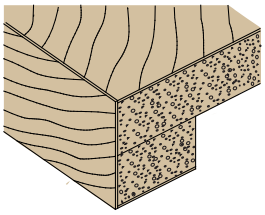


Figure: RG-354

  - **Solid Edgebanded**

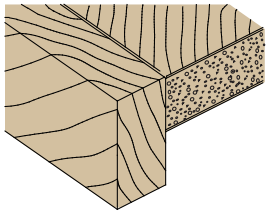


Figure: RG-355

  - **Solid Edgebanded with Overlaid Veneer**

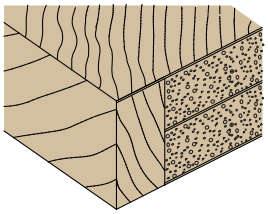


Figure: RG-356

TO PREVENT TELEGRAPHING, inset solid wood edging when used must have similar moisture content as panel core, be glued securely and calibrated with panel core thickness prior to being laminated with a wood veneer on both faces.

HISTORIC RESTORATION

SUGGESTION

INTRODUCTION

The United States Department of the Interior (doi.gov/), the National Park Service (nps.gov/), and the Historic Sites and Monuments Board of Canada (parkscanada.gc.ca/) publish documents related to work under their jurisdiction. The most recent publications from these entities will provide valuable information for the design professional and the woodwork fabrication, finishing, and installation.

The rationale and intent of this section is to assist in compliance with the U.S. Secretary of the Interior's "*STANDARDS FOR THE TREATMENT OF HISTORIC PROPERTIES* (The Standards) with Guidelines for Preserving, Rehabilitation, Restoring, and Reconstructing Historic Buildings (The Guidelines)" or the *STANDARDS AND GUIDELINES FOR THE CONSERVATION OF HISTORIC PLACES IN CANADA* which spell out requirements such as:

- The historic character of a property will be retained and preserved. The removal of distinctive materials or alterations of features, spaces, and spatial relationships that characterize a property will be avoided.
- Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
- Changes to property that have acquired historic significance in their own right will be retained and preserved. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a historic property will be preserved.
- Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
- Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible Treatments that cause damage to historic properties will not be used.
- New additions, exterior alterations, or related new construction will not destroy historic materials and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale, proportion, and massing to protect the historic integrity of the property and its environment.
- New additions and adjacent or related new construction will be undertaken in such a manner that if they are removed in the future, the essential form and integrity of the historic property and its environment will be unimpaired.
- Acceptable requirements of lumber and/or sheet products used within this woodwork product section are established by Sections 3 and 4, unless otherwise modified herein.
- Contract documents, furnished by the design professional, shall clearly indicate or delineate all material, fabrication, installation, and applicable building code / regulation requirements.

Quality assurance can be achieved by adherence to these standards and will provide the owner a quality product at competitive pricing. Working with a Woodwork Institute Certified Millwork Professional (CMP) and the Woodwork Institute Accredited Millwork Company (AMC) they represent to provide your woodwork will help ensure the understanding and performance of the quality level required. Illustrations in this Section are not intended to be all inclusive, other engineered solutions may be acceptable. In the absence of specifications; methods of fabrication are the manufacturer's choice. The design professional, by specifying compliance to these standards increases the probability of receiving the product quality expected.

HISTORIC RESTORATION (continued)

SUGGESTION

RESOURCES AND REFERENCES

Museums with period rooms - There are many historic houses around the country which are open to the public. Eighteenth Century homes such as Gunston Hall in VA, and Drayton Hall, near Charleston, SC, along the Eastern Seaboard and Neoclassical houses as one moves West. There are museums with period rooms as well. The Metropolitan Museum in New York, the Philadelphia Museum of Art, and Colonial Williamsburg are only a few.

Publications - Dover Publications, Inc., 31 East Second Street, Mineola, NY 11501.

Dover Publications has an incomparable listing of books which, for the most part, are reprintings of older publications; from Andrea Palladio's Four Books of Architecture to Augustus Charles Pugin's Gothic Ornament as well as handbooks and specialized subjects.

One invaluable Dover handbook is Illustrated Dictionary of Historic Architecture by Cyril M. Harris. It is from Harris that the definitions and many of the illustrations in the Glossary have been used with permission.

