

B

Shell

This Element includes all work associated with above-grade structure and building enclosure, including the superstructure, exterior vertical enclosures (walls, finishes, and openings), exterior horizontal enclosures (roofing, traffic bearing horizontal enclosures, and horizontal openings (skylights and hatches)).

The Design Professional is responsible for designing the building enclosure to remain watertight and comply with energy codes for air and thermal protection.

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B10 SUPER-STRUCTURE

Avoid ramps if possible

Design roof structure to support rooftop equipment, including additional equipment that may be installed in the future.

B1010 Floor Construction

1. Floor Construction Performance Requirements:

- a. See Appendix VI for “A Note on Earthquake Design of Caltech Buildings.”

B1010.20 Floor Decks, Slabs, and Toppings

1. **Reinforcement:** Provide reinforcing in locations of high density file systems.

B1010.50 Ramps

1. General:

- a. Avoid ramps (sidewalks, floors, etc. with slopes steeper than 1:20) if possible.

B1010.90 Floor Construction Supplementary Components

1. **Firestopping:** For joints between edges of fire-resistive-rated floor assemblies and exterior curtain walls, provide UL-listed, perimeter fire-containment systems with integrity ratings equaling or exceeding fire-resistive ratings of floor or floor/ceiling assembly forming one side of joint. Submit evaluation reports evidencing fire-resistive joint systems’ compliance with ICBO ES AC308, from the ICBO Evaluation Service.

B1020 Roof Construction

1. **Load Capacity:** Design roof structure to support rooftop equipment, including additional equipment that may be installed in the future. Coordinate requirements with Caltech Project Manager.

B1080 Stairs

1. Stairs Performance Requirements:

- a. Stair access should extend to roof, if possible.

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B20 EXTERIOR VERTICAL ENCLOSURES

Select exterior wall products and finishes for ease of maintenance and durability, with a uniform level of quality throughout the project.

Provide Sherwin Williams SherLastic Low VOC, Elastomeric Coating A5-800 Series...

EIFS is not permitted.

B2010 Exterior Walls

1. Exterior Walls Performance Requirements:

- a. Select exterior wall products and finishes for ease of maintenance and durability, with a uniform level of quality throughout the project.
- b. Submit a finish schedule and finish board(s) with samples of all exposed finish materials selected by the Design Professional to be incorporated into the project prior to completion of design development phase.
- c. Maintenance instructions to be furnished by contractor for all finishes.
- d. The design of exterior enclosures in the Historic Zone of the campus shall respect the contextual nature of the surrounding area.
- e. When appropriate, provide balconies with demountable railings and double doors for moving large equipment into lab spaces.

2. Exterior Wall Painting:

- a. Provide Sherwin Williams SherLastic Low VOC, Elastomeric Coating A5-800 Series paint as a baseline for all exterior architectural coatings.
- b. Exterior Historical Paint Standard to be Sherwin Williams Custom color for California Institute of Technology San Simeon.
- c. Exterior window trim color:
 - 1)Frazee, Aro-Thane Semi Gloss, Custom color for California Institute of Technology: ZZ-64-228/ OLD COCOA

B2010.10 Exterior Wall Veneer

1. Exterior Insulation Finish System: EIFS is not permitted.

2. Portland Cement Plaster: Comply with ASTM C 926.

- a. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.
- b. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, before lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout at least 6 inches (150 mm) at each jamb anchor.
- c. Metal Lath: Paper backed lath is not permitted, unless approved by Caltech Project Manager. Install according to ASTM C 1063.
- d. Provide zinc and zinc-coated (galvanized) accessories.

B2010.40 Fabricated Exterior Wall Assemblies

1. Glazed Curtain Wall Assemblies:

- a. Testing: As a minimum, before installation of interior finishes has begun, a minimum area of 75 feet by one story of curtain wall systems designated by design professional shall be tested according to AAMA 501.2 and shall not evidence

water penetration. Other tests may be necessary depending on the complexity of the design.

Energy conservation must be given prime consideration when incorporating fenestration into building design.

Provisions shall be made to allow for exterior cleaning of all glass with minimum inconvenience and hazard

Retain and restore existing windows when historically significant.

