

# STILE AND RAIL DOORS

SECTION  
1400

## Section 1400 Selection and Specification Checklist

Because most architecture, specification, and design firms have electronic master specifications in place, the AWI and AWMAC offer this quick checklist. A review of these items may help the design and specification team issue a complete and accurate contract document and avoid missing things vital to the successful completion of the project. The checklists are not considered a part of the Quality Standards for the purposes of compliance.

### Part 1. GENERAL

#### 1.1. REFERENCES

- A. AWI/AWMAC Quality Standards Illustrated (QSI), current edition

#### 1.2. SUBMITTALS

##### A. Shop drawings:

- Submit two copies; one of which will be returned with reviewed notations prior to commencement of work under this section.
- Indicate plans and elevations, materials, surface grain directions, profiles, assembly methods, joint details, fastening methods, accessories, hardware, compliance with specified fire-retardant treatments, preservative treatments, and schedule of finishes.

##### B. Finish samples:

- When appropriate, submit one or more samples of veneer-on-substrate, 200 x 250 mm [8 x 10"] illustrating expected range of component finish color and/or grain.
- When appropriate, submit one or more samples of solid lumber, 300 square centimeters [50 square inches] illustrating expected range of component finish color and/or grain.
- The sample shall bear identification of the project, architect or designer, general contractor, woodwork manufacturer, items to which the finish applies and the system utilized to attain the finish.

#### 1.3. QUALITY ASSURANCE

- A. Perform work in accordance with [Premium] [Custom] [Economy] Grade quality

- B. Work in this section shall comply with the specified Grade(s) of Work and Section (s) of the current edition of the AWI/AWMAC Quality Standards Illustrated.

#### 1.4. QUALIFICATIONS

- A. Contractors and their personnel engaged in the work shall be able to demonstrate successful experience with work of comparable extent, complexity and quality to that shown and specified.

- B. Manufacturers who are members in good standing of the Architectural Woodwork Institute (AWI) or the Architectural Woodwork Manufacturers Association of Canada (AWMAC) and are familiar with this Standard.

#### 1.5. DELIVERY, STORAGE AND HANDLING

- A. Protect work from moisture damage according to QSI, Section 1700, Installation.

### Part 2. PRODUCTS

#### 2.1. MANUFACTURERS

- A. Manufacturers who are members in good standing of the Architectural Woodwork Institute (AWI) or the Architectural Woodwork Manufacturers Association of Canada (AWMAC) and are familiar with this Standard.

#### 2.2. LUMBER

- A. Softwood Lumber: If a particular species is desired, specify here.

- For exposed surfaces:
- For semi-exposed surfaces:
- For concealed surfaces:

- B. Hardwood Lumber: If a particular species is desired, specify here.

- For exposed surfaces:
- For semi-exposed surfaces:
- For concealed surfaces:

### 2.3. PANEL PRODUCTS

- A. Softwood plywood: Not usually used for in fine architectural woodwork, but specify here if part of the design aesthetic.
- For exposed surfaces:
  - For semi-exposed surfaces:
  - For concealed surfaces:
- B. Hardwood plywood: Made with medium density particleboard or fiberboard (MDF) core for interior use or moisture-resistant core stock for exterior use; specify face veneer species here.
- For exposed surfaces:
  - For semi-exposed surfaces:
  - For concealed surfaces:
- C. High-pressure decorative laminate (HPDL), specify by brand name and design name/part number.
- For exposed surfaces:
  - For semi-exposed surfaces:
- D. Core material for veneered or laminated components, if other than QSI standards:
- For exposed surfaces:
  - For semi-exposed surfaces:
- E. Solid surface materials, Thermoplastic sheets, Acrylic or methacrylate sheets, Solid phenolic core, or any other special panel product, specify by brand name and design name/product number.

### 2.4. WOOD TREATMENT

- A. List the specific local requirement for fire retardant treatment, if any.
- B. List the specific chemical and process for preservative treatment, if any.

### 2.5. GLAZING, HARDWARE, AND ACCESSORIES

- A. If glass is to be supplied by woodworker, the materials and requirements should be listed here.
- Wood stops shall conform to the QSI for the Grade of Work specified.
  - Finish coats on glazed exterior work, if any, shall be allowed to flow on to the glass.
- B. Fasteners: Size and type to suit application. Weather resistant if exterior. The QSI does not set standards for fasteners.
- C. Hardware, if not specified by brand name and part number, shall be mill option to meet QSI minimums.

### 2.6. FABRICATION

- A. Fabricate to [Premium] [Custom] [Economy] Quality Standards.
- B. Shop prepare and identify components of assemblies for matching during site assembly.
- C. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.
- D. Select a joinery technique, or leave it up to the manufacturer to choose from QSI compliant methods.

### 2.7. FINISHING MATERIALS AND APPEARANCE

- A. List the name of the finish system (topcoats) to be used from Section 1500
- B. List the sheen desired: [Flat] [Satin] [Semi-gloss] [Gloss].
- D. List the special or extra steps and/or products to be used, such as bleach, distressing, filler, glaze, shading, stain, toner or washcoats.

## 2.8. FINISHING REQUIREMENTS

- A. Sand work smooth and set exposed nails [and screws].
  - For opaque finishes, apply wood filler in exposed nail [and screw] indentations and sand smooth.
  - For transparent finishes, use wax or burn-in filler which blends with surrounding color and sheen, often after stain and before final top coat.
- B. When combining wood and laminates or other specialty products, careful consideration must be given to finishing specifications. Responsibility for finish wood parts should be clarified by the design professional here.
- C. Finish work in the factory in accordance with Section 1500.
- D. [Prime paint] [Seal] surfaces in contact with cementitious materials.

## Part 3. EXECUTION

### 3.1. EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are in place and ready to receive this work.

### 3.2. INSTALLATION

- A. Install work in accordance with [Premium] [Custom] [Economy] Grade, Section 1700, QSI.
- B. Set and secure materials and components in place, plumb and level.

### 3.3. ADJUSTING

- A. Adjust work under provisions of Section [ ] of the contract documents.
- B. Adjust moving or operating parts to function smoothly and correctly.

### 3.4. CLEANING

- A. Clean work under provisions of Section [ ] of the contract documents.



## General Criteria

### 1400-G-1

#### Scope

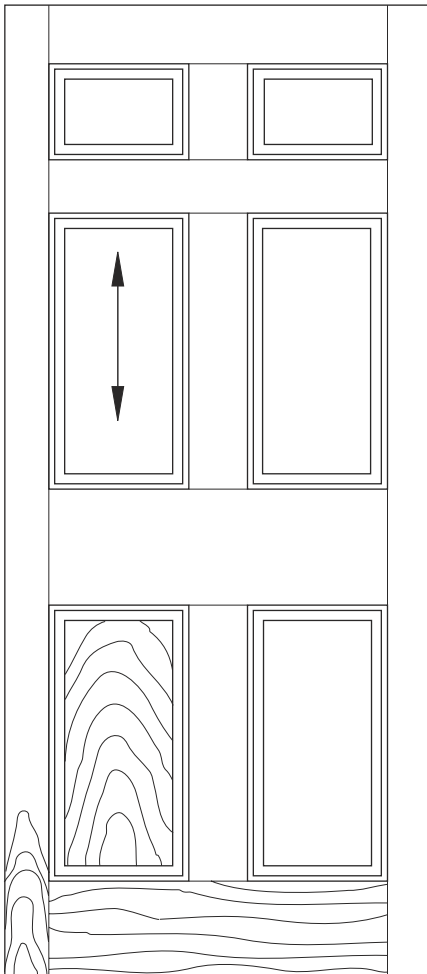
##### Includes:

Stile and rail doors, manufactured with solid lumber and/or panel products for a particular project.

Function, performance, and aesthetics are combined in producing a stile and rail wood door for a particular opening. Function and performance are primarily controlled by the door construction. Aesthetics are primarily controlled by species, veneer cut, matching of veneers and finish selected.

##### Excludes:

Commodity doors or commercial doors manufactured without the benefit of these standards.



Stile and Rail Doors - Figure 1400-01

### 1400-G-2

#### Specification Requirements

#### GRADE MUST BE SPECIFIED

These Standards provide for three grades: Premium, Custom, and Economy.

#### Premium Grade

The Grade specified when the highest degree of control over the quality of workmanship, materials, installation and execution of the design intent is required. Usually reserved for special projects, or feature areas within a project.

#### Custom Grade

The Grade specified for most conventional architectural woodwork. This Grade provides a well-defined degree of control over the quality of workmanship, materials and installation of a project. The vast majority of all work produced is Custom Grade.

#### Economy Grade

The Grade which defines the minimum expectation of quality, workmanship, materials, and installation within the scope of the Standards.

#### Prevailing Grade

When the Quality Standards are referenced as a part of the contract documents and no Grade is specified, Custom Grade standards shall prevail. In the absence of specifications, material shall be mill option lumber or veneers suitable for opaque finish.