Three others which offer good illustrations are:

- Colling, James K. *Medieval Decorative Ornament*, New York, (Reprint of 1874 edition); Dover Publications, Inc. 1995
- Griesbach, C.B. *Historic Ornament: A Pictorial Archive*, New York, Dover Publications, Inc., 1975.
- Speltz, Alesander. *The Styles of Ornament*, (Reprint of German Edition of 1906), New York, Dover Publications, Inc., 1959.

Several books explaining in detail the orders of architecture are:

- Adam, Robert. *Classical Architecture: A Comprehensive Handbook to the Tradition of Classical Style*, New York: Harry N. Abrams, Inc., Publishers, 1990.
- Chitham, Robert. *The Classical Orders of Architecture,* New York: Rizzoli International Publications, Inc., 1985 (may be out of print).
- Ware, William R. *The American Vignola: A Guide to the Making of Classical Architecture*, New York: Dover Publications, Inc., 1994.

A definitive history of architecture is:

- Fletcher, Sir Banister. *A History of Architecture on the Comparative Method*, 20th edition ed., Dan Cruickshank and Andrew Saint, Oxford: Architectural Press, 1996.

For carving classical architectural elements:
Wilbur, Frederick. *Carving Architectural Detail in Wood: the Classical Tradition*, Lewes, UK: Guild of Master Craftsmen Publications, Ltd. 2000.

CARE & STORAGE

SUGGESTION

INTRODUCTION

Herein we address the most important aspects of preserving a good woodwork installation. Storage, jobsite conditions and relative humidity requirements before, during and after installation.

CARE

All construction related products, regardless of material, have particular care and storage requirements. Woodwork is not unique in this respect.

Architectural woodwork should be treated like fine furniture, particularly that which is constructed of wood finished with a transparent finish system. Modern commercial finishes are durable and resistant to moisture.

FINISH MAINTENANCE - With the exception of true oil-rubbed surfaces, modern finishes do not need to be polished, oiled, or waxed. In fact, applying some polishing oils, cleaning waxes, or products containing silicone may impede the effectiveness of touch-up or refinishing procedures in the future.
Remove oil or grease deposits with a mild flax soap, following the directions for dilution on the container.
No abrasives, chemical or ammonia cleaners should be used to clean woodwork surfaces.

Routine cleaning is best accomplished with a soft, lint-free cloth lightly dampened with water or an inert household dust attractant. Allowing airborne dust, which is somewhat abrasive, to build up will tend to dull a finish over time.

IMPACT - Avoid excessive or repetitive impact, however lightly applied. The cellular structure of the wood will compact under pressure. Many modern finishes are flexible and will show evidence of impact and pressure applied to them.

HEAT - Avoid localized high heat, such as a hot pan or plate, or a hot light source, close to or in contact with the finished surface.

PHOTODEGRADATION – Avoid exposure to direct sunlight as this may alter the appearance of woodwork over time.

HUMIDITY - Maintain the relative humidity around the woodwork in accordance with the guidelines published in these standards, every hour of every day, to minimize wood movement.

MOISTURE - Architectural woodwork, when properly finished, is relatively durable and resistant to moisture. Prevent direct contact with moisture, and wipe it dry immediately should any occur. Allowing moisture to accumulate on, or stay in contact with, any wood surface, no matter how well finished, will cause damage.

OXIDATION - Is a reaction of acids in wood (e.g., tannic acid), with iron, oxygen, and moisture, whether this be relative humidity or direct moisture. Control of moisture is a simple way to protect wood products from stains as a result of oxidation.

ABUSE - Use the trims, cabinets and fixtures, paneling, shelving, ornamental work, stairs, frames, windows, and doors as they were intended. Abuse of cabinet doors and drawers, for example, may result in damage to them as well as to the cabinet parts to which they are joined.

CLEANING - should be routine and accomplished with a soft, lint-free cloth lightly dampened with water or an inert household dust attractant. Allowing airborne dust, which is somewhat abrasive, to build up will tend to dull a finish over time:

- Remove oil or grease deposits with a mild flax soap, following its directions for dilution.
- Do not use abrasives, chemical or ammonia cleaners on fine architectural woodwork surfaces.

