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**RECORD OF REVISIONS**

<b>Rev</b>	<b>Date</b>	<b>Description</b>	<b>POC</b>	<b>OIC</b>
0	06/28/99	Document rewritten to support LIR 220-03-01. Superseded Architectural Facilities Engineering Standards, Vol. 4, Manual Rev. 6, 2/17/98.	Miles Brittelle, <i>PM-DS</i>	Dennis McLain, <i>FWO-FE</i>
1	11/18/02	General revision and addition of endnotes. Replaces subsections 204, 205, 206, and 207.	Scott Richardson, <i>PM-1</i>	Kurt Beckman, <i>FWO-SEM</i>
2	8/16/04	Revised stair, guardrail, EIFS, window, landing, hardware, roofing, fall protection requirements.	Scott Richardson, <i>PM-DS</i>	Gurinder Grewal, <i>FWO-DO</i>
3	10/27/06	Administrative changes only. Organization and contract reference updates from LANS transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other administrative changes.	Scott Richardson, <i>FM&amp;E-DES</i>	Kirk Christensen, <i>CENG</i>
4	02/07/19	Incorporated VAR-2013-113 Fall Protection. Removed CSPE membrane roofing from list of approved systems except for patching. General update of information, references, URL links, codes and standards throughout.	Scott Richardson, <i>ES-EPD</i>	Larry Goen, <i>ES-DO</i>

**CONTACT THE ARCHITECTURAL STANDARDS POC**

for upkeep, interpretation, and variance issues

<b>Ch. 4, B-Shell</b>	<a href="#"><u>Architectural POC/Committee</u></a>
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**B1010 EXTERIOR STAIRS & RAMPS****1.0 EXTERIOR CONCRETE STAIRS**

- A. Exterior stairs shall have a minimum tread width of 4 feet clear.<sup>1</sup>
- B. Provide slip-resistant stair treads; when solid material, provide a tread slope of 1/8 inch per foot from back to front of tread.<sup>2</sup>
- C. Provide risers with a minimum of 4 inches to a maximum of 7 inches in height.
- D. Avoid steps with less than 3 risers, as their lack of visual prominence creates a safety hazard.

**2.0 HANDRAILS FOR EXTERIOR STAIRS & RAMPS**

- A. Provide handrails for exterior steps and ramps on both sides of stairs and ramps.<sup>3</sup>
- B. Refer to LANL Master Specification 05 5213, *Pipe and Tube Railing*.
- C. Mesh-type paneling (expanded metal or diamond mesh) for infill of rails and balusters is considered inappropriate for office or business type occupancies. Perforated metal panels, coiled fabrics, or cable systems would be an acceptable alternative.

**3.0 EXTERIOR PEDESTRIAN GUARDRAILS**

- A. Install exterior guardrails when the top of the sidewalk, ramp, or pedestrian area is 30 in. or greater above adjacent grade<sup>4</sup> (*or the adjacent downhill slope is 2:1 or greater*).
- B. Mesh-type paneling (expanded metal or diamond mesh) for infill of rails and balusters is considered inappropriate for office or business type occupancies. Perforated metal panels, coiled fabrics or cable systems would be an acceptable alternative.

**B2010 EXTERIOR WALLS****1.0 GENERAL**

- A. Any "system" of components shall be designed and specified as a system, approved and intended by the manufacturer.

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<sup>1</sup> Safe passage for two people.

<sup>2</sup> Moisture drainage, not required for grating-type treads.

<sup>3</sup> 2015 ICC IBC, Section 1014.1.

<sup>4</sup> 2015 ICC IBC, Section 1015.