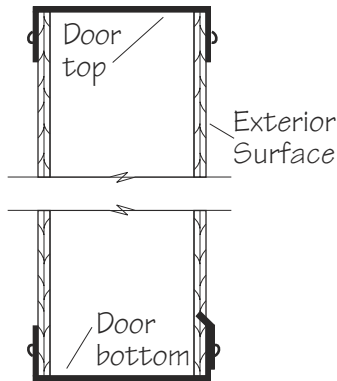
### 1400-G-3

#### Exterior Doors

Careful consideration must precede specification of wood doors for exterior use. The selection of a wood species suited for exterior exposure is critical. See Section 100 of this QSI for recommended species. Exterior doors shall be water repellent treated at the factory after manufacturing. Protect doors according to manufacturers' requirements, which may include flashing of top, bottom and cut outs. Exterior doors shall be properly sealed immediately after sizing and machining for fit in the field. Wood doors shall be protected from the sun and other weather elements by overhangs, deep recesses, etc. While wood stile and rail entry doors have performed well for centuries, the selection of a wood door places a burden on the owner to maintain the door by keeping it painted or sealed, protected from moisture, and properly adjusted in the opening.

Some door companies limit their warranties on exterior doors; some will provide no warranty.

### 1400-G-4 Flashing



Flashing Detail - Figure 1400-02

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

### 1400-G-5 Fire Ratings (when specified)

The traditional model codes have established a fire door rating and operating classification system for use in protecting door openings in fire-resistive-rated wall constructions. All fire doors must meet the requirements of current codes and bear certifying labels of an independent testing agency approved by the building official.

### Code and Rule Requirements

The design professional shall be responsible for contract documents which clearly detail products which will comply with applicable codes and rules including, but not limited to, NFPA 80 requirements; ADA national and federal guidelines; local, state, and federal building codes; positive pressure requirements and labeling; glass or glazing; prefabricating and/or machining for hardware; pre-hanging and/or machining for weatherstripping; priming, sealing and/or transparent finishing; and flashing and/or metal edge guards. The door manufacturer is often a valuable assistant in these matters.

### 1400-G-6 Factory Finishing (when specified)

Member firms differ in the variety of factory finishes offered. Some finishes may not be available from all manufacturers.

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.

### Finishing Options

Section 1500 of this Standard defines the finishing systems and performance characteristics.



Note: Careful study of Section 1500 and consultation with your member woodworker 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.

### Sample Submission

Member woodworkers often provide standard colors for selection.

To specify nonstandard colors and sheens, the architect shall provide two or more samples, at least 200 x 250 mm [8 x 10"], showing the desired finish effect on the wood species and cut to be used.

Samples shall bear identification of the project, architect, general contractor, and door supplier. The door manufacturer may elect to submit samples in sets of two or more, illustrating the possible range of variations. The finished sample sets then become the final criteria for evaluating color and finish appearance conformity. However, variations can be expected due to the nature of wood; such as the barber-pole effect in book matching, variations from heartwood to sapwood, etc.

### Sample Protection

Approved samples must be protected from the effect of light. Cover faces and place samples in closed storage during the period between approval and fabrication, finishing and delivery of the finished product.

### 1400-G-7

### Care and Installation at Job Site

#### Storing

- Store flat on level surface in a clean, dry, well-ventilated area protected from sunlight.
- Some species are sensitive to light and must be covered.
- Doors should not be subjected to extremes of heat and/or humidity. Relative humidity should not be less than 25% nor more than 55%.

- Store doors in closed-in building with operational HVAC system.
- Cover doors to keep clean, but allow air circulation.
- Seal at earliest possible moment. Edge sealing is particularly important.
- Lift or carry door. Do not drag one door against another.
- Handle doors with clean hands or clean gloves.

### Installation

- Allow doors to become acclimated to finished building heat and humidity before fitting and hanging.
- Utility or strength of doors must not be impaired by fitting to the opening, applying hardware, plant-ons, louvers or other detailing.
- In fitting for width, trim equally from both sides. See Fire Door Requirements (following section) for special fitting instructions on rated doors.
- In fitting for height, do not trim top or bottom edge more than 3/4" unless accommodated by additional blocking. See Fire Door Requirements (following section) for special fitting instructions on rated doors.
- Threaded-to-the-head wood screws are preferable for fastening all hardware on non-rated doors and required on all rated doors. Pilot holes must be drilled for all screws to avoid splitting.
- Use two hinges for doors up to 60" in height, three hinges for doors up to 90" in height, and an additional hinge for every additional 30" of door height or portion thereof.

### Fire Door Requirements (when specified)

Install doors as required by NFPA Pamphlet 80. Core reinforcements can be specified to permit hardware to be surface mounted with screws. Labels shall not be removed from fire-rated doors.

### Preparation of Labeled Doors

Preparation of rated doors must be done under label service in accordance with the manufacturer's service procedure. This includes trimming for size except a maximum of 19 mm [<sup>3</sup>/<sub>4</sub>"] off the bottom of the door. Preparation of locks, latches, hinges, closers, lights, louvers, astragals, and any fabrication must be done under licensed label service. Refer to NFPA 80, Standards for Fire Doors and Fire Windows for requirements and exceptions.

### 1400-G-8

### Construction Details

#### Stiles

Stiles are the vertical outside members. They may be solid wood or veneered. Stiles usually have solid sticking (solid stuck, solid moulded). Sticking is usually of two profiles: "cove and bead" or "ovolo." 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

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.

The 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.

The 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

The mullion is an upright or vertical member between panels. It is similar to a cross rail in the way it is fit and machined.

#### Panels

The door 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 along their longest dimension; vertical for tall panels and horizontal for wide (or laying) panels.

#### 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 moulding 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.

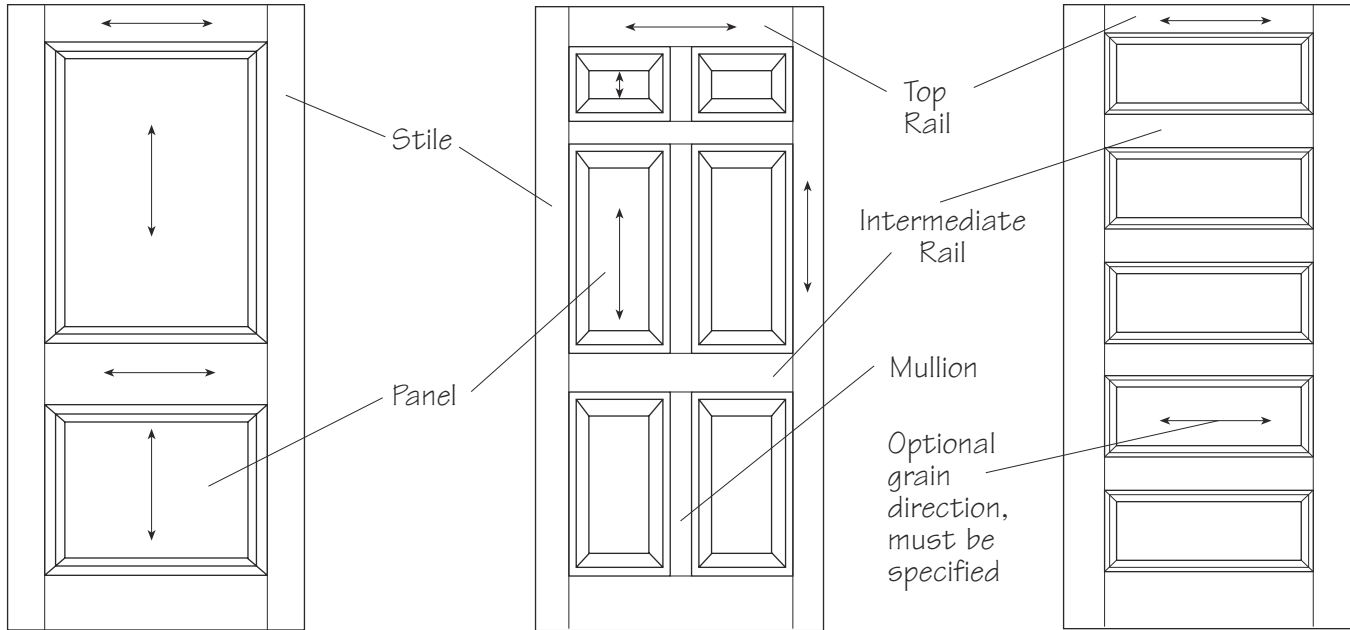
Custom-designed stile and rail doors offer many opportunities for creativity and choice. Some of the variables include:

- Panel layout
- Grain patterns and relationships
- Stile and rail construction
- Moulding details
- Panel construction
- Joinery techniques