REFINISHING - Contact a local Sponsor Association member / affiliate, to explore the options for repair or refinishing. It is often cost effective to replace damaged woodwork elements rather than attempting large scale, on site refinishing.

CARE & STORAGE (continued)

RELATIVE HUMIDITY AND MOISTURE CONTENT

The space in which architectural woodwork is to be installed should be engineered with appropriate humidity controls to maintain its optimum relative humidity. Wood for architectural woodwork manufacturing use needs a moisture content within an optimum range.

A major cause for failure in architectural woodwork is the lack of controls for maintaining a consistent, year-round, appropriate relative humidity in a building or building space. Wood is susceptible to movement, shrinkage, expansion and warpage when exposed to air that has not been humidified. Without considerations made to properly regulate the relative humidity in any space containing architectural woodwork, some degree of failure of the woodwork can be expected.

Relative humidity outside the range shown on Table RG-011 for the respective region is particularly harmful to wood and wood products.

This table is intended to establish a range in which architectural woodwork can be properly stored, acclimatized, installed and maintained.

The most important effect of temperature is the effect it has on altering relative humidity levels See Table RG-012. Once a controlled humidity and temperature environment has been established the humidity shall be maintained without sudden changes, especially repetitive changes. It is suggested that daily / monthly range vary no more than 10° F (5.6° C) degrees and 15% relative humidity.

The table and map that follow (adapted from USDA's *The Wood Handbook* (latest edition), published by their Forest Products Laboratory, fpl.fs.fed.us/index.php) shows the Optimum Moisture Content and the Indoor Relative Humidity required to hold such moisture content within the general areas of the United States and Canada.

SOME OF THESE AREAS HAVE ADDITIONAL MICRO-CLIMATES NOT SHOWN OR REFERENCED.

CARE & STORAGE (continued)

Table: RG-011 - **RELATIVE HUMIDITY** and **OPTIMUM MOISTURE CONTENT**

CLIMATE CONTROLLED areas will be maintained with an operational HVAC system, and relative humidity meeting the range appropriate for the region as follows:

Geographical Location	Optimum Moisture Content	Optimum Relative Humidity
Most of U.S. and Canada	5-10%	25-55%
Damp Southern Coastal areas of the U.S. and Canadian Eastern Coastal Provinces	8-13%	43-70%
Dry Southwestern U.S.	4-9%	20-50%
Alberta, Saskatchewan, and Manitoba in Canada	4-9%	20-50%

and maintained Optimum Moisture Content between 5 - 10% inclusive, except in:

The damp Southern Coastal areas of the U.S. and in Eastern Coastal Provinces will be between 8 - 13% inclusive.

and

The dry Southwestern U.S., and Alberta, Saskatchewan, and Manitoba in Canada will be between 4 - 9% inclusive.