B2010.90 Exterior Wall Supplementary Components

1. Flashing and Sheet Metal: Comply with SMACNA’s “Architectural Sheet Metal Manual” for fabrication and installation. Comply with CDA’s “Copper in Architecture Handbook” for copper flashing and trim.

a. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch long but not exceeding 12-foot long, sections, under copings, at shelf angles, and other areas where required. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings. Form with 2-inch-high end dams. Fabricate from 16 oz./sq. ft. copper.

B2020 Exterior Windows

1. Exterior Windows Performance Requirements:

a. Select window products and finishes for ease of maintenance and durability, with a uniform level of quality throughout the project.

b. Energy conservation must be given prime consideration when incorporating fenestration into building design. Shading, orientation, low-emissivity glass, insulating glass, and thermally broken frames shall be given consideration as potential energy conservation methods. When insulating glass is used, it shall be hermetically sealed to prevent condensation between the two layers of glass and shall have a 10-year warranty.

c. Provisions shall be made to allow for exterior cleaning of all glass with minimum inconvenience and hazard (e.g. double-hung windows or windows which open into the building). Provide swing stage or other similar connections to facilitate window washing where height exceeds 40 feet, and reach from nearest ground access exceeds 30 feet.

d. Glass shall be heat-strengthened, unless tempered is required by California Building Code, or for safety reasons.

e. Retain and restore existing windows when historically significant.

f. If new steel windows are required to match existing, provide windows with thermal break to comply with Title 24, Part 6 of the California Code of Regulations “Building Energy Efficiency Standards for Residential and Nonresidential Buildings,” current adopted edition.

B2020.30 Exterior Window Wall

1. Storefronts:

a. Testing: As a minimum, before installation of interior finishes has begun, a minimum area of 75 feet by 1 story of storefront systems designated by design professional shall be tested according to AAMA 501.2 and shall not evidence

water penetration. Other tests may be necessary depending on the complexity of the design.

B2050 Exterior Doors and Grilles

1. Exterior Doors Performance Requirements:

- a. Select door products and finishes for ease of maintenance and durability, with a uniform level of quality throughout the project.

B2050.90 Exterior Door Supplementary Components

1. Door Hardware:

- a. Mandatory Meetings: Design Professional shall request a hardware meeting with Campus Lockshop to determine specific existing site requirements and standards.
- b. Refer to Caltech Master Specification, Section 08 71 00 *Door Hardware* in Appendix IV.

Design Professional shall request a hardware meeting with Campus Lockshop to determine specific existing site requirements and standards.

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B30 EXTERIOR HORIZONTAL ENCLOSURES

Styrene-Butadiene-Styrene-(SBS) modified bituminous membrane roofing is the preferred roofing membrane.

B3010 Roofing

1. Roofing Performance Requirements:

- a. Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.
- b. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- c. Energy Performance: Provide roofing system that meets the requirements of California's Title 24 Energy Efficiency Standards for Residential and Non-Residential Buildings and has been tested according to the standards of the Cool Roof Rating Council.

B3010.50 Low-Slope Roofing

1. General:

- a. Styrene-Butadiene-Styrene- (SBS) modified bituminous membrane roofing is the preferred roofing membrane. Use of alternate types of membrane roofing shall be considered by Caltech on a case-by-case basis.

2. Styrene-Butadiene-Styrene-Modified Bituminous Membrane Roofing:

One ply of fire-rated, white granule surfaced, SBS-modified bituminous roofing membrane cap sheet in cold adhesive applied over two plies of SBS-modified asphalt sheet (reinforced with polyester fabric), smooth-surfaced roofing membrane sheets applied in cold adhesive over one layer of composite ply base adhered with hot-melt asphalt over high-density wood fiber insulation with hot-melt asphalt. Base flashing shall be one ply of white granule-surfaced, fire resistant modified bitumen membrane in modified mastic, over one composite ply base sheet in modified mastic.

- a. Roofing Membrane Load-Strain Properties: Provide a roofing membrane identical to component systems that have been successfully tested by a qualified independent testing and inspecting agency to meet the following minimum load-strain properties at membrane failure when tested according to ASTM D 2523:
 - 1) Tensile Strain at Failure, at 77 deg F: 396 lbf machine direction, minimum; 3 percent elongation, minimum.
 - 2) Tensile Strain at Failure, at 77 deg F: 272 lbf cross-machine direction, minimum; 3 percent elongation, minimum.
- b. Roofing Membrane Flashing Load-Strain Properties: Provide a roofing membrane modified flashing membrane system identical to component systems that have been successfully tested by a qualified independent testing and inspecting agency to meet the following minimum load-strain properties at membrane failure when tested according to ASTM D 2523:
 - 1) Tensile Strain at Failure, at 77 deg: 490 lbf machine direction, minimum; 4 percent elongation, minimum.