- B. Refer to the *Site and Architectural Design Principles*<sup>5</sup> document for preferred exterior materials, finishes, and colors.
- C. Refer to the following LANL Master Specifications:
  - 1. Section 07 1113, *Bituminous Dampproofing*
  - 2. Section 07 2400, *Exterior Insulation and Finish Systems*
  - 3. Section 09 9100, *Painting*

## 2.0 THERMAL AND MOISTURE PROTECTION

- A. Limit building insulation combustibility to flame spread rating less than 25 and smoke developed less than 50.
- B. Exterior Insulation and Finish Systems (EIFS)
  - 1. EIFS shall be listed as an assembly in the Factory Mutual (FM) Global Approval Guide.
  - 2. Care shall be exercised as to placement of EIFS such that application to locations subject to physical damage from impact, scuffing, puncture, penetration, etc. are avoided or offered protection.
  - 3. *Guidance: Utilize manufacturer's methods of increasing impact resistance with use of heavy duty mesh inlays, or use of another material all together may be warranted. Typical locations to consider include, but are not limited to, doorways/entries, building corners, areas where grade meets foundation, and locations where exterior door locksets may contact exterior walls.*
  - 4. Positive means of shedding/relieving moisture from the system shall be provided in accordance with the Manufacturer's standard design details—use of sealants alone at joints, door/window frames, etc. is inadequate.
  - 5. EIFS shall not be used on horizontal surfaces exposed directly to weather (soffits are not considered to be directly exposed to weather but measures conforming to the Manufacturer's standard details shall be taken to prevent moisture migration to soffit surfaces). Tops of parapets where EIFS is employed as the wall finish shall have sheet metal copings provided.
  - 6. Consideration to potential for bird damage shall be given when using rigid board insulation with a thickness greater than 2 inches.

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<sup>5</sup> Posted as a reference on this chapter's webpage.

**B2020 EXTERIOR WINDOWS****1.0 GENERAL**

- A. Refer to the following LANL Master Specifications.
  - 1. Section 08 4113, *Aluminum-Framed Entrances and Storefronts*
  - 2. Section 08 5113, *Aluminum Windows*
- B. Storefronts and other large glass installations shall have horizontal mullions at 36" +/- above the walking surface to increase the glass visibility and reduce pane replacement costs.
- C. Large expanses of windows shall be provided with a means to wash them.<sup>6</sup>

**B2030 EXTERIOR DOORS & FRAMES****1.0 GENERAL**

- A. Use Underwriter's Laboratory (UL) or Factory Mutual (FM) approved labels on all doors, frames, and hardware required to be fire-rated.
- B. Provide insulated metal doors and door frames.
- C. Provide landings that lead to safe pedestrian ways a distance from the building that offers refuge from emergencies<sup>7</sup>. Slope landings away from door. Doors shall be provided with weather protection including forces of prevailing wind.
- D. Refer to the following LANL Master Specifications.
  - 1. Section 08 1100, *Metal Doors and Frames*
  - 2. Section 08 1213, *Hollow Metal Frames*
  - 3. Section 08 3323, *Overhead Coiling Doors*
  - 4. Section 08 8000, *Glazing*

**2.0 ACCESS CONTROLLED DOORS**

- A. Comply with NFPA 101, Life Safety Code, and ICC IBC for installation of access/egress controlled doors.
- B. Reader systems (badges, etc.,) installed on the egress side of required exit /exit access doors shall not require activation to exit through the door.

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<sup>6</sup> EMRef-29 E-mails on SCC and NISC Issues from Maez and Ojeda to Oruch June-July-04 (Note: EMref refers to a Standards Program internal filing system for hard-to-find references).

<sup>7</sup> 2015 ICC IBC, Section 1010.1.5. & 1010.1.6.

**3.0 DOOR HARDWARE**

- A. For interior doors use Best Lock Corporation 9K Series cylindrical locksets with Style 14 or Style 15 levers. For exterior doors not equipped with exit devices use Best 45H Series mortise locksets with Style 14 or Style 15 levers. No substitutions are allowed, but where Best locksets cannot work in the application, locks shall accommodate the installation and removal of a 7-pin changeable core manufactured by Best. The cores will be supplied and installed by LANL.
- B. Refer to LANL Master Specification 08 7100, *Door Hardware*.

