

07 40 00 – Roofing

1. General

Several factors repeatedly show up during the inspection of roofs that have failed prematurely. They include inappropriate use of materials, poor drainage systems, poor details for installation of roof accessories, damage by construction traffic and poor access to all parts of the roof area. The design of a roof should incorporate these fundamental features: appropriate and proven materials, good drainage and drains, good accessory details, proper protection and good access to the roof and areas around roof-mounted equipment.

1. Duke University follows several guiding principles:
 - a. First, roof design is to provide slope for rapid and dependable drainage.
 - b. Second, a roofing system is puncture resistant. The membrane should have a durable surface and high puncture resistance. The insulation should have high compressive strength.
 - c. Third, the roofing system and all other components (i.e., mechanical equipment and wall assemblies) shall be designed to allow for reroofing in the future.
 - d. Fourth, ease of maintenance should be an important part of the roofing design.
2. It is vital that the weak points of a roofing system be accessible in order to allow for proper inspection and maintenance. For this reason, ballasted or protected membrane systems using a single-ply membrane are discouraged. The roofing system shall be designed based on the planned activities and equipment scheduled directly beneath the roof. The roofing system shall be designed to comply with Factory Mutual (FM), Class 1-60 or Class 1-90 standards. Criteria must be considered as they affect insurance requirements for Duke University. Thermosetting roofing systems are prohibited.

2. References and Codes

- A. All new roofing and reroofing projects shall comply with applicable codes and guidelines described in the following publications:
 1. N.C. State Building Code (most current version)
 2. NRCA Roofing and Waterproofing Manual
 3. SMACNA Architectural Sheet Metal Manual
 4. UL and FM Manuals

5. Asphalt Roofing Manufacturers Association Manuals
6. Single-Ply Roofing Institute Manuals
7. Steel Deck Institute Roof Deck Design Manual
8. Copper Development Association Manual
9. Copper and Common Sense published by Revere Copper, Inc.

3. Reroofing

- A. Reroofing projects are approached the same as new construction except that thorough investigation is needed to determine conditions of the existing building and projects must consider the condition and usability of existing flashings. The top priority during reroofing is to determine the weaknesses of the existing system and design them out of the new roof.
- B. Reroofing over an existing roof is prohibited except in special situations.
- C. Problems associated with noise, smell, dust and access shall be considered. Building components shall be protected from damage during the reroofing process. After a reroofing project, the building is expected to be in the same condition it was originally.

4. Drainage

- A. Water-shedding roofs with a slope greater than 4 inches per foot shall be specified whenever practical. The slope to drainage outlets shall be a minimum 1/4 inch per foot and the slope should be in the structure if at all possible. Crickets must be used on all curbs and penetrations to smoothly direct water flow around obstructions. Crickets should be specified and shown on a roof plan for low or flat areas between drains and on the high side of all roof curbs located perpendicular to the roof slope. The slope of crickets should be twice the slope of the roof system.
- B. Contractor shall avoid locating long skylights, HVAC units and other obstructions perpendicular to the slope. Crickets shall be furnished where necessary to provide drainage around obstructions. Valleys should not be located over a beam-column line. As many obstructions on the roof as possible shall be eliminated. The roof design shall be kept simple. All live and dead loads shall be considered, including future expansion, when planning the design slope.

5. Drainage Type

- A. Internal drainage systems are preferred. External drainage systems (gutter and downspout) must receive approval prior to specifying.

6. Drainage Capacity

- A. Minimum size of drain shall be 4 inch diameter. Each major roof section should have at least two drains or four drains per 150 squares of roof area. If drains are too far apart in the drainage valley of the roof, ponding will result. Spacing drains no more than 40 feet apart will prevent this and will also allow the use of crickets that are smaller and simpler.

7. Location of Drains

- A. Drains shall not be located adjacent to roof columns, to walls that support decks, or to walls that are extended to the roof deck. Drains shall be located symmetrically in order to simplify the tapered insulation design.

8. Overflows

- A. Conductor heads should have an overflow port, permitting water to escape if the downspout becomes obstructed. Scuppers shall be sloped outward and downward. An overflow scupper should be designed so that no more than 6 inches of water will accumulate at the inlet if the drain fails to work.

9. External Drainage Systems

- A. Materials, gauges, shapes and details shall follow the recommendations in the SMACNA Architectural Sheet Metal Manual. The Consultant may reference this manual in the contract documents but shall not substitute that reference for appropriate specifications and details. External drainage systems shall not incorporate pop rivets and caulking in their design.

10. Internal Drainage Systems

- A. A sump created by tapered insulation should be provided at the drain to lower it below the level of the roof. Vertical leaders must have expansion joints at the drains if there is any possibility of deck movement. Horizontal leaders must be insulated to prevent condensation from forming and dripping to ceiling. In multiple prime contracts, the drains are to be provided and installed by the Roofing Contractor and the connection and leaders are to be installed by the Plumbing Contractor. Drains and slopes should be shown on a separate architectural roof plan. Key elevations and slope arrows should be given to the Roofing Contractor. Internal drainage systems with PVC leaders are not permitted in fire-rated construction, noncombustible construction or ceiling spaces used for return air in HVAC design. Refer to the current N.C. State Building Code for additional information.