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

1400-G-9

Door Thickness, Panel Layout, and Grain Patterns

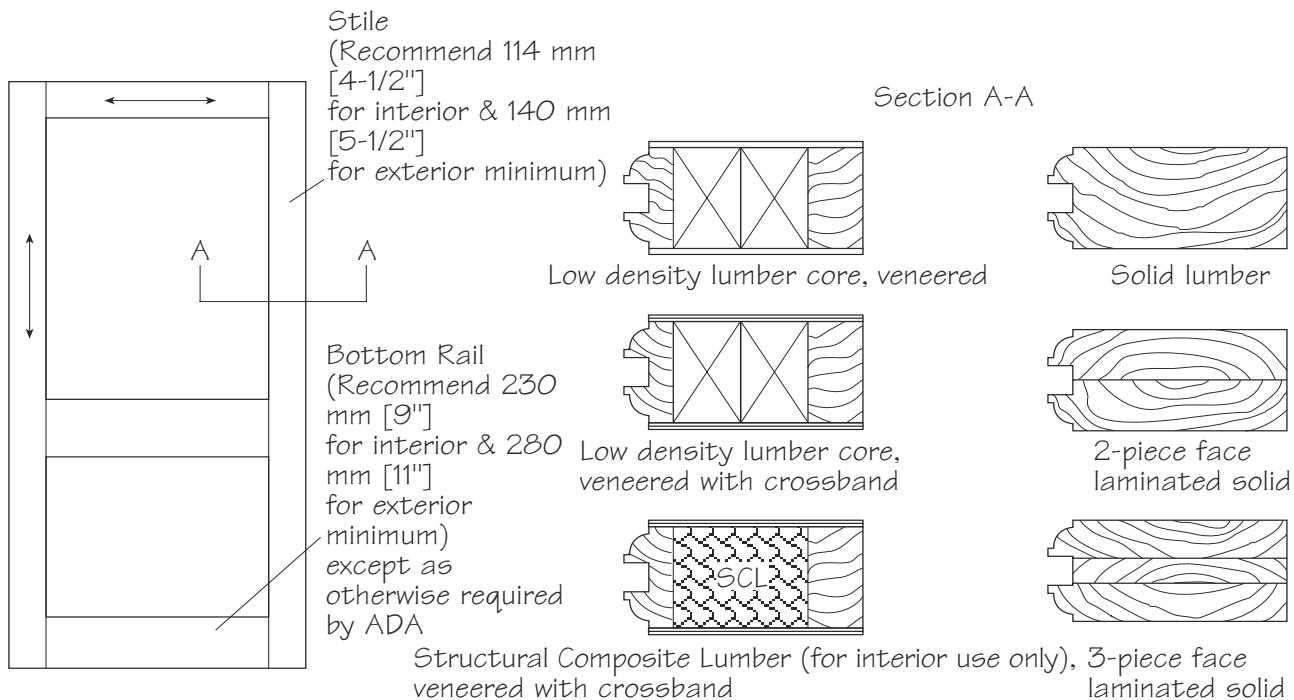


Layout and Grain - Figure 1400-04

Stile and rail doors are usually 44 mm [1-3/4"] thick. For doors over 1067 mm [3'-6"] in width or 2440 mm [8'-0"] in height, 57 mm [2-1/4"] minimum thickness is required. Doors over maximum width or height and required by specification to be less than 57 mm [2-1/4"] in thickness shall not be subject to this Standard's test for warp. Traditionally, the grain direction flows with the longest dimension of the stile, rail, or panel. Panel grain direction can sometimes be altered for design purposes, and must be specified. 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.

1400-G-10

Stile and Rail Construction

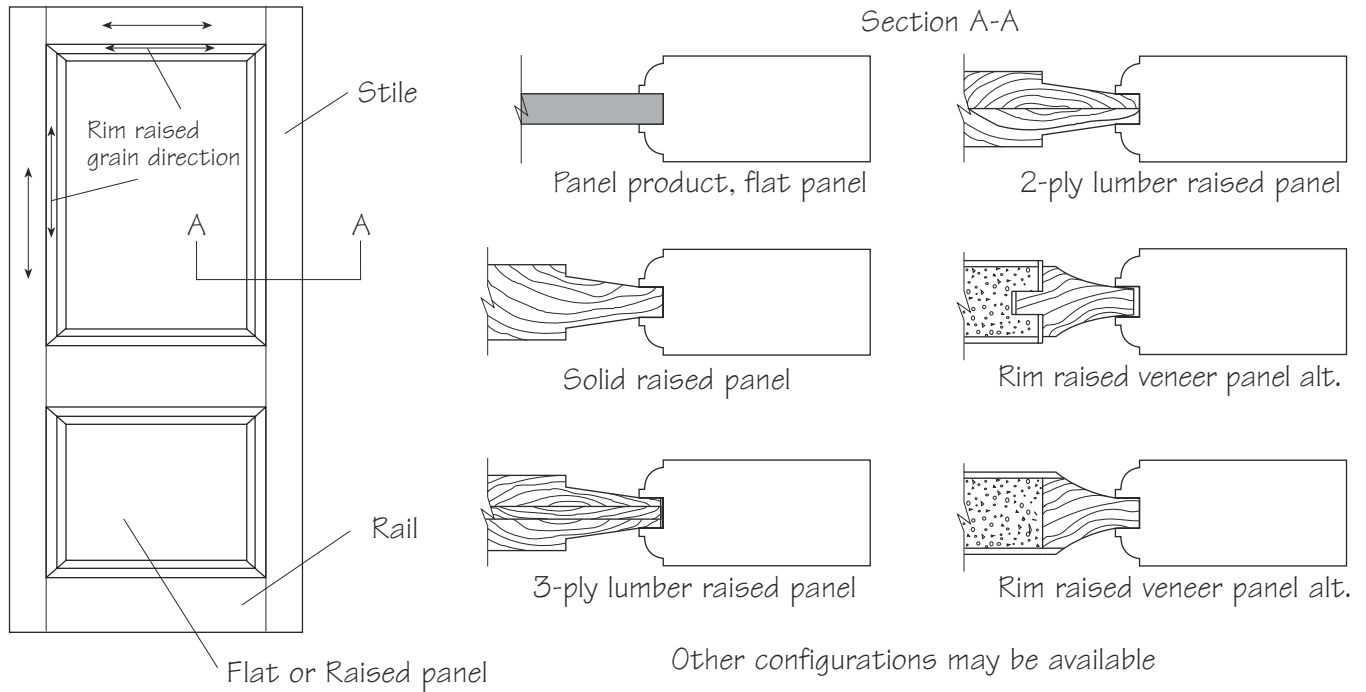


Stile and Rail Options - Figure 1400-05

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 the Test Sections of this Standard using any of the illustrated techniques and others.



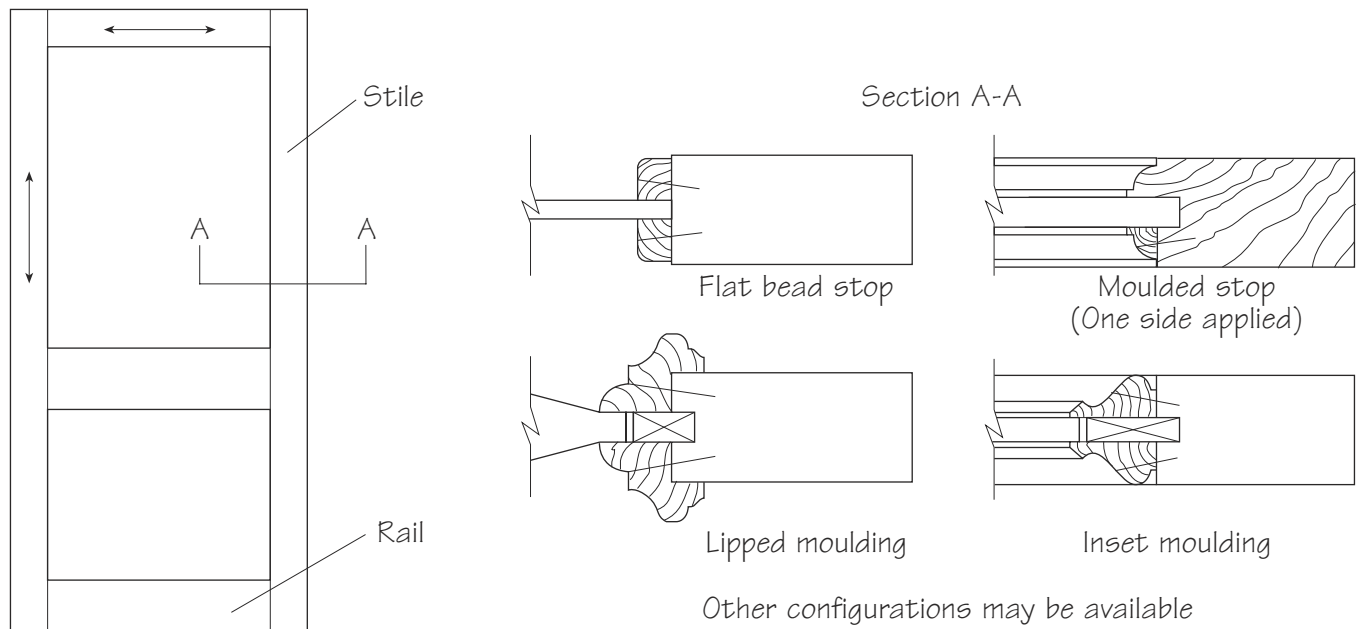
**1400-G-11**  
**Panel Construction**



*Panel options - Figure 1400-06*

There are a variety of methods of flat panel and raised panel fabrication. Review the Standards in this section for maximum allowable widths in solid or edge-glued lumber. It is possible to fabricate stile and rail doors that will perform within the tests established in the compliance criteria of this standard using any of the illustrated techniques and others.

**1400-G-12**  
**Panel and Glass Retention**



*Panel and Glass details - Figure 1400-07*

A wide variety of design choices are available from woodworkers. 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. Mouldings and stop are usually applied with small brads or finish nails.



