

NC State University Design and Construction Guidelines

Division 07 Thermal and Moisture Protection

1.0 Purpose

- A. This section provides NC State's minimum requirements for thermal and moisture protection.

2.0 Materials and Standards

- A. Roofing Program Sequence of Priorities
 - 1. Any new or replacement roof project shall include the installation of a fall protection system.
 - 2. New or replacement roof type shall be selected from the tables included in this document.
- B. Designs for existing low sloped roofs (<3:12 slope) shall consider a coating application under the following conditions:
 - a) 25% or less of warranty remaining.
 - b) No major flaws or damages visually observed.
 - c) Evaluation (infrared, resistance) determines any sub-membrane deficiencies to be remedied.
 - d) All repairs have been completed.
- C. Roof Replacement
 - 1. Designer shall examine the roof and make a recommendation regarding replacement if any of the following criteria is met:
 - a) When the project includes significant mechanical upgrades that alter the number of penetrations to the surface of the roof, roof traffic and loads are increased, or PV/Solar panels are added.
 - b) When only 25% of the warranty remains in effect.
 - c) When the roof has a documented history of leaks caused by material failure.
- D. Roofing Systems (see table for types)
 - 1. Built up or Modified Bitumen
 - a) Shall be used when 15% or more of total roof area is occupied by mechanical equipment.
 - b) Shall utilize either lightweight insulating concrete with adhered or hot mopped Oriented Strand Board (OSB) covered polyisocyanurate, or extruded polystyrene (XPS).
 - c) Shall not employ mechanical fasteners on a high-traffic roof.

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2. Single-ply membrane
 - a) Shall be used when less than 15% of total roof area is occupied by mechanical equipment.
 - b) Shall utilize 25 psi polyisocyanurate or XPS, and be mechanically attached, adhered, hot mopped or installed in conjunction with a pressure equalizing vent system.
 - c) Shall include rigid insulation that sustains the weight of all roof traffic and loads. Roof insulation must be specified to make up a “total roofing system” and shall be warranted by roofing manufacturer.
3. Ballasted single ply roofs are not acceptable.

NCSU Roof Type Selection Matrix - Slope > 3:12		
Roof Type	Warranty	Comments
Metal	20-years	Sheet metal roofing shall be supported by a continuous structural deck. [Corrosion-resistant metals shall be specified for roofs having vents or fume hoods that emit acidic, caustic, and oxidizing agents of a corrosive nature].
Composite Slate	50-years	Slate shingles shall have an expected 75-year minimum life. Minimum slope for slate shingled roofs shall be 6:12. The contractor shall supply one (1) square of replacement slate shingles for future maintenance.
Asphalt Shingles	30-years	Asphalt shingles shall have a 30-year minimum warranty. Slope for shingled roofs shall be a minimum of 4:12. Shingles shall comply with the latest version of ASTM designations and requirements for fiberglass mat, fire rating and wind resistance.

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NCSU Roof Type Selection Matrix - Slope \leq 3:12						
Application	HVAC Density	Roof Type	Insulation Type	Material Warranty	Installer Warranty	Comments
High-Traffic/ Lab	>15%	BUR	OSB / ISO OSB / XPS	30-year	2-year	
High-Traffic	>15%	2-Ply Modified Bitumen	OSB / ISO OSB / XPS	20-year	2-year	
Medium Traffic	<15%	Thermoplastic (TPO)	ISO / XPS	20-year min.	2-year	Avoid use of highly reflective material where occupants would experience glare. Specified single-ply roofing systems must have been used in similar applications successfully for a minimum of five (5) years. Protection shall be provided to single-ply membranes subject to mechanical damage from dropped tools, equipment, or mechanical equipment covers. Protection shall also be provided in areas subject to chemical attack from lubricants or exhaust fan emissions per roofing manufacturer recommendations.
Low Traffic	<15%	EPDM 60-mil	ISO / XPS	20-year min.	2-year	Specified single-ply roofing systems must have been used in similar applications successfully for a minimum of five (5) years. Protection shall be provided to single-ply membranes subject to mechanical damage from dropped tools, equipment, or mechanical equipment covers. Protection shall also be provided in areas subject to chemical attack from lubricants or exhaust fan emissions per roofing manufacturer recommendations.

