Chapter 4-8: Openings

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4-8.01 General

This chapter includes guidelines for openings (various types of doors and windows) for building projects.

Topics covered in this chapter include: steel doors and frames, wood doors, access doors, overhead coiling doors, overhead coiling grilles, bi-folding doors, folding partitions, sectional overhead doors, telescoping steel doors, automatic sliding doors, windows, cold-formed steel windows, door hardware, and glazing. Other miscellaneous items such as fire-rated shutters are also discussed.

Review any Standard Special Provisions (SSPs) from Section 99[1], *Building Construction*, Division 8, *Openings*, that have been included in the project *Special Provisions*, since much of the information therein typically will not be repeated in the following sections of this chapter.

An excellent resource for additional information related to openings is *Building Construction Illustrated,* by Francis D.K. Ching. This book is currently in its seventh edition and is available online. The California Building Code (CBC) is also a particularly valuable resource for this work and is available through the Caltrans Transportation Library[1].

4-8.01A Materials

Pay close attention to the material requirements described in the project *Special Provisions*. These requirements are extensive and can vary depending on the components' classifications. For example, for doors and their frames, material requirements will depend on whether those items are exterior or interior, fire- or smoke-control rated, as well as what material the door frame will connect to (CIP concrete or precast tilt-up concrete panels, masonry, etc.).

Materials Engineering and Testing Services (METS) generally has minimal involvement in the release of materials for the building components covered by Division 8. These items are all typically field-released by the Engineer, but this needs to be discussed and verified with the METS Representative before any project work begins (discuss at the preconstruction conference or an internal prejob meeting).

Many items covered in this chapter have a coating system (or components thereof) described in their respective *Special Provisions* section; refer to SSP 99-09900, *Painting*, for additional requirements. For field-applied coatings, verify that surface

[1] Caltrans internal link only

preparation work has been properly performed. After the coatings have been applied, verify that the colors match the color samples in the authorized submittals.

4-8.02 Steel Doors and Frames

4-8.02A General

This section contains guidelines for installation of steel doors and frames, including various appurtenances such as inserts and fasteners, frame anchors, stops and moldings, louvers, and accessories such as mullions and transom bars, ceiling struts, grout guards, and sealants.

An important resource for the installation of doors is the building floor plan details, which are found in the architectural plans; see Figure 4-8.1 below for an example. The “Door Schedule” detail, also in the architectural plans, will provide a list of door types and door numbers (which can be cross-referenced with the numbers on the floor plans) for each door to be installed, as well as other information including swing direction and specified fire-rating. See Figure 4-8.2 and Figure 4-8.3 below for examples. Door hardware groups will also be shown – these groups are defined in the *Special Provisions*. Door handing charts will be provided as well; see Figure 4-8.4 for an example. Review all relevant details carefully to confirm that the Contractor installs the correct door with the correct accessories in the correct location.