## Technical Criteria

### 1400-T-1

#### Specification Requirements

Specific requirements for face, matching veneers, vertical edges, lights, louvers, moulding and transoms are provided in the following tables. Grade must be specified.

Architect or Design Professional shall ...

- specify the Grade required;
- specify the species and type of cut, if other than plain sawn;
- specify whether the panels are to be flat, rim-raised or solid;
- specify the ornamental details and joinery which affect the aesthetics and function;
- specify the preservative treatment for exterior use, if required
- specify the fire retardant rating, if required; and
- specify the fabrication techniques or door types as appropriate.

### 1400-T-2

#### Face Material Requirements

##### Veneers for Transparent Finishes

###### Premium Grade

“AA” grade faces are required for Premium Grade doors. Veneer is required to be of sufficient thickness to preclude sand-through, show-through of core, and glue bleed.

###### Custom Grade

“A” grade faces are required for Custom Grade doors. Veneer is required to be of sufficient thickness to preclude sand-through, show-through of core, and glue bleed.

###### Economy Grade

“B” grade faces are required for Economy Grade doors. Veneer is required to be of sufficient thickness to preclude sand-through, show-through of core, and glue bleed.

##### Solid Lumber for Transparent Finish

###### Premium Grade

Grade I hardwood or softwood

###### Custom Grade

Grade II hardwood or softwood

###### Economy Grade

Manufacturer’s option

## Materials for Opaque Finishes

### Premium Grade

Grade II hardwood or Grade I softwood lumber or sound close grain hardwood veneer, minimum “A” grade. Plain medium density fiberboard (MDF) or medium density overlay (MDO) also permitted.

### Custom Grade

Grade II lumber or sound close grain hardwood veneer, minimum “B” grade. Plain medium density fiberboard (MDF) or medium density overlay (MDO) also permitted.

### Economy Grade

Mill option

### 1400-T-3

#### Core Requirements (for Veneered Fabrication)

The architect/specifier is required to make a core selection depending upon the application. In some cases medium density fiberboard (MDF) core is recommended for panels. Stave lumber core is the traditional core for stile and rails. SCLC may be used for any Grade stiles or rails. MDF may be used for stiles or rails when specified or approved by the design professional in Premium Grade. The core materials are manufactured according to the following:

##### Medium Density Fiberboard Core (MDF)

Medium Density Fiberboard (MDF) core is manufactured to the ANSI standard A208.2.

##### Structural Composite Lumber Core (SCLC)

An engineered composite that utilizes wood strands from a variety of tree species providing an alternative to dimension lumber. The material is engineered for strength and stability. While not really “lumber,” it is marketed as a lumber substitute, to be used in primarily place of stave lumber core materials. SCLC is tested under a number of ASTM and other test criteria. There are insufficient data to recommend SCLC for exterior use.

##### Low Density (Stave) Lumber Core

May be a combination of blocks or strips, not more than 63.5 mm [2-1/2"] wide, of one species of wood at 6 to 9 percent moisture content. Joints to be tight and staggered in adjacent rows.

**1400-T-4**

**Exposed Vertical Edges**

**Premium Grade**

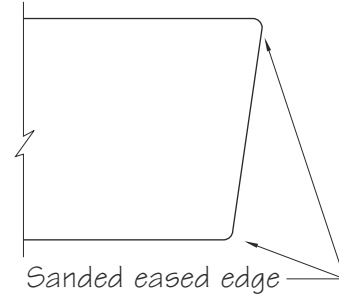
Same species as face, lumber, or veneer over hardwood.  
Joints not allowed. Sanded ease.

**Custom Grade**

Same species as face, lumber, or veneer, or compatible hardwood. Joints allowed. Sanded ease.

**Economy Grade**

Manufacturer's option



**1400-T-5**

**Glass and Glazing**

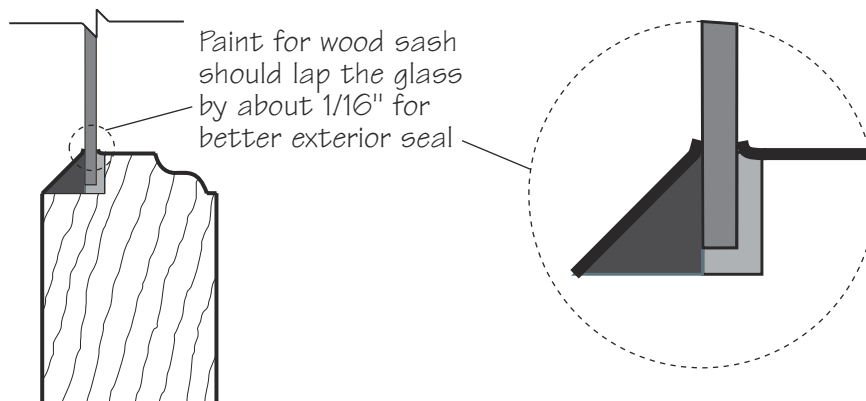
In the absence of specifications, the following standards will apply. Where more than one method or material is listed for a Grade, woodworkers will supply their choice from the alternatives.

Glass/Glazing	Premium	Custom	Economy
Wood Moulding Glass Stop	Plant prepared and bundled in sets appropriately labeled for the jobsite	Plant prepared and bundled in sets appropriately labeled for the jobsite	Shipped loose without preparation

Type, thickness, and manufacturer of glass, particularly insulated glass, must be specified as its construction dictates details of the receiving members. Specifications regarding code compliance are the responsibility of the design professional.

In the absence of specifications, profile of stop shall be mill option.

**It is recommended that the following be included in the painting section of the specifications: "To create the proper seal against weather, wind, and rain, the finish coats of all doors should be allowed to flow onto the glass area at least 1.6 mm [1/16"]. When cleaning the glass, a razor blade should not be used to scrape the glass. This will destroy the seal. A broad blade putty knife should be used to protect the seal between the glass and the wood."**



*Flow paint seal - Figure 1400-08*

## 1400-T-6

### Materials

In the absence of specifications, the following standards will apply. Where more than one method or material is listed for a Grade, manufacturers will supply their choice from the alternatives.

Materials	Premium		Custom		Economy	
	Transparent	Opaque	Transparent	Opaque	Transparent	Opaque
<b>Solid Lumber (see Section 100)</b>						
Stiles, rails, mullions and applied mouldings	I Well matched for grain and color between veneer and lumber	II	II Compatible for color between veneer and lumber	II	II With no selection for grain or color	II
Flat panels	Not permitted, panel product required		II Permitted for panels less than 350 mm [13-3/4"] across the grain		II Permitted for panels in any dimension	
Raised panels	I Used to rim panel product centers	II Used to rim panel product centers	II Used to rim panel product centers and permitted for panels less than 350 mm [13-3/4"] across the grain			

It is recommended all exterior wood elements be treated with a wood preservative in accordance with Section 100 of these Standards. Due to environmental considerations, not all manufacturers can treat wood products at their plant.

### Panel Products (see Section 200)

Core for veneered stiles, rails, and mullions	Low density lumber or SCL (MDF by specification)		Low density lumber, SCL or MDF		Mill option	
Core for veneered flat and raised panels	Particleboard or fiberboard (veneer core only by direct specification)		Particleboard or fiberboard (veneer core only by direct specification)	Particleboard or fiberboard recommended (veneer core permitted)	Particleboard or fiberboard recommended (veneer core permitted)	Particleboard, fiberboard or veneer core
Face veneer grade for transparent finish and material for opaque finish	"AA" face well matched for grain and color between veneer and lumber	"B" veneer, plain fiberboard or medium density overlay	"A" face compatible for color between veneer and lumber	"B" veneer, plain fiberboard or medium density overlay	"B" face veneer	"B" veneer, plain fiberboard or medium density overlay

### Minimum Assembly Thickness (up to 1067 mm [3'-6"] wide and/or 2440 mm [8'-0"] tall)

Veneered stiles and rails	44 mm [1-3/4"]	35 mm [1-3/8"]	35 mm [1-3/8"]
Flat panels	9.5 mm [3/8"]	9.5 mm [3/8"]	6.4 mm [1/4"]
Raised panels	19 mm [3/4"]	19 mm [3/4"]	12.7 mm [1/2"]

Note: 1) Wood has natural markings and characteristics which will enhance the beauty and value of any project. However, these natural characteristics may, when seen in the final product, not fulfill the design professional's intent. Therefore, it is the responsibility of the design professional to review the allowable criteria for these characteristics, in Section 100 of this Standard, to insure that material being specified will meet the project requirements. 2) Veneer slicing produces a "tight" and "loose" face on each leaf of veneer. Book matching of some species accentuates this condition, reflecting light differently in adjacent leaves and even causing differences in the absorption of stain. Consult Section 200, of this Standard, or your local woodwork manufacturer, when specifying veneer panels.

1400-T-7

**Workmanship**

Subject to design considerations, connecting joints between stiles, rails, and mullions shall be mortise and tenon, lag screws, or doweled, and glued under pressure, using Type I assembly on exterior doors. The following details and chart give a quick picture of reasonable expectations when doors are specified using the Premium and Custom Grades.