**B30 ROOFING**

**1.0 GENERAL**

- A. The following criteria should first be determined for selection of roofing materials:
  1. Life Expectancy of a structure, regardless of age, based upon condition and design life.
  2. Roof Structure (composition).
  3. Roof Pitch (slope).
  4. Projected roof use/traffic, including maintenance activities and potential exposures to chemicals.
  5. Energy efficiency and heat island reduction goals (*light color, LEED credit*)

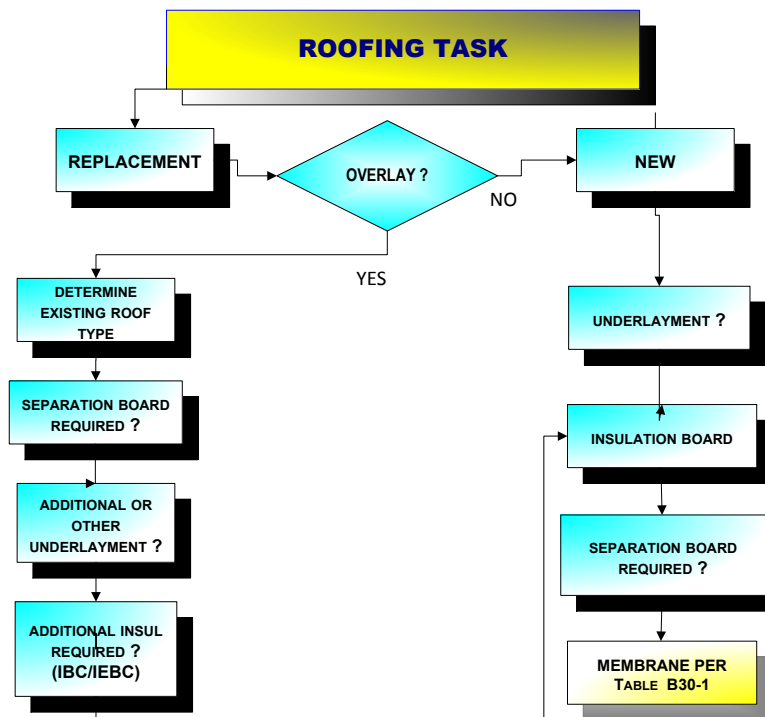


Figure B30-1- Roof Component Decision Flowchart

- B. Select new and reroofing systems from options listed in Table B30-1. Systems listed in Table B30-2 can only be used with written permission of the ESM Architectural POC. *Guidance: POC, Alternate, and LANL roofing SMEs can provide specification assistance.*

**TABLE B30-1**

Approved Roof Systems <sup>8</sup>				
Roof Material	System Life Expectancy (years)	Pitch (Slope)	Traffic Tolerance (Light Duty)	Comments
CSPE (e.g., Hypalon®) fully adhered	30+	< 2 in 12	Quarterly Access	No grease or asphalt. Most are "Energy Star." Cannot be installed during winter due to adhesive viscosity. Because of limited-term manufacturing in U.S. and limited sources, use only for patching of existing CSPE roof membranes.
SBS-Modified Bitumen Built-Up	30+	< 4 in 12	Weekly Access	No solvents, cold-applied
APP-Modified Bitumen Built-Up	30+	< 4 in 12	Weekly Access	No solvents, cold-applied
Metal	40+ (repair likely after 10+ if lapped seam)	>2 in 12	Semi-Annual	Easy traffic damage. Apply over wood deck or framework only.
Asphaltic Shingles	15+	> 3 in 12	Semi-Annual	Easy traffic damage. Existing wood deck only.

<sup>8</sup> Life expectancies are as observed at LANL (high UV conditions). Other table data from LANL experience, industry standards, and manufacturer trade association documents listed below and in later endnotes. Also, SBS and Hypalon are capable of being recoated to extend their life. National Roofing Contractors Assoc. (<http://www.nrca.net/>) *Roofing and Waterproofing Manual and Handbook of Accepted Roofing Knowledge.*