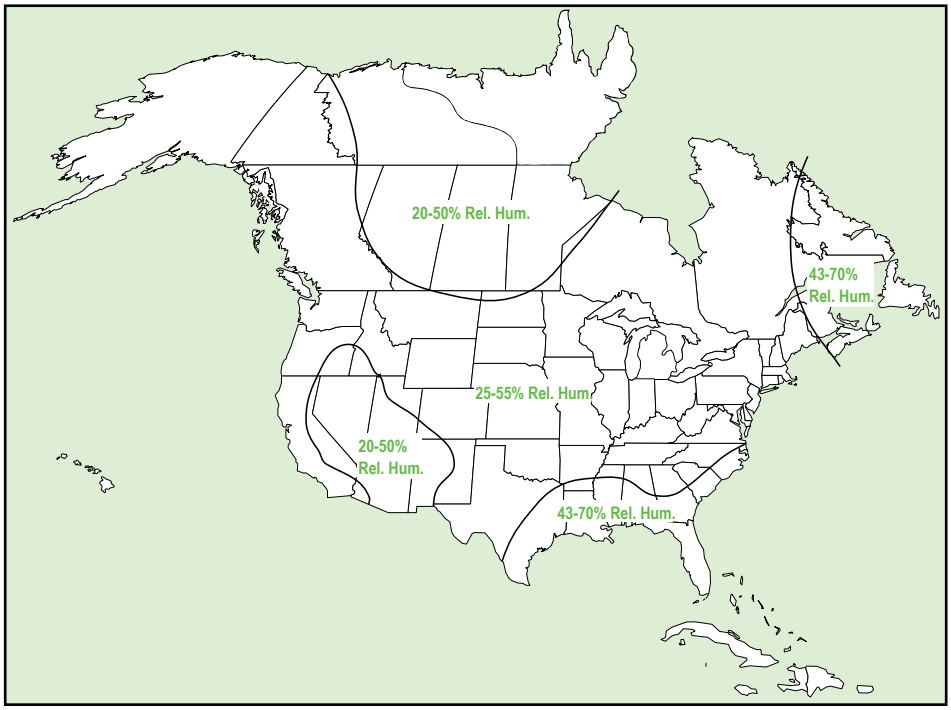


Figure: RG -357

RECLAIMED or RECYCLED WOOD

Ambient humidity and initial moisture content of reclaimed wood can be very important factors in insuring dimensional stability of the end product, and:

- With reclaimed wood moisture content may need to be addressed on a case by case basis. Typically. “barn wood” is supplied “dry” and is of little concern in this regard. On the other hand-timbers encrusted in earth or reclaimed from moist environments exposed to rain and water may require further drying to ensure stability.
- Additional drying may be particularly important when secondary milling is required to create the final form. Wood that may appear to be dry may contain a reservoir of moisture at its core which could be activated by further milling. This could result in a product which checks, cracks and distorts in unacceptable ways.
- For some design purposes instability may be a desired result. In other words, initial high moisture content may cause lumber to twist and crack after installation over time in ways that achieve a particular aesthetic result. Achieving these effects is the responsibility of the design professional working in close collaboration with the architectural woodwork manufacturer.

SUGGESTION

Table: RG-012 - **EQUILIBRIUM MOISTURE CONTENT VALUES AT VARIOUS TEMPERATURES AND HUMIDITY**

The following table indicates relative humidity must average between 25% and 55% to maintain wood moisture content between 5-10%. This range is best suited for most of the U.S. and Canada. While temperature has an impact on relative humidity, temperature alone has little effect on wood products if the relative humidity is maintained within recommended ranges.