Workmanship	Premium		Custom		Economy	
	Transparent	Opaque	Transparent	Opaque	Transparent	Opaque
Cut of Lumber	Plain sawn	Plain sawn	Plain sawn	Plain sawn	Mill option	
Cut of Veneer	Plain sliced	Mill option	Plain sliced	Mill option		
<b>Matching Considerations</b>						
Stile and rail orientation	Top, cross & bottom rails shall run between the vertical stiles. Mullions shall run between horizontal rails. For Transparent finish, components shall be well matched for grain and color, member-to-member. No selection required for opaque finish.				Mill option	
Veneer match between adjacent leaves on a single panel face	Book match	Mill option	Book match	Mill option	Mill option	
Note on Special Matching: Book Match and End Match or Slip Match and End Match, or Special Sketch Faces must be specified and detailed in the architectural drawings. Consult an AWI/AWMAC manufacturer for design solutions.						
Veneer match within each panel face	Center and balance	Mill option	Running	Mill option	Mill option	
Veneer sequence between adjacent panels (Blueprint match available. See Section 200.)	Sequence match side-to-side and continuous vertically	Mill option	Selected for compatibility of grain and color	Mill option	Mill option	
Veneered panel sequence between doors (Blueprint match available. See also Section 200)	Selected for compatibility of color	Mill option	Selected for compatibility in general appearance	Mill option	Mill option	
Solid lumber panel	Not permitted		Selected for compatibility of color (transparent finish only)		Mill option	
Fiberboard or MDO panel	Permitted for opaque finish or core under veneer in any Grade					
<b>Minimum Thicknesses for 35 mm [1-3/8"] Thick Door</b>						
Flat Panels	9.5 mm [3/8"]		9.5 mm [3/8"]		6.4 mm [1/4"]	
Raised Panels	19 mm [3/4"]		19 mm [3/4"]		12.7 mm [1/2"]	
<b>Minimum Thicknesses for 44 mm [1-3/4"] Thick Door</b>						
Flat Panels	12.7 mm [1/2"]		12.7 mm [1/2"]		12.7 mm [1/2"]	
Raised Panels	28.6 mm [1-1/8"]		28.6 mm [1-1/8"]		28.6 mm [1-1/8"]	
<b>Minimum Thicknesses for 57 mm [2-1/4"] Thick Door</b>						
Flat Panels	19 mm [3/4"]		19 mm [3/4"]		19 mm [3/4"]	
Raised Panels	38 mm [1-1/2"]		38 mm [1-1/2"]		38 mm [1-1/2"]	
NOTE: Panel products for exterior doors must have Type I assemblies.						

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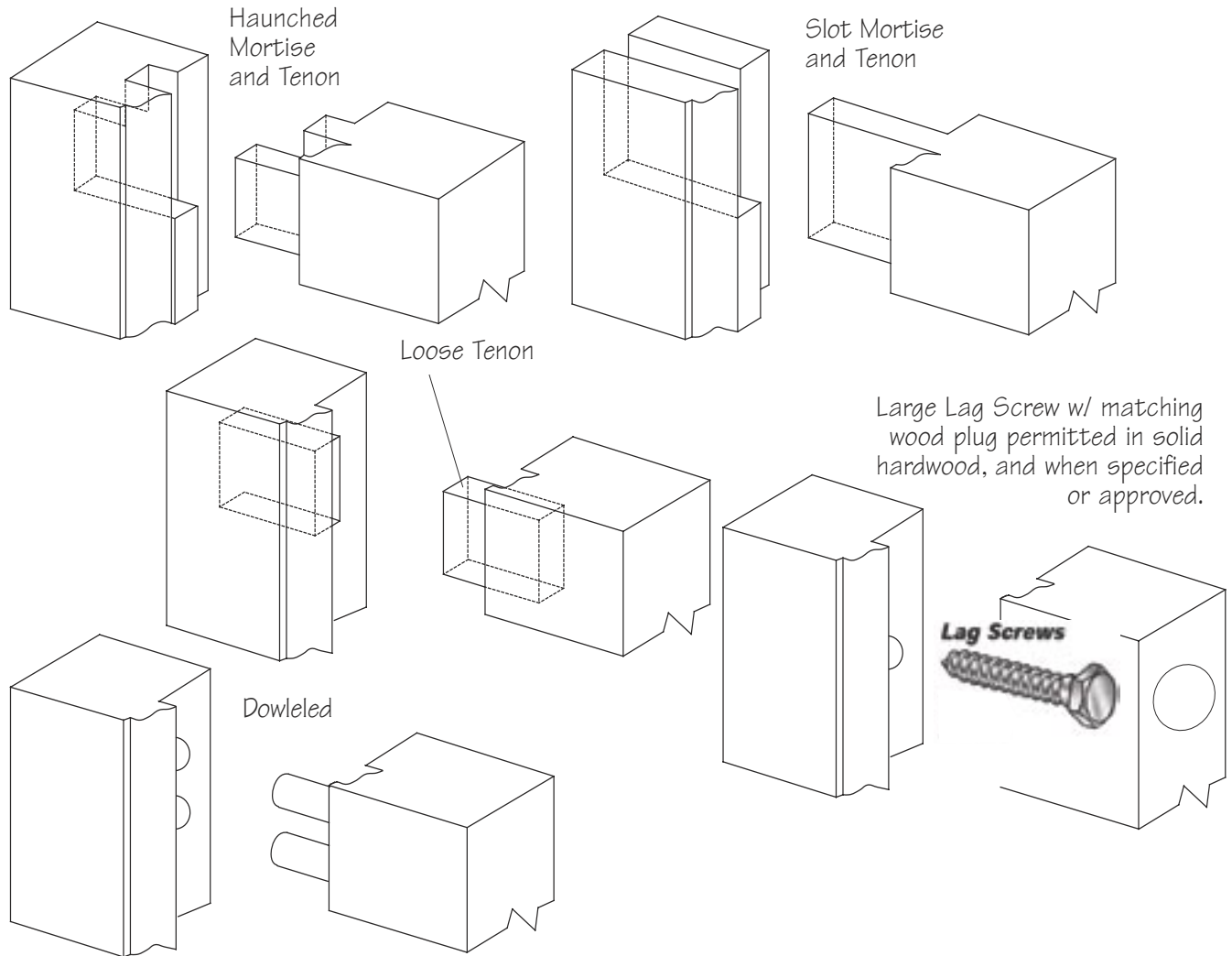
## 1400-T-8

### Machining and Joinery

In the absence of specifications, the following standards will apply. Where more than one method or material is listed for a Grade, manufacturers will supply their choice from the alternatives.

Machining	Premium	Custom	Economy			
<b>Plant Machining Considerations</b>						
Door sizing	Unless otherwise specified, doors will be shipped full width and full height for field fitting. Prefitting and premachining is available from most manufacturers. Doors shall be manufactured to a thickness tolerance of $\pm 1.6$ mm [ $\pm 1/16$ " ] of specified thickness.					
Panel retention note	Regardless of method of retention, panels must have freedom and room to expand and contract in reaction to ambient humidity changes.					
Lock clearance	Stile width must be designed to allow machining for the lock. A min. of 25.4 mm [1" ] of stile must remain between the back of the lock case and the edge of adjacent panel or glass.					
<b>Joinery and Assembly Considerations</b>						
Stiles, rails, & mullions	Joined with mortise and tenon, 12.7 mm [1/2" ] diameter dowels or loose tenon or 12.7 x 152 mm [1/2 x 6" ] concealed lag screw type joinery, glued under pressure.* Moulded profiles (sticking) shall be at the option of the manufacturer, unless full size details are shown in bid documents. Involve your manufacturer early in the design process.					
Solid lumber panels	Not permitted	Edge glued and planed/sanded to thickness (up to 350 mm [13-3/4" ])	Edge glued and planed/sanded to thickness			
Raised panel rims	Mitered; and glued to panel body under pressure	Mitered; and glued to panel body under pressure	Mitered; and glued to panel body under pressure			
Panel product centers	Panel core must be covered by veneer or concealed by rim moulding	Panel core must be covered by veneer or concealed by rim moulding	No edge treatment required			
Applied mouldings	Plant fastened; spot glued, fine finish nailed, set, filled and sanded	Plant fastened; spot glued, fine finish nailed	Plant fastened; spot glued, fine finish nailed			
<b>Minimum Veneer Thickness (visible surface species)</b>						
Veneer on stile and rail	Industry standard (varies by species) of sufficient thickness to preclude show through or telegraphing of core after sanding.					
Veneer on panels						
<b>Edge Treatments of Stiles and Rails</b>						
<b>Final Finish ---&gt;</b>	Transparent	Opaque	Transparent	Opaque	Transparent	Opaque
Outside square edge: solid lumber (top and bottom not considered exposed edges)	All exposed edges one piece (no joints), same species as face	Mill option	All exposed edges one piece (no joints), compatible species to face	Mill option	Mill option	Mill option
Lag insertion hole plugs*	Minimum 12.7 mm [1/2" ] thick, same species tightly fit, select & orient for grain and color.					
Inside Moulded Edge	Permitted only in solid lumber. Profile must be able to be coped without a feather edge.					
NOTE: Site applied mouldings are governed by Section 300 and Section 1700. The this table applies to mouldings contained wholly within an individual panel or used as rim or panel retention members. Integral Applied Moulding: Acceptable with solid or veneered stiles and rails. Mouldings must be mitered. Mouldings must be fastened to stile or rail (not to panel to permit movement), utilizing not more than two positioning nails. * Some manufacturers have demonstrated success using lag screws in place of tenons or dowels. Assembly with minimum 12.7 x 152 mm [1/2 x 6" ] diameter lag screws can be acceptable for any grade when specified or approved.						