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- E. Rooftop equipment installations:
 - 1. Concrete pavers and splash blocks shall be specifically designed for rooftop use, of materials approved for use by roof system manufacturer.
 - 2. Roofs supporting towers greater than six (6) feet tall shall be protected from damage by falling ice.
 - 3. All roof equipment shall be mounted on curbs or raised support frames.
 - a) Curbs must extend eight (8) inches minimum high above the finished roof surface.
 - b) Support frames must maintain 18" min. clearance from the lowest point of the frame to the finished roof surface.
 - 4. Walk-pads shall be included leading from the roof access to equipment requiring service and inspection.
- F. Green Roof Systems shall include:
 - 1. Root barrier.
 - 2. Filter fabric.
 - 3. Modular tray system.
 - 4. Intensive type systems (less than eight inches soil depth).
 - 5. Pre-engineered growth medium (80% Lightweight - 20% organic).
 - 6. Plants specifically based on geographical location (drought tolerant).
 - 7. Substrate shall be concrete or concrete composite slab.
 - 8. Designer shall include all dead and live load as required in the Code plus additional load such as engineered soil, insulation, pavers, water retained by soil and retention system, and absorption by filter fabric.
 - 9. The substrate or roof structure should be sloped for positive drainage and shall include primary and secondary drainage systems.
 - 10. Protection board under green roof installations shall be high-density, high compressive strength, and moisture resistant. Protection boards shall be laid on top of the roofing membrane and not considered in thermal calculations of the roof system.
 - 11. The roofing membrane selected must be able to withstand prolonged moisture exposure.
 - 12. The selected Roofing/Waterproofing system shall be fully adhered to the substrate.
- G. PV (Photovoltaic)/Solar Panel installations shall:
 - 1. Be installed on roofs less than five (5) years old.
 - 2. Maintain a 12-inch minimum lateral clearance from any parapet, rooftop equipment, or penetration.
 - 3. Require panels to attach to top of sleepers (curbs) at a minimum of 12 inches o.c.

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4. Maintain 48-inch clearance between adjacent curbs.
5. Use post and beam support construction:
 - a) Vertical members at a minimum of 48 inches o.c.
 - b) Horizontal members with a minimum of 18-inch clearance above membrane.

H. Flashing and Trim

1. Provide flashing for all roof drains and scuppers.
2. Gutters, down spouts, and all other exposed metal work shall be specified for durability and resistance to corrosion. Sixteen/twenty-ounce copper, lead-coated copper, and Kynar-coated 24-gauge galvanized steel are acceptable.
3. Curbs shall be properly flashed with a two (2) piece type flashing that will facilitate re-roofing in the future or the equipment to be set atop it includes a cover with turn down edge forming a flashing.

I. Roof Penetrations

1. NCSU recommends a minimum of 12 inches of clearance between pipes; a minimum of 12 inches clearance between pipe and curb or wall; and a minimum 24 inches between curb and wall to facilitate proper installation of the roof and flashing. Multiple pipe penetrations should be ganged through a penetration pocket.
2. Penetration flashings should include prefabricated boots or sheet metal flashing systems to conform to the profile of the penetrations.
-Pitch pockets are discouraged, however, when necessary due to conditions, sheet metal hoods should be fabricated to fully cover the base.
3. Multiple pipe penetrations should be ganged through a fabricated metal box with penetrations entering the box on the vertical sides.

J. Insulation

1. Layered insulation shall be installed with staggered joints and taped at each layer to prevent heat loss.
2. Tapered insulation shall slope minimum ¼" per foot. Insulation at the drain sump may be 2" thick due to the need to clamp the roof drain.

K. Metal Coping:

1. A piece of roofing underlayment or roofing membrane shall be placed on top of the wood block prior to installing the metal coping.
2. The top of the metal coping shall slope ¼" per foot to the roof side.
3. Lapped seams or butt joints of metal copings should not be used.

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4. The metal coping shall be secured on both sides of the parapet by continuous cleats on the outside and other attachments on the roof side.
5. The lower edge of the coping on both exterior and interior side shall extend a minimum 1 inch below the parapet wood blocking.

L. Wall Flashing:

1. Roofing shall terminate under a two-piece type wall flashing and counter flashing. This is to facilitate re-roofing in the future without having to tear out the whole flashing system.
2. A two-piece type wall flashing and counter flashing shall be set not less than 8 inches above the finish roof surface nor more than 24 inches maximum above the finish roof surface.
3. Exposed Termination Bar must not be used to terminate roofing membrane onto a brick masonry or CMU wall.
4. There are two conditions when Termination Bar can be used. When it is protected from the weather and where Termination Bar is used to terminate the roofing membrane on a smooth concrete wall with appropriate sealant on top.