Dry bulb temperature in degrees Fahrenheit	Wet bulb lowering in degrees Fahrenheit																												
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
40	83 17.6	75 14.8	68 12.9	60 11.2	52 9.9	45 8.6	37 7.4	29 6.2	22 5.0	15 3.5	8 1.9																	
45	85 18.3	78 15.6	72 13.7	64 12.0	58 10.7	51 9.5	44 8.5	37 7.5	31 6.5	25 5.3	19 4.2	12 2.9	6 1.5															
50	86 19.0	80 16.3	74 14.4	68 12.7	62 11.5	56 10.3	50 9.4	44 8.5	38 7.6	32 6.7	27 5.7	21 4.8	16 3.9	10 2.8	5 1.5													
55	88 19.5	82 16.9	76 15.1	70 13.4	65 12.2	60 11.0	54 10.1	49 9.3	44 8.4	39 7.6	34 6.8	28 6.0	24 5.3	19 4.5	14 3.6	9 2.5	5 1.3											
60	89 19.9	83 17.4	78 15.6	73 13.9	68 12.7	63 11.6	58 10.7	53 9.9	48 9.1	43 8.3	39 7.6	34 6.9	30 6.3	26 5.6	21 4.9	17 4.1	13 3.2	9 2.3	5 1.3	1 0.2								
65	90 20.3	84 17.8	80 16.1	75 14.4	70 13.3	66 12.1	61 11.2	56 10.4	52 9.7	48 8.9	44 8.3	39 7.7	36 7.1	32 6.5	27 5.8	24 5.2	20 4.5	16 3.8	13 3.0	8 2.3	6 1.4	2 0.4						
70	91 20.9	86 18.2	81 16.5	77 14.9	72 13.7	68 12.5	64 11.6	59 10.9	55 10.1	51 9.4	48 8.8	44 8.3	40 7.7	36 7.2	33 6.6	29 6.0	25 5.5	22 5.6	19 4.3	15 3.7	12 2.9	9 2.3	6 1.5	3 0.7				
75	91 21.0	86 18.5	82 16.8	78 15.2	74 14.0	70 12.9	66 12.0	62 11.2	58 10.5	54 9.8	51 9.3	47 8.7	44 8.2	41 7.7	37 7.2	34 6.7	31 6.2	28 5.6	24 5.1	21 4.7	18 4.1	15 3.5	12 2.9	10 2.3	7 1.7	4 0.9	1 0.2	
80	92 21.2	87 18.7	83 17.0	79 15.5	75 14.3	72 13.2	68 12.3	64 11.5	61 10.9	57 10.1	54 9.7	50 9.1	47 8.6	44 8.1	41 7.7	38 7.2	35 6.8	32 6.3	29 5.8	26 5.4	23 5.0	20 4.5	18 4.0	15 3.5	12 3.0	10 2.4	7 1.8	5 1.1
85	92 21.3	88 18.8	84 17.2	80 15.7	76 14.5	73 13.5	70 12.5	66 11.8	63 11.2	59 10.5	56 10.0	53 9.5	50 9.0	47 8.5	44 8.1	41 7.6	38 7.2	36 6.7	33 6.3	30 6.0	28 5.6	25 5.2	23 4.8	20 4.3	18 3.9	15 3.4	13 3.0	11 2.4
90	92 21.3	89 18.9	85 17.3	81 15.9	78 14.7	74 13.7	71 12.8	68 12.0	65 11.4	61 10.7	58 10.2	55 9.7	52 9.3	49 8.8	47 8.4	44 8.0	41 7.6	39 7.2	36 6.8	34 6.5	31 6.1	29 5.7	26 5.3	24 4.9	22 4.6	19 4.2	17 3.8	15 3.3
95	92 21.3	89 19.0	85 17.4	82 16.1	79 14.9	75 13.9	72 12.9	69 12.2	66 11.6	63 11.0	60 10.5	57 10.0	55 9.5	52 9.1	49 8.7	46 8.2	44 7.9	42 7.5	39 7.1	37 6.8	34 6.4	32 6.1	30 5.7	28 5.3	26 5.1	23 4.8	22 4.4	20 4.0
100	93 21.3	89 19.0	86 17.5	83 16.1	80 15.0	77 13.9	73 13.1	70 12.4	68 11.8	65 11.2	62 10.6	59 10.1	56 9.6	54 9.2	51 8.9	49 8.5	46 8.1	44 7.8	41 7.4	39 7.0	37 6.7	35 6.4	33 6.1	30 5.7	28 5.4	26 5.2	24 4.9	22 4.6
110	93 21.4	90 19.0	87 17.5	84 16.2	81 15.1	78 14.1	75 13.3	73 12.6	70 12.0	67 11.4	65 10.8	62 10.4	60 9.9	57 9.5	55 9.2	52 8.8	50 8.4	48 8.1	46 7.7	44 7.5	42 7.2	40 6.8	38 6.6	36 6.3	34 6.0	32 5.7	30 5.4	28 5.2
120	94 21.3	91 19.0	88 17.4	85 16.2	82 15.1	80 14.1	77 13.4	74 12.7	72 12.1	69 11.5	67 11.0	65 10.5	62 10.0	60 9.7	58 9.4	55 9.0	53 8.7	51 8.3	49 7.9	47 7.7	45 7.4	43 7.2	41 6.8	40 6.6	38 6.3	36 6.1	34 5.8	33 5.6
	13% moisture								10% moisture																			5% moisture

TO USE TABLE

Obtain wet and dry bulb readings. Subtract wet bulb reading from dry bulb reading. Find dry bulb on left margin of table and follow across to the column where the value at the top corresponds with the difference between wet and dry readings. At point of intersection, the upper figure in the square gives relative humidity in percent and the lower figure gives equilibrium moisture content of the woodwork.

EXAMPLES OF MOISTURE EQUILIBRIUM TABLE USE

The above may be used as a guide in determining whether or not the conditions in a construction area are suitable for receiving woodwork. For example: if woodwork with an 8% average moisture content is to be installed and the average temperature in the building will be maintained at 70° F, it can be determined by following the 70° F column horizontally to the right until the lower moisture content figures of 8.3% and 7.7% are reached.