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Stile and Rail Joinery Options - Figure 1400-09

## 1400-T-9

### General Moulding Requirements

Species shall match or be compatible with face. Moulding shall be free of open defects, shake, splits, or doze. Moulding shall be smooth with inconspicuous knife, saw, or sanding marks.

## 1400-T-10

### Dimensional Tolerances

#### Doors Not Prefit

Width:  $\pm 2$  mm [ $1/16$ "]

Height:  $\pm 2$  mm [ $1/16$ "] Top rail to bottom rail

Note: Stiles (horns) may extend an inch or more beyond the rails, to be trimmed to fit on installation.

Thickness:  $\pm 2$  mm [ $1/16$ "]

#### Doors Machined for Hardware

Width:  $\pm 1$  mm [ $1/32$ "]

Height:  $\pm 2$  mm [ $1/16$ "]

Thickness:  $\pm 2$  mm [ $1/16$ "]

Hardware location:  $\pm 1$  mm [ $1/32$ "]

Locks and hinges:  $\pm 1$  mm [ $1/32$ "]

#### Typical Prefit Clearances

Top and hinge edges: 3 mm [ $1/8$ "]

Single door, lock edge: 3 mm [ $1/8$ "]

Pair meeting edge: 2 mm [ $1/16$ "] per leaf

Bottom (rated or non-rated): 13 mm [ $1/2$ "] from top of decorative floor covering; 19 mm [ $3/4$ "] maximum from top of noncombustible floor; 10 mm [ $3/8$ "] maximum from top of noncombustible sill or threshold.

1400-T-11

Smoothness of Exposed Surfaces (Minimum Requirements)

In the absence of specifications, the following sanding standards will apply.

Smoothness Table	Premium		Custom		Economy	
	Transparent	Opaque	Transparent	Opaque	Transparent	Opaque
Sharp edges (Arris)	Eased with fine abrasive		Eased with fine abrasive		Mill option	
Top flat surfaces	150 grit		120 grit		100 grit or 15 KCPI	
Moulded surfaces	120 grit		minimum 20 KCPI			
Shaped surfaces	120 grit		minimum 20 KCPI			
Turned surfaces	120 grit		100 grit			
Sanding cross scratches	None allowed	Not to exceed 6.4 mm [.25"]	None allowed	Not to exceed 6.4 mm [.25"]		

NOTE: No tearouts, knife nicks, or hit-or-miss finish allowed. No knife marks allowed where sanding is required. Surface variations as a result of multiple tool passes treated as turned surfaces above. Glue and filler, if used, must be inconspicuous and sanded as smoothly as the surrounding surface. Sanding before final stain and/or finish should be a consistent grit and scratch pattern, as it influences blend of color and sheen between components. Top Flat Surfaces are those which can be sanded with a drum or wide belt sander. Turnings are customarily sanded on the lathe, and will exhibit cross scratches.

Before finishing, all exposed portions of architectural woodwork shall have handling marks or effects of exposure to humidity or moisture removed by a thorough uniform final sanding. The sanded surface shall then be cleaned and dust free, prior to proceeding with the first step in the finishing process. Veneer sand-through, with veneer sanded to the point where cross banding or core is visible, and/or core telegraphing (variation from a true plane in excess of 0.25 mm [0.010"] in any 76 mm [3"] span) is not allowed in any Grade.

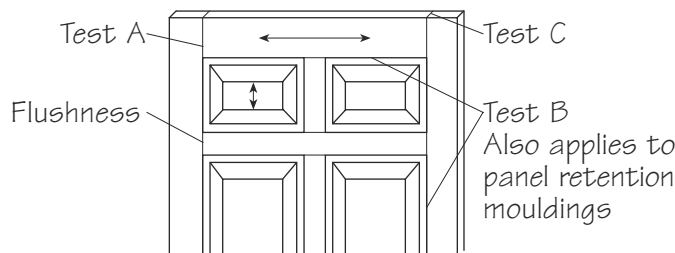
1400-T-12

Tightness of Plant Assembled Joints

Plant Assembled Joint Table	Premium		Custom		Economy	
	Interior	Exterior	Interior	Exterior	Interior	Exterior
Maximum gap: Test A	0.4 mm [.015"] wide by 20% of joint length	0.6 mm [.025"] wide by 30% of joint length	0.6 mm [.025"] wide by 20% of joint length	1.3 mm [.050"] wide by 30% of joint length	1.3 mm [.050"] wide by 20% of joint length	1.9 mm [.075"] wide by 30% of joint length
Maximum gap: Test B	0.4 mm [.015"] x 76 mm [3"], and no gap may occur within 1829 mm [72"] of a similar gap	0.6 mm [.025"] x 152 mm [6"], and no gap may occur within 762 mm [30"] of a similar gap	0.6 mm [.025"] x 152 mm [6"], and no gap may occur within 1524 mm [60"] of a similar gap	1.3 mm [.050"] x 203 mm [8"], and no gap may occur within 660 mm [26"] of a similar gap	1.3 mm [.050"] x 203 mm [8"], and no gap may occur within 1219 mm [48"] of a similar gap	1.9 mm [.075"] x 254 mm [10"], and no gap may occur within 610 mm [24"] of a similar gap
Maximum gap: Test C	0.4 mm [.015"]	0.6 mm [.025"]	0.6 mm [.025"]	1.3 mm [.050"]	1.3 mm [.050"]	1.9 mm [.075"]

Maximum gap between fixed components shall be tested at points designed to join; where members connect or touch.

Flushness Variation	0.03 mm [.001"]	0.4 mm [.015"]	0.1 mm [.005"]	0.6 mm [.025"]	0.6 mm [.025"]	1.3 mm [.050"]
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Test Locations - Figure 1400-10



### 1400-T-13

#### Selection for Grain and Color

For plant assemblies in this section only, when table(s) in this section of the Standards are more strict, the table(s) take precedence over the following:

For transparent finish, adjacent members shall ...

- Premium Grade: ... be well matched for grain and color.
- Custom Grade: ... be compatible for color.
- Economy Grade: ... not be selected.

Visible finger joints not permitted in Premium and Custom Grades. No selection for grain or color is required for opaque finish in any Grade.



Note: There will be normal color variations between vertical and horizontal members.

#### Field Assemblies

Selection of adjacent members for compatibility is the responsibility of the installation contractor.

### 1400-T-14

#### Weather Resistant Assembly

Stile and rail doors intended for exterior exposure shall be Type I assemblies, using independently tested adhesives and methods which are highly resistant to failure when exposed to moisture.



#### Compliance Criteria

### 1400-C-1

#### Tests for Smoothness of Exposed Surfaces

KCPI (Knife Cuts Per Inch) can be determined by holding the surfaced board at an angle to a strong light source and counting the visible ridges per inch, usually perpendicular to the profile.

SANDING can best be checked by sanding a sample piece of the same species with the required grit of abrasive. Observation with a hand lens of the prepared sample and the material in question will offer a comparison of the scratch marks of the abrasive grit. Reasonable assessment of the performance of the finished product will be weighed against absolute compliance with the Standards.

### 1400-C-2

#### Tightness and Flushness of Plant Assembled Joints

Joint tightness and/or flushness will meet the standard when tested with a feeler gauge at the points indicated in the illustration. Joint length will be measured with a ruler with a minimum division of 1 mm [ $1/16$ "] and calculations made ac-

cordingly. Reasonable assessment of the performance of the finished product will be weighed against absolute compliance with the Standards.

### 1400-C-3

#### Warp

Warp is any distortion in the door itself, and it does not refer to the door in relation to the frame or the jamb in which it is hung. Warp is measured by placing a straight edge or a taut string on the concave face and determining the maximum distance from the straight edge or string to the door face. The accompanying table and drawing illustrate the Standard and Test.