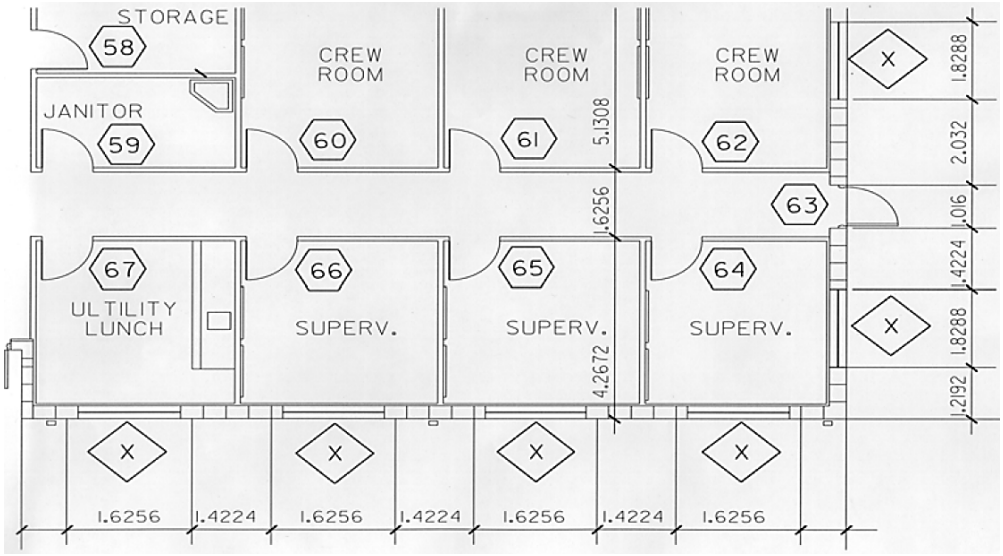


Figure 4-8.1. Partial Floor Plan Showing Door Numbers

DOOR SCHEDULE

BLDG NAME	DOOR NO.	DOOR TYPE	NOMINAL OPENING SIZE			DOOR		FRAME		SIGNAGE	NAME PLATE	HDWE GROUP	DETAILS		
			WIDTH	HEIGHT	THICK	MTL	COLOR	MTL	COLOR						
REGIONAL OFFICE	D1	A	6'-0"	7'-0"	1 3/4"	GLASS	X	PMF	X			4	5/A1.12.1	4/A1.12.1	3/A1.12.1
	D2	D	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X	A0-6	MENS	1	5/A1.12.1	4/A1.12.1	3/A1.12.1
	D3	D	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X	A0-6	WOMENS	2	4/A1.12	4/A1.12	5/A1.12-SIM.
	D4	C	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X			3	4/A1.12	4/A1.12	5/A1.12
	D5	C	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X			2	4/A1.12	4/A1.12	5/A1.12-SIM.
	D6	D	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X			1	6/A1.12	6/A1.12	7/A1.12
	D7	C	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X			3	4/A1.12	4/A1.12	5/A1.12
	D8	E	6'-0"	7'-0"	1 3/4"	HM	X	PMF	X			2	4/A1.12	4/A1.12	5/A1.12-SIM.
	D9	C	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X			1	4/A1.12	4/A1.12	5/A1.12
	D10	B	3'-0"	7'-0"	1 3/4"	GLASS	X	PMF	X			2	4/A1.12	4/A1.12	5/A1.12-SIM.
	D11	C	3'-0"	7'-0"	1 3/4"	HM	X	PMF	X			1	6/A1.12	6/A1.12	7/A1.12