B10 Superstructure
 B20 Exterior Vertical Enclosure
B30 Exterior Horizontal Enclosures

B3010 Roofing
B3010.50 Low-Slope Roofing
 B3010.90 Roofing Supplementary Components
 B3040 Traffic Bearing Horizontal Enclosures
 B3040.10 Traffic Bearing Coatings
 B3040.30 Horizontal Waterproofing Membrane

1) Fire/Windstorm Classification: Class 1A-90 (roof system and attachment only).

2) Hail Resistance: MH.

Manufacturer Qualifications: A qualified manufacturer that has UL listing and FMG approval for roofing system identical to that used for this Project.

Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

2) Tensile Strain at Failure, at 77 deg F: 423 lbf cross-machine direction, minimum; 4 percent elongation, minimum.

c. FMG Listing: Provide roofing membrane, base flashings, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system. Roofing system shall comply with the following:

1) Fire/Windstorm Classification: Class 1A-90 (roof system and attachment only).

2) Hail Resistance: MH.

d. Manufacturer Qualifications: A qualified manufacturer that has UL listing and FMG approval for roofing system identical to that used for this Project.

1) Be Associate Member in good standing with National Roofing Contractors Association (NRCA) for at least five years.

2) Be nationally recognized in the roofing, waterproofing, and moisture survey industry.

3) Be approved by Caltech.

4) Has not been in Chapter 11 bankruptcy during the last five years.

5) Provide Evidence of Financial Responsibility: Certificate of Insurance showing Products Liability in the amount of \$25 million minimum and provide an affidavit signed by a corporate officer showing corporate net worth of \$50 million, minimum.

6) Provide a copy of Corporate Health, Safety and Welfare policy.

7) Manufacturer must manufacture a minimum of 70 percent of the materials that they supply, by dollar volume, in facilities owned or solely leased by said manufacturer, including equipment used in manufacturing operations.

8) Provide evidence of 20 quarters of continuous plant inspections of roofing manufacturing sites over the previous five years by an independent Nationally Recognized Testing Laboratory (NRTL) as defined in 29 CFR Ch. XVII (7-1-93 Edition) from the Occupational Safety and Health Administration (OSHA).

9) Be ISO 9001 registered for at least the prior five years.

10) Furnish a service agreement/warranty.

11) Provide Caltech names of at least five qualified applicators.

12) Employ full-time Field Technical Services Representatives for daily job site monitoring and production of daily reports.

13) Acquire local field representatives to make periodic site visits and produce work quality and progress reports.

e. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL or FMG. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1) Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.

Multiple Roof Systems: Warranty to be used by single manufacturer to cover all roofs specified

Adhesives and sealants that are not on the exterior side of weather barrier shall comply with current SCAQMD limits for VOC content

f. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

- 1) Special warranty includes roofing membrane, base flashings, roofing membrane accessories, fasteners, all sheet metal related details, and other components of roofing system.
- 2) Manufacturer Services in Years Two and Five: Inspection by a Technical Service Representative and delivery of a written inspection report documenting roof conditions. Preventative maintenance and necessary repairs, including splits, tears, or breaks in the roof membrane and flashings which threaten the integrity of the roof system and are not exempt from coverage due to neglect, negligence, vandalism, or other exclusion. General rooftop housekeeping and clean-up, subject to limits, but generally including removal of incidental debris.
- 3) Warranty Period: 10 years from date of Substantial Completion.
- 4) Multiple Roof Systems: Warranty to be used by single manufacturer to cover all roofs specified – modified bitumen and tile underlayment – to provide a single source of responsibility.

g. Special Project Warranty: Submit roofing installer's warranty, signed by Installer, covering Work of this Section, including all components of roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the warranty period of **5 years** from date of Substantial Completion.

h. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with current SCAQMD limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

i. Installation: Install roofing membrane system in accordance with roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

3. Coated Foamed Roofing: Rigid cellular polyurethane with liquid urethane elastomeric coating system specifically formulated for coating spray polyurethane roofing.

a. Fire-Test-Response Characteristics: Provide coated foamed roofing systems with the fire-test-response characteristics indicated, as determined by testing identical systems per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

- 1) Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively; ASTM E 84.
- 2) Exterior Fire-Test Exposure: ASTM E 108; Class A.