M. Other Design Criteria

1. Designer shall ensure that structure can support roof system and that the roof is compatible with all building systems. All components of the roof system shall be adequately supported and detailed.
2. Designer shall utilize reflective roofing systems when possible.
3. Wood blocking must be pressure treated. Treated wood shall not be left exposed.
4. In roof replacement, all existing wood blocking and other edge securement materials' anchorage strength must comply with roof manufacturer's requirements.
5. A vapor retarder below the roof insulation shall be used where the indoor relative humidity during winter months exceeds 45%.
6. Flood testing of completed roofing systems is required. NC State shall be notified seven (7) days in advance of testing.
7. Roof drain placement shall be symmetrical and no greater than 40 feet apart. Interior roof drains shall be accessible with interior cleanouts. Any horizontal leg of an internal roof drain must be insulated.
8. A minimum requirement of ¼ inch per foot slope is required. There should be no ponding on the roof. Any water that does not drain must evaporate within 48 hours.

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9. Positive drainage should be designed in all valleys with crickets. Valleys shall have the same minimum slope as the adjacent roofing.
10. Roof framing should be sloped to achieve the desired slope per Code. This creates a uniform thickness of roof insulation and reduces the amount required to build-up the slope.
11. Drainage onto sidewalks or pedestrian paths should be controlled or eliminated, particularly in locations where frozen precipitation is anticipated.
12. Roof drain capacities should be verified for both new construction and roof replacement.
13. Drainage calculations should be included on the drawing for both new construction and for re-roofing.
14. Roof drains are required to have strainers extending no less than 3" above adjacent roofing.
15. Scuppers are acceptable for use as primary drainage system but shall include conductor heads and downspouts to control and direct water off the roof.
16. Overflow drains or scuppers shall be sized to prevent ponding water from exceeding that for which the roof was designed.
17. The overflow drain shall be set 2 inches above the primary drain intake. If the roof slope is at $\frac{1}{4}$ " per foot, this will produce an area of ponding at 8 feet radius around the drain.

N. Warranty

1. The designer shall require a contractor warranty of at least two (2) years. The warranty shall cover all materials (insulation, roof membrane, flashings, sheet metal, sealants, etc.), and workmanship to maintain the roofing system and flashings watertight and weathertight, effective from the date of substantial completion. Contractor must be on site within twenty-four hours to make necessary leakage repairs.
2. The roofing system manufacturer must provide a 20-year minimum roofing system watertight warranty. A separate, extended membrane weathering 20-year warranty shall be included.
3. Work on existing roofs shall preserve any existing roof warranties.
4. Warrantor shall define a leak as water or moisture entering the building or the roof system.
5. Warrantor shall state that observations of blisters, soft insulation, and thermal anomalies etc. at the roof shall be considered sufficient evidence

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of a leak, with repairs within the first two (2) years covered under the workmanship warranty.

O. Waterproofing

1. Composite sheet waterproofing shall be placed under concrete topping in habitually wet areas.
2. Flashing shall be provided in the following locations:
 - a) Openings in laboratory and kitchen floors. Sleeves shall also be provided at all locations.
 - b) Floor drains.
 - c) Flashing pans under all showers.
 - d) Openings in exterior walls.
3. All foundation walls and below grade walls shall be waterproofed with a minimum of three layers bituminous waterproofing and a layer of protection board. Waterproofing shall be backfilled with clean, crushed stone. A continuous drainage tile shall be provided to the foundation drains.

P. Building Insulation thermal calculations must include the use of Aged R-Values

Q. Water Testing New Construction:

1. The completed roof/waterproofing system must be tested to ensure integrity of the completed roof system for leaks. There are two methods of testing, testing the integrity of the roof membrane and detecting moisture for leaks.

R. Roof Recover Overlay:

1. -A non-destructive roof survey indicates no moisture under the existing membrane and/or a minimum of definable areas of repair or replacement. No Moisture may remain in the system after recovery.
NOTE: Under no circumstances shall Roof Recover Overlay be utilized in lieu of a roof replacement. Guidelines are for internal Facilities Division repair, and not for new design projects, Formal or Informal.
2. Before RRO can be considered, the following criteria must be evaluated:
 - a) The roof insulation is not soaked with water.
 - b) Drainage is adequate.
 - c) The existing roofing has not deteriorated and can act as a base for additional roof.
 - d) The existing roofing does not have two or more layers of roofing.

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- e) The new roof system must be compatible with the existing and carry a full warranty.