Figure 4-8.2. Partial Door Schedule Showing Information for Each Door

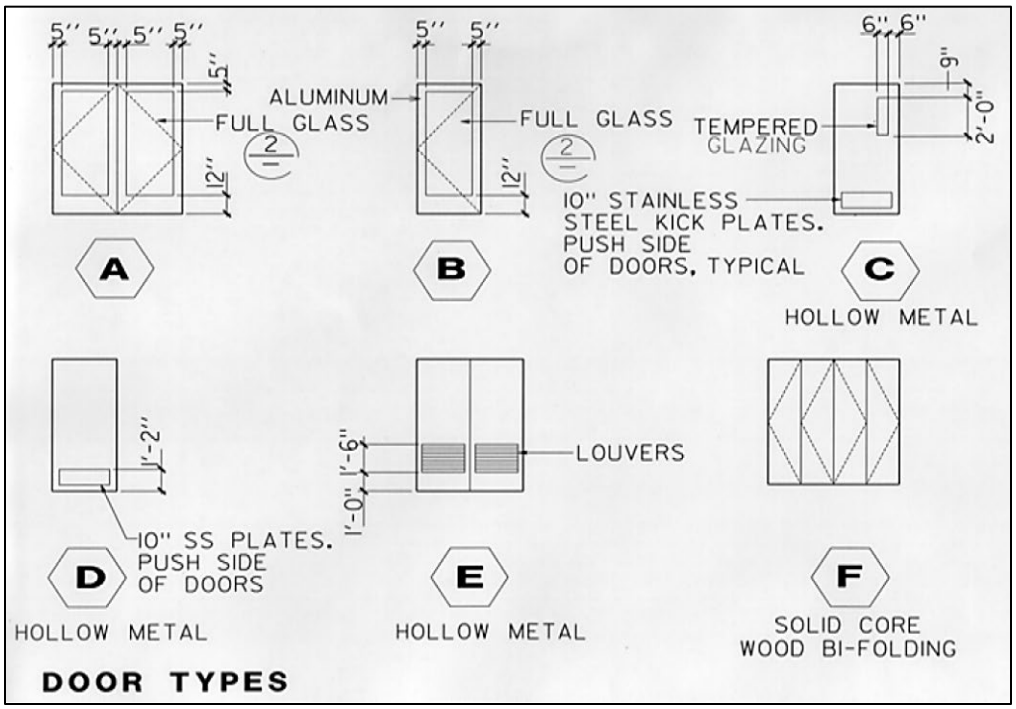


Figure 4-8.3. Door Types on the Plans

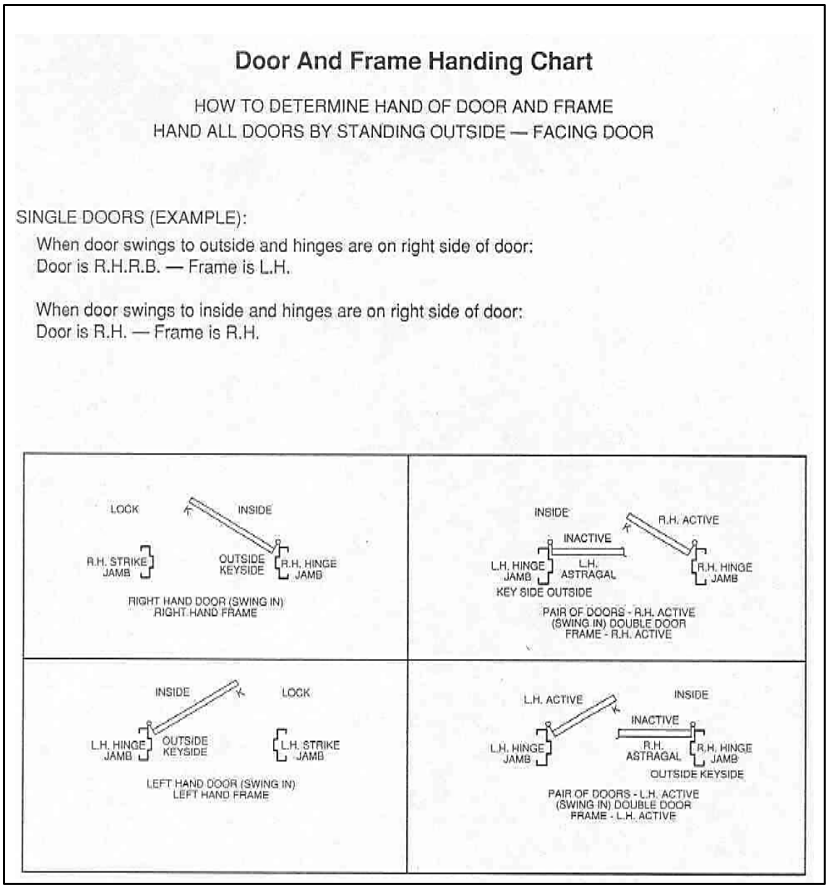


Figure 4-8.4. Door Handing Chart

All steel doors and frames for a building project must be sourced from a single manufacturer, unless otherwise authorized by the Engineer.

Steel doors and frames will typically be shipped pre-hung. The hinges will be the only hardware installed before the units are shipped.

Verify that all components and the pre-assembled panels are checked for shipping damage immediately after being uncrated. Confirm that all measurements conform to the authorized submittals.

Storage requirements for steel doors and frames are provided in the *Special Provisions* and should also be described in the manufacturer's recommendations (which can be found in the Contractor's product data submittal). If there is a conflict between the two, the requirements presented in the *Special Provisions* will govern.

The doors will be manufactured with additional reinforcing, backing, and/or inserts to accommodate components such as door hinges, door strikes, adjustable door closers, anchor points in jambs, lock and latch sets, and surface-mounted panic hardware.

Additional backing will be provided if glazed lites or vision panels (see Figure 4-8.5 and Figure 4-8.6 below) will be installed in the doors.



Figure 4-8.5. Steel Doors with Lites



Figure 4-8.6. Steel Door and Frame With Three Different Vision Panels

Any louvers (for ventilation and air passage) required to be installed in a door will typically be called out in the notes for that specific door. Louvers will also be indicated in the details for that door type. Examples of louvers are shown in Figure 4-8.7 and Figure 4-8.8 below.