TABLE B30-2

Systems Requiring ESM Architectural Chapter POC's Written Approval for Use <sup>9</sup>				
Roof Material	System Life Expectancy (years)	Pitch (Slope)	Membrane Traffic Tolerance (Light Duty)	Comments
EP	10+	<2 in 12	Semi-annual	Very limited experience
EPDM	10+	< 2 in 12	Semi-annual	Low UV resistance
PVC including DuroLast	10+	< 2 in 12	Semi-annual access	Low UV resist; low asphalt and petrochemicals resistance
Other elasto- and plasto-meric membranes including TPO	Variable	< 2 in 12	Variable	Limited or non-positive LANL experience
Sprayed-in-place foam	5+	<4 in 12	Quarterly access	Self-flashing; limited positive experience.
Unmodified Asphalt Built-up	15+	< 2 in 12	Quarterly access	Low UV resistance

- C. Vapor: Design roof systems to ensure that the dew point temperature does not occur within the roof system.
- D. Wind Resistance: Design roof systems to [FM Global Loss Prevention](#) Class 1-90 Windstorm Resistance criteria (as a minimum).<sup>10</sup> See ESM Structural Chapter 5 for local wind load requirements.

<sup>9</sup> Allowed roof types have the lowest life cycle costs for LANL. PVC, EPDM, and unmodified bitumen rapidly embrittle at LANL's high UV levels, and there is little LANL experience with the other products in Table B30-2. The oldest PVC roofs in Los Alamos are SM-40 (circa 1998), the County pump station (circa 1/97, shrinkage found 2001), and TA-53-3, Sector G (circa 1997; after 5 years it had lost approx. 50% of original elasticity). PVC performance concerns are also discussed in (1) *Challenges of the 21st Century. Roofing Technology, Fourth (4th) International Symposium. Proceedings. First (1st) Edition. U.S. National Institute of Standards and Technology, U.S. National Roofing Contractors Association, Canadian Roofing Contractors Association, National Research Council of Canada, International Waterproofing Association, CIB, RILEM. September 17-19, 1997, Gaithersburg, MD, 253-264 pp, 1997* <http://www.fire.nist.gov/bfrlpubs/build97/art122.html> and (2) *Performance of Polyvinyl Chloride Roofing: An Overview* by Rossiter and Paroli published in *Proceedings of the Sustainable Low-Slope Roofing Workshop, ORNL, Oct 9-10, 1996, CONF-9610200, Desjarlais* <http://www.fire.nist.gov/bfrlpubs/build97/art047.html>. Stevens EP (TPO) was first used on the SCC in 2001 primarily due to the immediate availability of low noise specs on it. Variability in chemical formulations among TPO manufacturers and minimal high altitude durability data precludes further use at LANL until issues are resolved. Foam systems have shown poor historically poor performance for the Postal Service (1975-89), SRS (1982-1985), and many other locations; furthermore, there is a lack of local expertise to maintain or modify foam systems at LANL, and there are mechanical damage and UV degradation concerns. **Summary:** With high re-roofing costs and the tendency to occupy buildings beyond original intentions at LANL, the installation of short-life or unproven membranes is rarely justified.

<sup>10</sup> Class 1-90 typically exceeds local roof uplift forces and is an industry standard for commercial roof systems.



- E. Fire Resistance over Metal Decking: Specify FM Class 1 or UL Class A roofing assemblies. See FM Data Sheet 1-28 series, the FM Approval Guide, or UL Fire Resistance Directories for acceptable materials and construction methods.<sup>11</sup>  
*Guidance: The two FM classes are:*
1. **Class 1 (acceptable)** - Includes construction with only minimal asphalt or other readily combustible material between the insulation and the metal deck. The vapor barrier is noncombustible.
  2. **Class 2 (unacceptable)** - Includes construction using larger quantities of asphalt for adhesion or wind resistance and/or asphalt-coated insulation between the insulation and the metal deck.
- F. Comply with LANL Master Specification 07 2100, *Thermal Insulation*. *Guidance: Low-slope roof systems typically involve a vapor barrier, board insulation, separation board (to protect insulation from compression), membrane, and traffic topping. Steep systems are typically metal on pre-engineered metal buildings or shingles on transportables with batt insulation (also protected by vapor barrier).*

## 2.0 ROOF SYSTEMS

### 2.1 SBS-Modified Bitumen Built-up<sup>12</sup>

- A. Comply with LANL Master Specifications 07 5050, *Membrane Roofing General Provisions*; and 07 5217, *Styrene-Butadiene-Styrene Modified Bituminous Membrane Roofing, Cold Applied*.