The term warp includes bow, cup and twist, which are defined as follows:

**Bow.** A flat wise deviation from a straight line drawn from top to bottom; a curvature along the length of the door.

**Cup.** A deviation from a straight line drawn from side to side; a curvature along the width of the door.

**Twist.** A deviation in which one or two corners of the door are out of plane with the other corners of the door.

Door Thickness	Door Size	Warp a defect when maximum deviation exceeds
35 mm [1-3/8"]	914 x 2134 mm [3'-0" x 7'-0"] or smaller	6.4 mm [1/4"]
44 mm [1-3/4"] or thicker	1067 x 2134 mm [3'-6" x 7'-0"] or smaller	6.4 mm [1/4"]
44 mm [1-3/4"] or thicker	Larger than 1067 x 2134 mm [3'-6" x 7'-0"]	6.4 mm [1/4"] in any 1067 x 2134 mm [3'-6" x 7'-0"] section
NOTE: 35 mm [1-3/8"] doors are not recommended for sizes in excess of 914 mm x 2134 mm [3'-0" x 7'-0"]		

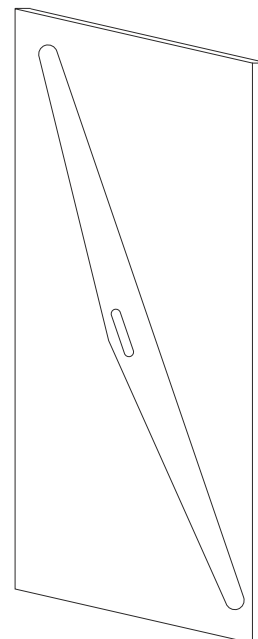


Illustration of Warp Test - Figure 1400-11

## 1400-C-4

### Flushness of Plant Assembled Joints (Maximum Variation in Alignment of Similarly Shaped Surfaces)

#### Premium Grade

Stiles and rails - Interior: no variation permitted; Exterior: 0.4 mm [.015"] maximum  
Mouldings, beads, rims, etc. - Interior or Exterior: 0.2 mm [.007"] variation maximum

#### Custom Grade

Stiles and rails - Interior: 0.1 mm [.005"] maximum; Exterior: 0.6 mm [.025"] maximum  
Mouldings, beads, rims, etc. - Interior or Exterior: 0.4 mm [.015"] variation maximum

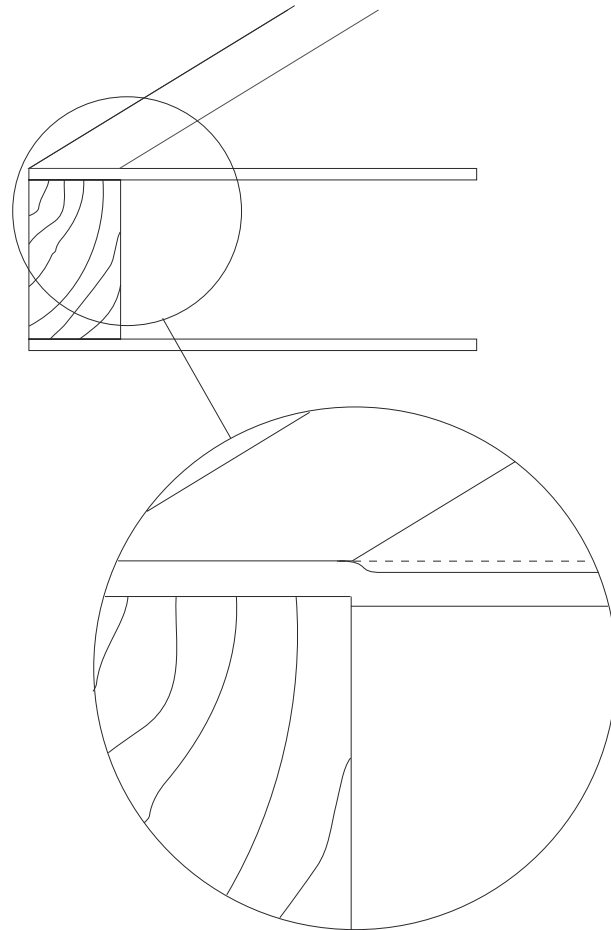
#### Economy Grade

Stiles and rails - Interior: 0.6 mm [.025"] maximum; Exterior: 1.3 mm [.050"] maximum  
Mouldings, beads, rims, etc. - Interior or Exterior: 0.8 mm [.030"] variation maximum

## 1400-C-5

### Show-through or Telegraphing

Telegraphing is any distortion in the face veneer of a door caused by variations in thickness between the core materials and/or the vertical or horizontal edge bands. In any Grade, variation from a true plane in excess of 0.25 mm [0.010"] in any 76 mm [3"] span is considered a defect. The accompanying table and drawing illustrate the standard and test. (The selection of high gloss finishes should be avoided because they tend to accentuate natural variations in material and construction.)



*Illustration of Show-through Test - Figure 1400-12*



## Design Ideas

### 1400-D

#### Freedom of Expression

This section is a sample of design ideas. It makes no pretense of being complete. It's here for the reader to use as a starting place. The exercise of personal creativity is the essence of fine architectural woodworking.

Custom-designed woodwork gives you complete freedom of expression.

- **Design flexibility:** The use of custom-designed woodwork in a building allows the design professional freedom of expression while meeting the functional needs of the client. A custom-designed building is enhanced by the use of custom-designed woodwork.
- **Cost effective:** Custom woodwork does compete favorably with mass-produced millwork, and offers practically limitless variations of design and material. Most woodwork lasts the life of the building - quality counts.
- **Complete adaptability:** By using custom woodwork, the architect or designer can readily conceal plumbing, electrical and other mechanical equipment without compromising the design criteria.
- **No restrictions:** Custom architectural woodwork permits complete freedom of selection of any 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 plastic laminates and decorative overlays. These materials can be fashioned into a wide variety of profiles, sizes, and configurations. The owner and design professional have the best of both worlds - high quality and freedom of choice.
- **Dimensional flexibility:** 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 handicapped can readily be accommodated by the custom architectural woodwork manufacturer.
- **Quality assurance:** Adherence to the QSI and specifications will provide the design professional a quality product at a competitive price. Use of a qualified AWI/AWMAC member firm will help ensure the woodworker's understanding of the quality level required.