Figure 4-8.7. A Steel Door with a Bottom Louver



Figure 4-8.8. Top and Bottom Louvers Being Fitted in a Steel Door

Doors, frames, stops, moldings, louvers, and accessories must be cleaned, prepared, and painted prior to installation as shown in the contract documents. Refer to SSP 99-09900, as well as Chapter 4-9, *Finishes,* of this manual, for requirements for surface preparation and application of coatings (which are in addition to any factory-applied finishes, shop primers, or other surface treatments). The shop primer applied to the metals at the fabricator's facility is not considered a prime coat – it is a coating applied by the fabricator to protect the metals from rust during transit from the fabrication point to the job site and is not a means of long-term protection from rust. Thus, it is very important that door materials stored at the job site are protected and covered. Monitor for any rusting during storage.

Confirm that jamb, head, and sill members are attached and anchored to the structure in accordance with the manufacturer's recommendations and the project plans.

The specific details for the head, jamb, and sill are used to determine how the door frame is to be installed and anchored in the opening. In wood or steel stud framing, the door frame can typically be installed after the framing is complete. For masonry walls, door frames must be installed before any concrete masonry units (CMUs) are placed around them. Similarly, door frames for cast-in-place (CIP) concrete walls must be installed before the concrete is poured. Hollow door frames installed in masonry or CIP concrete walls must be filled with grout; this is done to improve the overall durability of the frame as well as to boost the frame's ability to dampen sound from one side of the door to the other. In precast concrete tilt-up panel walls, the structural plans must be checked to determine whether the door frame will be poured in place, installed in the panel after pouring but prior to erection, or installed with expansion anchors after the panels are in place. Examples of door frames in a masonry building are shown in Figure 4-8.9 and Figure 4-8.10 below. An example of a steel door and frame in a precast concrete tilt-up panel wall is shown in Figure 4-8.11 below.



Figure 4-8.9. A Door Frame with Wood Bracing in a Masonry Wall



Figure 4-8.10. Multiple Door Frames Set and Braced in a Completed Masonry Wall



Figure 4-8.11. A Steel Door and Frame Installed in a Precast Concrete Tilt-up Panel Wall

Final cleaning is required for all door units after the assembly and installation have been completed.

The exit hardware for doors must be able to be operated without any special knowledge or instruction. Panic hardware will be specified for all exits as required by the room's occupancy classification. Verify that doors can be operated in accordance with the Americans with Disabilities Act (ADA); the pressure required to open or close the door is measured in pounds and can be checked by using a linear spring scale to operate the door in both directions while verifying the force required to do so.

4-8.02B Special Requirements for Fire-Rated Steel Doors and Frames

If the door is fire-rated, both the door and the frame will bear Underwriters Laboratories Inc. (UL) labels and must not be altered.

Fire-rating requirements are not the same for every door. Determine the fire-rating requirement for each door (by checking the door number) and confirm that the properly rated door and frame are installed in those openings.

If glazing is specified for fire-rated doors, the size of the glazed opening and the type of glass and glazing will be determined by the fire-rating of the door.

Fire-rated doors must be manufactured with thresholds and smoke gaskets.

Fire-rated louvers will be required if the opening is fire-rated.

4-8.03 Wood Doors

Wood doors must be properly stored and handled to ensure that the doors remain flat and are protected from water, dirt, and abuse. They must not be exposed to excessive heat, dryness, or direct sunlight. Wood doors must be lifted and carried individually to prevent the doors from scratching each other.

Prior to installation, verify that the species, veneer, number of plies, and edge banding (veneer for vertical edges and potentially the top and bottom edges) comply with the contract documents.

Wood doors for building projects are required to have solid cores.

Tops, bottoms, and edges of wood doors must be resealed with an oil-based sealer if they are planed or routed during fitting.

Although field-cut openings are uncommon, if there are field cuts then those cuts must be within the standards allowed by the door manufacturer. All edges must then be resealed with an oil-based sealer.

Wood doors are typically predrilled for such items as locksets, latch sets, and cylinders. If not predrilled, templates should be (and commonly are) provided by the hardware manufacturer. Holes must be bored to the proper diameter, and the backset must match the hardware supplied.

See Figure 4-8.12 and Figure 4-8.13 below for examples of wood doors in steel frames.



Figure 4-8.12. Wood Door with Vision Panel in Steel Frame



Figure 4-8.13. Wood Door in Steel Frame

4-8.04 Access Doors

Access doors are small doors or hatches that are factory assembled with steel frames. They are installed in walls and ceilings to provide access to valves, air handlers, equipment switches, and other devices located within walls or ceiling spaces that would otherwise be inaccessible.