3) Fire-Resistance Ratings: ASTM E 119, determined for coated polyurethane foam roofing as part of a roof assembly.

b. Comply with recommendations in NRCA's "Quality Control Guidelines for the Application of Spray Polyurethane Foam Roofing."

c. Comply with recommendations in SPFA AY 104, "Spray Polyurethane Foam Systems for New and Remedial Roofing."

d. Warranty Period: **5 years** for labor and **10 years** for materials from date of Substantial Completion.

e. Installation: Mix and apply polyurethane foam according to coated foamed roofing manufacturer's written instructions.

1) Surface Finish: Smooth to orange peel, free of voids, pinholes, and depressions. Unacceptable foam textures must be removed and re-foamed prior to coating application

2) Apply coating system at wall terminations and vertical surfaces to extend beyond polyurethane foam by 4 inches, minimum.

B3010.90 Roofing Supplementary Components

1. Sheet Metal Flashing and Trim: Anchor roof edge flashing to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as required for Project. Comply with SMACNA's "Architectural Sheet Metal Manual" for fabrication and installation. Comply with CDA's "Copper in Architecture Handbook" for copper flashing and trim.

a. Parapet Scuppers: Minimum 16 oz./sq. ft copper; fabricate scupper of dimensions required with closure flange trim to exterior, 4-inch-wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.

b. Roof Edge Flashing (Gravel Stop) and Fascia Caps: Fabricate in minimum 96-inch long, but not exceeding 10-foot-long, sections. Furnish with 6-inch wide joint cover plates.

c. Base Flashing, Counterflashing, Flashing Receivers, and Roof Penetration Flashings: Fabricate from minimum 20 oz./sq. ft. copper, or 0.032-inch to 0.022-inch thick galvanized steel.

d. Roof-Drain Flashing: Fabricate from minimum 20 oz./sq. ft. zinc-tin alloy-coated copper.

e. Valley Flashing: Fabricate from minimum 20 oz./sq. ft. copper, or 0.028-inch thick galvanized steel.

B3040 Traffic Bearing Horizontal Enclosures

B3040.10 Traffic Bearing Coatings

1. Traffic Coatings: Manufacturer's standard, traffic-bearing, seamless, high-solids-content, cold liquid-applied, elastomeric, waterproofing membrane system

with integral wearing surface for exterior pedestrian and vehicular traffic according to ASTM C 957. Include sealants, sheet flashing, adhesive, reinforcing strip, and pavement markings as required for a complete system.

- a. Contractor shall submit warranty, signed by Manufacturer, agreeing to repair or replace traffic coating that fails in materials or workmanship, including all components of traffic coating system for five years from date of Substantial Completion.
- b. Manufacturer's representative to inspect completed application and provide a written report that application complies with manufacturer's written instructions.

Sheet Metal Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" for fabrication and installation.

B3040.30 Horizontal Waterproofing Membrane

1. Horizontal Waterproofing: Refer to A2010.90 "Subgrade Enclosure Wall Supplementary Components."

B3040.90 Horizontal Enclosure Supplementary Components

1. Sheet Metal Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" for fabrication and installation. Comply with CDA's "Copper in Architecture Handbook" for copper flashing and trim.

- a. Base Flashing, Counterflashing, Flashing Receivers, and Penetration Flashings: Fabricate from minimum 20 oz./sq. ft. copper, or 0.032-inch to 0.022-inch thick galvanized steel.
- b. Drain Flashing: Fabricate from minimum 20 oz./sq. ft. zinc-tin alloy-coated copper.

Skylights will be considered on a case-by-case basis due to the quantity of equipment located on building roof tops,

B3060 Horizontal Openings

B3060.10 Roof Windows and Skylights

1. Skylights: Skylights will be considered on a case-by-case basis due to the quantity of equipment located on building roof tops, and need for flexibility to place additional rooftop equipment in the future.

Roof hatches should be avoided.

B3060.50 Vents and Hatches

2. Roof Hatches: Roof hatches should be avoided. Stair access to roof is preferable.

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ELEMENT B**

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