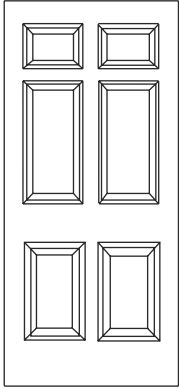


Fig. 1400-D-1

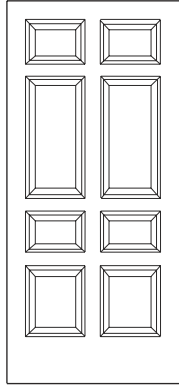


Fig. 1400-D-2

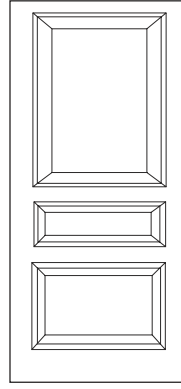


Fig. 1400-D-3

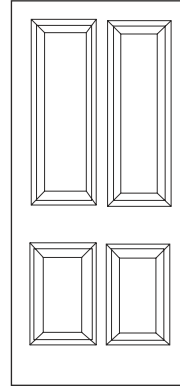


Fig. 1400-D-4

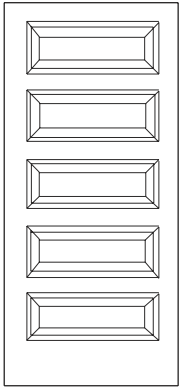


Fig. 1400-D-5

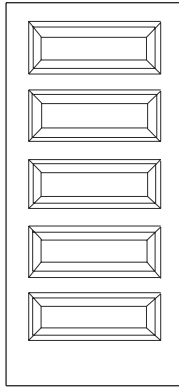


Fig. 1400-D-6

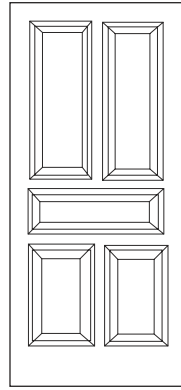


Fig. 1400-D-7

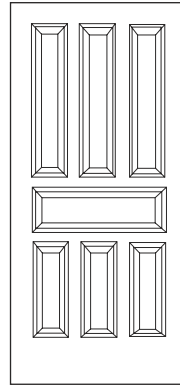


Fig. 1400-D-8

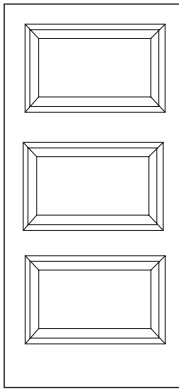


Fig. 1400-D-9

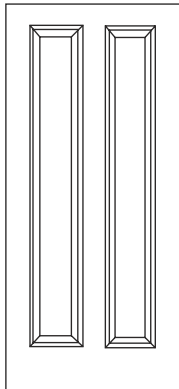


Fig. 1400-D-10

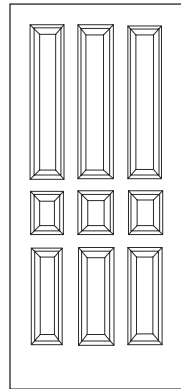


Fig. 1400-D-11

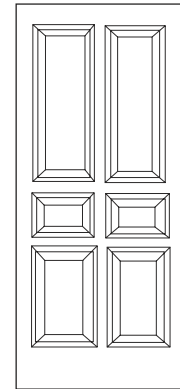


Fig. 1400-D-12

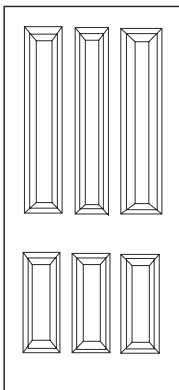


Fig. 1400-D-13

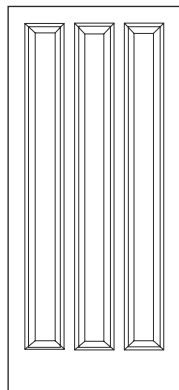


Fig. 1400-D-14

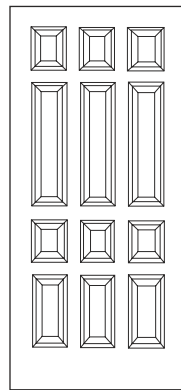


Fig. 1400-D-15

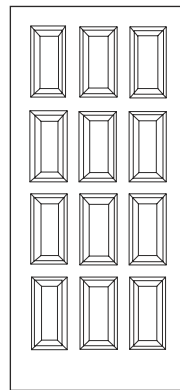


Fig. 1400-D-16

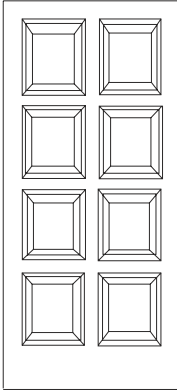


Fig. 1400-D-17

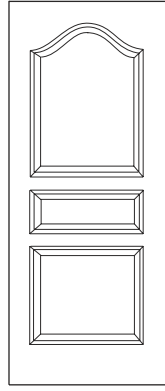


Fig. 1400-D-18

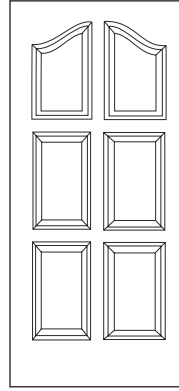


Fig. 1400-D-19

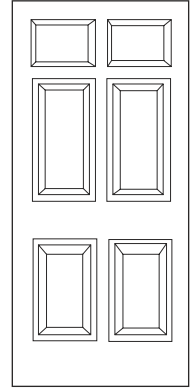


Fig. 1400-D-20

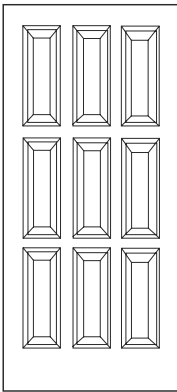


Fig. 1400-D-21

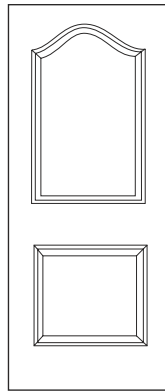


Fig. 1400-D-22

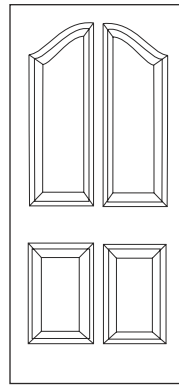


Fig. 1400-D-23

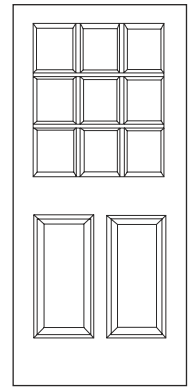


Fig. 1400-D-24

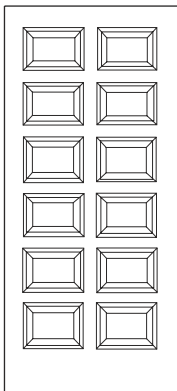


Fig. 1400-D-25

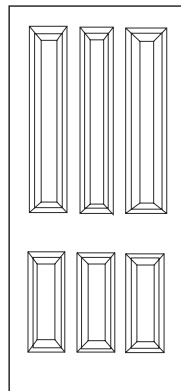


Fig. 1400-D-26

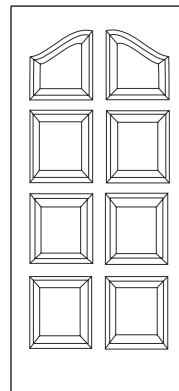


Fig. 1400-D-27

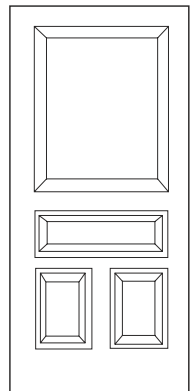


Fig. 1400-D-28

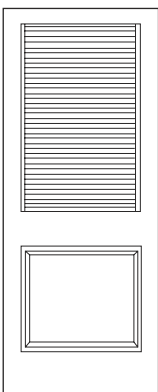


Fig. 1400-D-29

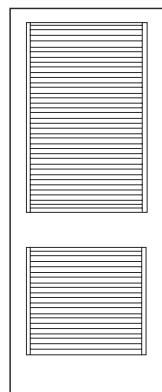


Fig. 1400-D-30

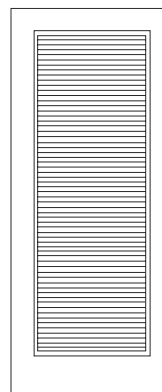


Fig. 1400-D-31

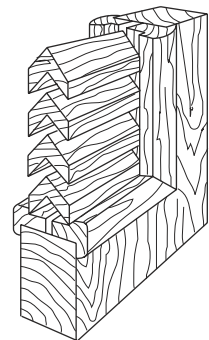


Fig. 1400-D-32

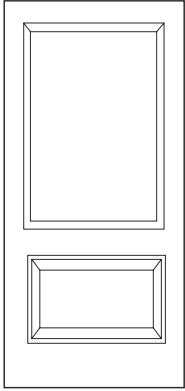


Fig. 1400-D-33

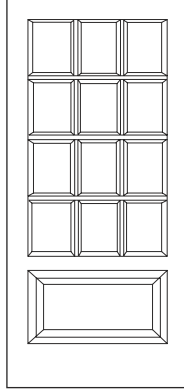


Fig. 1400-D-34

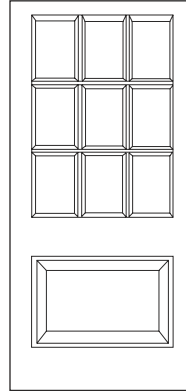


Fig. 1400-D-35

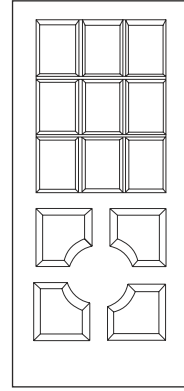


Fig. 1400-D-36

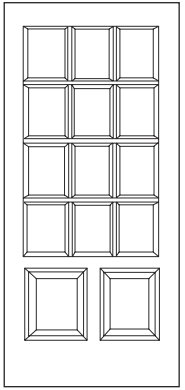


Fig. 1400-D-37

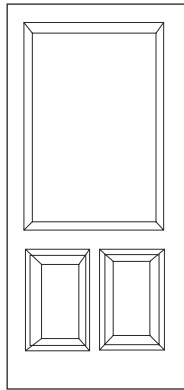


Fig. 1400-D-38

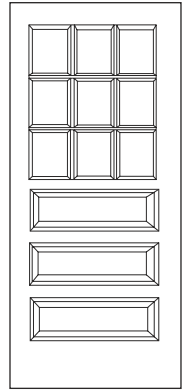


Fig. 1400-D-39

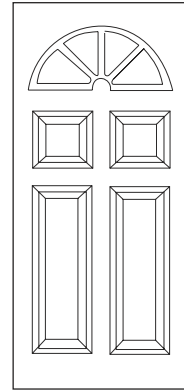


Fig. 1400-D-40

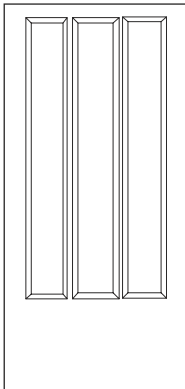


Fig. 1400-D-41

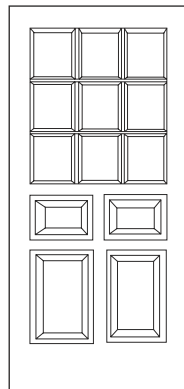


Fig. 1400-D-42

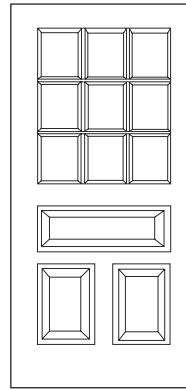


Fig. 1400-D-43

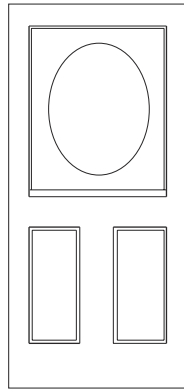


Fig. 1400-D-44

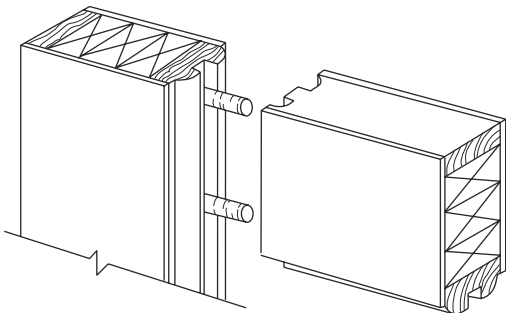


Fig. 1400-D-45

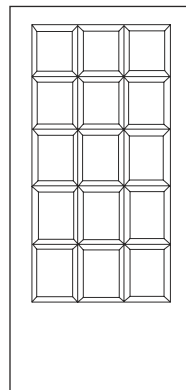


Fig. 1400-D-46

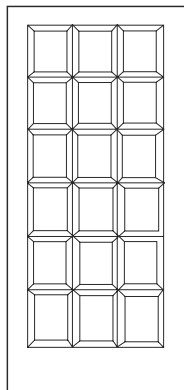


Fig. 1400-D-47