These doors must be installed in accordance with the manufacturer's instructions. Access door assemblies must be painted to match the color of the adjacent walls and ceilings. Review the project *Special Provisions* to determine if there are any keying requirements for access doors; a discussion with the Project Architect may be necessary.

4-8.05 Overhead Coiling Doors

Overhead coiling doors are most commonly used for vehicle access at various types of facilities. They are similar to sectional overhead doors (which are described in Section 4-8.09 below), except they are raised by means of coiling at the top rather than being lifted as one unit on tracks.

The coiling mechanism for overhead coiling doors must have the proper structural support. This should be a point of emphasis when reviewing the Contractor's submittal.

Note that manufacturers have required clearances for their products, and these may be different from the specified size of the opening. Check these clearance requirements when reviewing the Contractor's submittal.

4-8.06 Overhead Coiling Grille

Overhead coiling grilles, also known as security grilles, are commonly used to secure parts counters or other sensitive areas; see Figure 4-8.14 below for an example.



Figure 4-8.14. Overhead Coiling Grilles

The grille must be manufactured by a nationally recognized door manufacturer for commercial and institutional buildings as required by the *Special Provisions*. The manufacturer must have an established parts store and an authorized service organization in California.

The coiling mechanism for overhead coiling grilles must have the proper structural support. This should be a point of emphasis when reviewing the Contractor's submittal.

Note that manufacturers have required clearances for their products, and these may be different from the specified size of the opening. Verify these clearance requirements when reviewing the Contractor's submittal.

4-8.07 Bifolding Doors

These doors are factory-assembled panels that are typically used for closets and other storage areas; see Figure 4-8.15 below for an example. SSP 99-08352, *Bifolding Doors*, requires the panels to be fabricated with close grain hardwood veneer face sheets. However, this material is significantly more expensive than Masonite or other composite materials. If bifolding doors are shown in low-visibility areas (such as a closet in an office room), discuss with the Project Architect if a material downgrade would be allowed in the interest of cost savings for the project.



Figure 4-8.15. Bifolding Doors for A Closet

4-8.08 Folding Partitions

Folding partitions are typically used in break rooms, crew rooms, or conference rooms. They are designed so that larger assembly spaces can be separated into smaller meeting rooms by closing the folding partition. See Figure 4-8.16 below for an example. In these scenarios, note that there may be occupancy signage requirements for the separated spaces.

Folding partitions are typically suspended from the roof or ceiling structure. The panels must be factory-finished with a wood-grain vinyl covering or a veneer face. However, both options must be applied over a wood-core panel (either as a covering or laminated to the wood core).



Figure 4-8.16. A Partially Closed Folding Partition

4-8.09 Sectional Overhead Doors

Sectional overhead doors are commonly used for vehicle access at various types of facilities; see Figure 4-8.17 below for an example.



Figure 4-8.17. Sectional Overhead Doors Used for Equipment Bays

Sectional overhead doors are primarily power-operated via an electric motor. They will also have push-ups or chain hoists to allow for manual operation in the event of power failure.

Other components of sectional overhead doors include the tracks for raising and lowering the door (see Figure 4-8.18 and Figure 4-8.19 below), vision panels, a counterbalance mechanism, hardware (such as hinges, rollers, lifting handles, and locks), and reversing door edges.



Figure 4-8.18. A Closed Sectional Door and Its Tracks

Louvers (either static or adjustable) for fresh air intake and make-up air for the exhaust fans may be required; check the contract documents. A louver in a sectional overhead door is shown in Figure 4-8.19 and Figure 4-8.20 below.



Figure 4-8.19. Side View of the Tracks for Sectional Overhead Doors with Visible Louver



Figure 4-8.20. A Closed Sectional Overhead Door with Vision Panels and Louvers

Sectional overhead doors must be provided as complete units, produced by one manufacturer. A list of authorized manufacturers will be provided in the *Special Provisions.*

4-8.10 Telescoping Steel Doors

Telescoping steel doors are very similar to sectional overhead doors, except the doors telescope vertically as shown in Figure 4-8.21 below. A full view of a closed telescoping steel door is shown in Figure 4-8.22 below. These types of doors are typically used for California Highway Patrol Vehicle Inspection and Agricultural Inspection Facilities.