### 2.2 APP-Modified Bitumen Built-up

- A. Comply with LANL Master Specifications 07 5050, *Membrane Roofing General Provisions*; and 07 5213.13, *Atatic-Polypropylene Modified Bitumen Roofing, Cold-Applied*.

### 2.3 Metal<sup>13</sup>

- A. *Guidance: In general this designation refers to standing seam sheet metal roofs. Many metal roof systems are the product of a pre-engineered metal building manufacturer. If purchasing as part of such a building, comply with LANL Master Specification [13 3419](#), *Metal Building Systems and Paragraph "H"* below.*
- B. The roof shall be designed with a concealed fastener system, except for pre-engineered buildings where capped seam/exposed fasteners are allowable.<sup>14</sup>

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<sup>11</sup> ICC IBC-2015, Chapter 15.

<sup>12</sup> Information from ARMA -- Asphalt Roof Manufacturers Association (<http://asphaltroofing.org/>) ARMA Residential Asphalt Roofing Manual and ARMA Guide to Preparing Built-Up Roofing (BUR) Specifications, Recommended Performance Criteria for Roofing Membranes using Polymer Modified Bituminous Products; and Air Force (AF) M91-36, Built-Up Roof Management Program with enclosed BUR Repair/Replacement Guide Specifications.

<sup>13</sup> From MBMA -- Metal Building Manufacturers Association (MBMA) (<http://www.mbma.com/>)

<sup>14</sup> Exposed fasteners tend to leak over time, especially if system is not installed under ideal conditions.

- C. The designer shall take special care to detail wall-to-roof joints and roof penetrations to ensure a watertight fit and resistance to ice entrapment and ice dam formation. All surfaces perpendicular to roof slope over 12 inches wide require a cricket.
- D. Provide an overhang of 6 inches minimum at the wall.<sup>15</sup>
- E. Fabricate fascia, trim, flashing, and other metal components from same material as metal roof panels. Provide exposed metal surfaces with same finish as exposed face of metal roof panels.<sup>16</sup>
- F. Panel Materials: Pre-finished and galvanized (or Galvalume-type) steel sheet 24 gage (0.024 inch) minimum.
- G. Architectural Batten or Standing-Seam Metal Roofing: Minimum slope of not less than 2 inches per foot.
- H. Structural Lapped-Seam Metal Roofing (pre-engineered structures only): Factory formed metal roofing panel system with exposed fasteners. Minimum slope of not less than 1 inch per foot. Exposed fasteners to be of matching color with neoprene or manufacturer-approved gaskets.
- I. Comply with LANL Master Specification 07 4113, *Metal Roof Panels*.

## 2.4 Shingles and Tiles

- A. **Composition Asphaltic Shingles** - Fiberglass mat reinforced type shingles shall be used if this type of roof is selected and approved for use. Shingles shall be of a minimum weight of 220 lbs per square. Shingles shall not be applied to roofs with slope less than 3-in-12.
- B. **Clay, Slate, and Concrete Tiles** -- The designer is required to perform a life cycle cost analysis justification prior to selection of this type of roof treatment. Pre-finished metal tile shall only be applied to steep roofs. Other constraints for use of these types of roof systems are defined in the NRCA Publication "Steep Roofing Manual."<sup>17</sup>

## 3.0 ACCESSORIES<sup>18</sup>

### 3.1 Roof Pavers and other Traffic Toppings

- A. Whenever either access frequency or duty level exceeds the guidelines in Tables B30-1 and B30-2, install roof traffic pads or pavers per Table B30-3.

<sup>15</sup> Overhang helps prevent water under-running back to wall.

<sup>16</sup> Dissimilar materials induce corrosion; refer to LANL Site and Architectural Design Principles ([http://engstandards.lanl.gov/ESM\\_Chapters.shtml#esm4](http://engstandards.lanl.gov/ESM_Chapters.shtml#esm4)) for color palettes.