Here the upper figures in the same squares show that ideally a relative humidity of between 44% and 40% should be maintained in order to achieve dimensional equilibrium. After the woodwork is painted or finished, moisture changes in the wood are retarded so that maintenance of relative humidity between the practical limits shown on the curve (between 5%-10% moisture content) of the humidity table, i.e., 25%-55% relative humidity, is usually satisfactory.

FRACTION, DECIMAL, & MILLIMETER CONVERSIONS

FRACTION	DECIMAL	MILLIMETER
1/64	0.01563	0.3969
1/32	0.03125	0.7938
3/64	0.04688	1.1906
1/16	0.06250	1.5875
5/64	0.07813	1.9844
3/32	0.09375	2.3813
7/64	0.10937	2.7781
1/8	0.12500	3.1750
9/64	0.14063	3.5719
5/32	0.15625	3.9688
11/64	0.17188	4.3656
3/16	0.18750	4.7625
13/64	0.20312	5.1594
7/32	0.21875	5.5563
15/64	0.23438	5.9531
1/4	0.25000	6.3500
17/64	0.26563	6.7469
9/32	0.28125	7.1438
19/64	0.29688	7.5406
5/16	0.31250	7.9375
21/64	0.32813	8.3344
11/32	0.34375	8.7313
23/64	0.35938	9.1281
3/8	0.37500	9.5250
25/64	0.39063	9.9219
13/32	0.40625	10.3188
27/64	0.42188	10.7156
7/16	0.43750	11.1125
29/64	0.45313	11.5094
15/32	0.46875	11.9063
31/64	0.48438	12.3031
1/2	0.50000	12.7000

FRACTION	DECIMAL	MILLIMETER
33/64	0.51563	13.0969
17/32	0.53125	13.4938
35/64	0.54688	13.8906
9/16	0.56250	14.2875
37/64	0.57813	14.6844
19/32	0.59375	15.0813
39/64	0.60938	15.4781
5/8	0.62500	15.8750
41/64	0.64063	16.2719
21/32	0.65625	16.6688
43/64	0.67188	17.0656
11/16	0.68750	17.4625
45/64	0.70313	17.8594
23/32	0.71875	18.2563
47/64	0.73438	18.6531
3/4	0.75000	19.0500
49/64	0.76563	19.4469
25/32	0.78125	19.8438
51/64	0.79688	20.2406
13/16	0.81250	20.6375
53/64	0.82813	21.0344
27/32	0.84375	21.4313
55/64	0.85938	21.8281
7/8	0.87500	22.2250
57/64	0.89063	22.6219
29/32	0.90625	23.0188
59/64	0.92188	23.4156
15/16	0.93750	23.8125
61/64	0.95313	24.2094
31/32	0.96875	24.6063
63/64	0.98438	25.0031
1	1.00000	25.4000

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MISCELLANEOUS CONVERSIONS

WHEN KNOWN	MULTIPLY BY	TO FIND
Inches	2.54	Centimeters
Inches	25.4	Millimeters
Square Inches	6.452	Square Centimeters
Feet	30.48	Centimeters
Square Feet	.0929	Square Meters
Yards	.9144	Meters
Square Yards	.8361	Square Meters
Miles	1.6	Kilometers
Square Miles	2.59	Square Kilometers
Acres	.4047	Hectares
Ounces	28.349527	Grams
Pounds	.4536	Kilograms
Pressure	.0703	Bar
Radius	2	Diameter
Diameter	.5	Radius
Diameter	3.1416	Circumference
Diameter	.8862	Side of an Equal Square
Circumference	.31831	Diameter
Circumference	.15915	Radius
Circumference	.2821	Side of an Equal Square
Square of Diameter	.7854	Area of Circle
Square of Diameter	3.1416	Square of Sphere of Globe
Square of Circumference	.07958	Area of Circle
Square of Radius	3.1416	Area of Circle
TO FIND	DIVIDE BY	WHEN KNOWN

WHEN KNOWN	MULTIPLY BY	TO FIND
Fahrenheit	0.556 after subtracting 32	Celsius
Celsius	1.8 and add 32	Fahrenheit

END OF RESOURCE GUIDE

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