Figure 4-8.21. Telescoping Steel Door Panels Stacking Vertically as the Door Opens



Figure 4-8.22. Full View of a Telescoping Steel Door at a Vehicle Inspection Bay Viewed from the Building's Interior

4-8.11 Automatic Sliding Doors

Reserved

4-8.12 Windows

4-8.12A General

There are six types of windows described in the special provisions: door and transom windows, fixed windows, projected windows, horizontal sliding windows, casement windows, and hung windows. See sub-sections below for explanations of each window type.

Windows complying with SSP 99-08520, *Windows,* must be commercial-class aluminum unless otherwise shown. Refer to Section 4-8.13 for cold-formed steel windows, which are covered by SSP 99-08522, *Cold-Formed Steel Windows*.

Most windows for building construction projects will be fixed. Operational windows can have a negative impact on the effectiveness and efficiency of the facility's HVAC system.

The location of each window will be shown on the "Floor Plan" sheet within the architectural section of the project plans. Refer to the "Window Schedule" (typically on the "Floor Plan" sheet, or an associated detail sheet) to determine the type and size of window required for each location.

The window dimensions shown on the plans are nominal; the actual dimensions of the constructed rough opening must accommodate the window size and allow for typical clearances for final adjustment and shimming. Before the wall is framed for the window, verify that the window rough opening is appropriately sized (this will be dependent on the window manufacturer).

Windows must be installed according to the manufacturer's instructions.

Window openings installed in fire-rated walls must have the same fire rating as the overall wall assembly. All windows must be labeled if they are fire-rated.

4-8.12B Door and Transom Windows

"Door windows" is a broad term for any windows that are installed within a door unit. A door window can serve various functions, such as allowing more natural light into a space or enhancing aesthetics and visibility. The term "door window" is somewhat interchangeable with "vision panel"; however, the primary purpose of a vision panel is to allow people to see through the door without opening it for safety and security, which is not necessarily the case for a door window. Door windows can be larger and can be located anywhere on the door, while vision panels are typically smaller and are usually

strategically positioned to offer the best view of the area beyond the door. See Figure 4-8.23 and 4-8.24 for examples.



Figure 4-8.23. A Steel Door With A Door Window for Security / Visibility Purposes (A Vision Panel)



Figure 4-8.24. Double Steel Doors With Door Windows and Transom Window Above

Transom windows are small windows that are hung over doors, open passageways, or even other windows. Transom windows are primarily utilized as an aesthetic feature. A “transom” is a horizontal structural beam, bar, or crosspiece, often with an architectural flourish, that separates the top of a door (or window) from the transom window above it. See Figure 4-8.25 below for an example.



Figure 4-8.25. A Wood Door With a Transom Window Above and Vision Panels on the Sides

4-8.12C Fixed Windows

These are non-operational windows, meaning that they are permanently set in a closed position; see Figure 4-8.26 below for an example.

Fixed windows are not necessarily installed for visibility purposes as shown in Figure 4-8.26 and Figure 4-8.27 below. In these cases, they are simply an aesthetic feature and a means of allowing some natural light into the building. Fixed windows often utilize muntins, which are narrow strips of wood, metal, or vinyl that divide a single window sash into smaller panes or "lights".

Glass blocks (and especially frosted glass blocks), which have no conventional frames and are set directly into walls constructed with masonry units, are **not** considered to be fixed windows. Requirements for these building components are found in SSP 99-04270, *Glass Masonry Units*.



Figure 4-8.26. Fixed Windows



Figure 4-8.27. Fixed Windows With Muntins

4-8.12D Projected Windows

These types of windows open outward and can be either awning type (hinged at the top) or hopper type (hinged at the bottom). See Figure 4-8.28 below for an example of each.



Figure 4-8.28. Hopper Type (Top) and Awning Type (Bottom) Projected Windows

4-8.12E Horizontal Sliding Windows

These are operational windows that open horizontally rather than vertically. They are typically used for building exteriors, and screens are commonly installed over the window openings. See Figure 4-8.29, Figure 4-8.30, and Figure 4-8.31 below for examples of horizontal sliding windows.



Figure 4-8.29. A Horizontal Sliding Window (Viewed from Outside) with Fixed and Sliding Panes



Figure 4-8.30. The Same Horizontal Sliding Window as in Figure 4-8.29 Above (Except Viewed from Inside of the Building)



Figure 4-8.31. Horizontal Sliding Windows in a Masonry Building

4-8.12F Casement Windows

These types of windows are held in the frame by a set of hinges on the sides and open outward; see Figure 4-8.32 below for an example.