<sup>17</sup> In addition to adding a large dead load, mineral and ceramic tile roofing treatments have a very high initial cost, so they must be justified by aesthetic desires and long life.

<sup>18</sup> Information from PIMA – Polyisocyanurate Insulation Manufacturers Assoc. -- <http://www.pima.org> and SMACNA's Architectural Sheet Metal Manual.

**Table B30-3, Roof Usage and Required Protection**

Usage (Traffic) Expected	Required Protection
Equipment Access (Regular)	Recycled rubber traffic pads for walkways and around equipment
Equipment Access (Heavy)	Concrete pavers for walkways & around equipment
Public Usage (General Employee)	Concrete pavers for entire area

**3.2 Other Accessories**

- A. LANL Master Specifications to be complied with:
  - 1. 07 6200, *Sheet Metal Flashing and Trim*
  - 2. 07 7100, *Roof Specialties*
  - 3. 07 9200, *Joint Sealants*
- B. Gutters installed on the north side of buildings shall be provided with ice melting/anti-buildup devices.

**4.0 FALL PROTECTION**

- A. General: Fall protection requirements and provisions for LANL facilities shall be in accordance with OSHA Proposed Rules 29 CFR 1910.27 *Walking and Working Surfaces* and 29 CFR 1910.28 *Fall Protection Systems*.<sup>19</sup> Ref: [https://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_id=17819&p\\_table=FEDERAL\\_REGISTER](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=17819&p_table=FEDERAL_REGISTER). In addition, comply with guard requirements of IBC Chapter 10.
- B. Existing Facilities: Provide guardrails in accordance with the requirements of 29 CFR 1910.28 unless infeasible.

*Guidance:*

- 1. *Provide guardrail system as the primary fall protection system for all walking and working surfaces unless the use of a guardrail is infeasible. When the use of a guardrail system is infeasible, provide appropriate alternative fall protection such as personal fall protection systems, hole covers, safety nets, etc. Compliance with Exception 2 use of designated areas per paragraph (d) need not use guardrail systems.*
- 2. *Existing facilities with roof access hatches should be provided with retractable rails, curbside railing, landings and other safety enhancements whenever other modifications to the hatch or roof are made.*

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<sup>19</sup> NNSA Los Alamos Field Office Memorandum entitled Fall Protection: Use of OSHA Proposed Standard dated 4/1/2013.

- C. New Facilities: In lieu of providing guardrails in accordance with the requirements of 29 CFR 1910.28, provide minimum 42-inch-high parapets or other architectural physical barriers at the roof edge of the building.

*Guidance:*

1. *Eliminate need for rooftop activities within six feet of the roof edge. Do not place mechanical and electrical equipment (other than lightning protection) on roofs unless within a penthouse. Preference is to provide internal or ground-level mechanical and electrical equipment rooms.*
2. *Roof access for new facilities shall be by stairs with hand and guard rails conforming to IBC Chapter 10 with a standard personnel door opening out onto the roof.*

## 5.0 REROOFING

- A. *Guidance: This ESM section and the associated LANL Master Specifications govern all roofing at LANL, but of necessity they were written to support new building construction primarily, since re-roofing often presents many unique needs that cannot be addressed in a short standard or master spec.*
1. *As such, when developing a specification package for re-roofing, the LANL Master Specifications may require greater-than-normal levels of editing, augmentation, and supplementation to yield a spec package that adequately addresses all the existing conditions. Per the ESM, such alterations require the approval of the ESM Architectural POC. Additionally, roofing subject matter experts are available for assistance.*
- B. Particular attention must be given to the inventory of existing Systems, Structures, Components, features and equipment on existing roofs or attached to existing structural members including the roof deck whether from above or below. Design shall address these items and a construction (or demolition) sequence shall be provided as part of the contract documents or work order controls. Safety can easily be compromised if this is not done thoroughly.
- C. Code requirements concerning limits of the number or existing roof layers that can have a new roof applied over shall be followed.
- D. Comply with LANL Master Specification 07 0150.19, *Preparation for Re-Roofing*.