Figure 4-8.32. Casement Window

4-8.12G Hung Windows

These types of windows are traditionally used in residential construction and are not often specified for State building construction projects. They slide vertically within the jamb of the window; see Figure 4-8.33 below for an example.



Figure 4-8.33. A Hung Window

4-8.13 Cold-Formed Steel Windows

Reserved

4-8.14 Door Hardware

This section covers mechanical hardware for all doors as well as electrified hardware for swinging doors.

The mounting height for door hardware is governed by the ADA requirements for each specific door location. Carefully review the contract documents to verify that each installation meets its unique requirements.

A hardware group is defined as the package of hardware that will be installed on any particular door. This hardware can include hinges, knobs or handles, locksets, latch sets, and closing devices. Hardware group numbers are found in the architectural plans on the “Door Schedule” detail. Descriptions of hardware and hardware groups are found in the project *Special Provisions*.

Unless specified otherwise, hardware finish must be either US 26D satin chromium or US 32D satin stainless steel.

Hinge sizes are described with the hardware group in the *Special Provisions*. See Figure 4-8.34 and Figure 4-8.35 for examples of door hinges. Non-removable pins must be provided for exterior doors that swing outwards.



Figure 4-8.34. Door Hinges

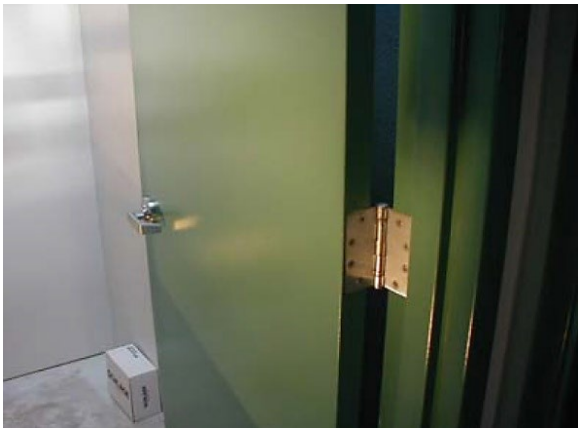


Figure 4-8.35. Close-Up View of a Door Hinge

All locksets must be lever-operated for accessibility; see Figure 4-8.36 below for an example.



Figure 4-8.36. A Mortise Lockset in a Steel Door with a Lever Handle

New facilities must have a building master key system established, using locks that have cylinders with small format interchangeable cores (SFIC) and 6-pin barrels. For existing facilities, new locks must be compatible with the existing master key system for that facility. The Contractor must provide cylinders for use during construction. Construction cylinders must remain in place until permanent cylinders are installed.

Upon completion of installation and adjustments, the Contractor delivers to the Structure Representative all dogging keys, closer valve keys, lock spanner wrenches, and other factory-furnished aids, instructions, and maintenance guides.

Permanent cores and keys are to be delivered by the Contractor to the Structure Representative at the completion of the project, and the Structure Representative will then hand over these items to the facility supervisor.

4-8.15 Glazing

Glazing for doors (also known as “Storefront System” entry door), windows, and other glazed openings includes various types of glass, as well as acrylic and polycarbonate sheets. See Figure 4-8.37 and 4-8.38 for illustrations of glazed openings.



Figure 4-8.37. Glazed Window Wall with Entry Door



Figure 4-8.38. Glazed Window Wall With Double Entry Doors

The protective covering must remain on all plastic glazing until construction is complete or two weeks after glazing, whichever occurs first.

Each individual pane of heat-strengthened glass, tempered glass, bullet-resistant glass, and plastic must have an identification label. These labels are typically engraved into the glazing.

All broken or cracked glass must be replaced before contract acceptance.

4-8.16 Other Miscellaneous Items

This section consists of items mentioned in the previous version of the *Building Construction Manual*, but not mentioned in any of the current SSPs within Section 99 Division 8, *Openings.*

4-8.16A Fire-Rated Shutters

Fire-rated shutters are installed in fire-rated walls, typically over counters or pass-through openings. Similar to fire-rated doors, they will also bear UL labels listing their fire-rating data, and these labels must be left intact.

Fire-rated shutters must be installed in accordance with the authorized submittals. They are typically operated by counterweight and gravity and are released automatically by fusible links or sensors in the event of smoke or fire.

4-8.16B Reserved