11. Drain Type

- A. Large sump with a cast iron body and a low-silhouette cast iron dome shall be used. The drain's strainer should be easily removable and its top must extend several inches above the adjacent roof surface. Drain receivers should be used on metal decks and other

types of decks that may need the distributed loading for a secure connection to the deck. Threaded drains do not leak as often as hot-poured or caulked drains.

12. Penetrations

- A. Penetrations through the roof membrane shall be minimized. The penetrations shall be routed through side walls when possible. Curbs shall be used; pitch pockets shall not be used. Reference the NRCA manuals for approved details. Projections through the roof should be completely closed or flashed. Tubular mounts extended through the roofing system are acceptable. Weather caps should be installed to cover pitch pans.

13. Accessibility to Roof

- A. All roof areas shall be accessible by maintenance personnel, but unauthorized access must be controlled. Walk-out access from a stairwell extension is preferred. Access from a penthouse is also acceptable. Doors and hatches providing roof access shall have locks.
- B. Hose bibbs and electrical outlets shall be provided on the roof for maintenance purposes. On a large roof, multiple access points at opposite ends will prevent unnecessary back-tracking. Ladders should be placed to connect multiple levels. Ladders should be mounted to the walls and never tied into the roof at the top. Keep lower ends of ladders from interfering with the counter flashing. Ladders shall be in accordance with requirements of the federal Occupational Safety and Health Administration (OSHA).
- C. Thresholds on doors opening onto the roof must be high enough (minimum 8 inches) to permit counter flashing on the wall to run under the sill without changing style or elevation. If the roof has heavy traffic, removable raised walkways made from non-rusting metal grating should be mounted on flashed curbs. Light-traffic walkway pads may be used if approved by the Owner. In a built-up roofing system, however, pads shall not be set in hot asphalt; install in cement after the gravel has been placed.
- D. When stairways are not required, a roof scuttle shall be provided. It shall be a minimum 2' x 3' in size and have a fixed ladder.
- E. Contaminated air is exhausted on the roof tops of laboratory buildings. Access to these roofs must be coordinated in advance with the Duke Occupational and Environmental Safety Office (OESO), Occupational Hygiene and Safety Division.

14. Interior Accessories

- A. The hanging of interior accessories from the roof deck shall be minimized. All HVAC equipment and ducts, light fixtures, and conduits shall be hung from structural members.

15. Fasteners

- A. Fasteners must meet UL/FM standards and be approved by the roofing manufacturer for the application and system rating. Fasteners must meet FM 4470 standard for corrosion resistance and must have a mechanism to prevent back out. Consultants shall obtain samples of fasteners, installation tools, installation instructions and evidence of code conformance.

16. Testing

- A. An independent testing agency approved by the University shall perform a nondestructive moisture survey before the installation of final ballast or roof coverings. Areas that indicate moisture shall be removed and restored to a dry condition at no cost to the Owner. Copies of the test results shall be submitted to the Owner. All roof drains shall be tested before installation of the roof and at the completion of the new roof. The Owner must be present at these tests.

17. Design Coordination

- A. Design of a roofing system must, at a minimum, be reviewed by an approved roofing consultant. A letter shall be submitted stating that the design has been reviewed and meets the requirements of a properly-designed, installable and maintainable roof.
 - 1. Manufacturers are to be involved in the design and construction of the roofing system. Manufacturer of the roof to be installed is expected to review the project drawings and must submit a letter stating that the roof design meets its requirements. The letter must be from the manufacturer's technical engineering department; review by sales representatives is not acceptable. Manufacturer is to attend the preconstruction conference, to provide technical backup and on-site assistance and to make on-site inspections. As a minimum, inspections shall be made at start up, during application and at completion. Manufacturers are to submit written inspection reports.

18. Submittals

- A. Confirmation in writing that all parties understand and accept the drawings and specifications as a complete system must be submitted to the Owner. Contractor and Manufacturer must confirm requirements relative to the delivery and storage of materials, including certification from vendors of the quality of the materials. Submittal of the manufacturer's standard details without modification to the specific conditions of the project will not be acceptable. Inspection reports by roofing manufacturers shall be copied and sent to the Owner. A roof will not be accepted until the reports have been received.

19. Manufacturer Qualifications

- A. The manufacturer must have been in the roofing business for at least twenty continuous years. The roofing system specified must have a local authorized repair contractor. Manufacturer must have a high quality, intensive program to train applicators.

20. Bidder Qualifications

- A. Roofing Contractors shall be prequalified by the Project Office when part of the general contract. The Roofing Contractor shall submit a letter from the manufacturer of the roofing materials stating that the Roofing Contractor is an approved applicator. The Roofing Contractor shall submit a list of the last ten similar projects installed and manufacturers' inspection reports on the quality of the projects.
 - 1. The Roofing Contractor must be able to perform all duties necessary to install the roofing system specified. Subcontracting is not acceptable unless approved by the Owner. For installing single-ply membrane systems, 90 percent of the work must be performed by employees who have successfully completed the manufacturer's applicator program. The Roofing Contractor shall furnish evidence from the manufacturer to verify this requirement.

21. Warranties

- A. The Roofing Contractor shall warrant the materials and workmanship of the roofing system against leakage and defects due to faulty materials, workmanship and negligence for a period of two years following acceptance of the project by the Owner. The roofing system Manufacturer shall inspect the installation and warrant the materials and workmanship of the roofing system against leakage for a period of twenty-five years, as specified, with no cost limit on the recovery of cost to restore the roof to an absolutely dry condition.
- B. The roofing system shall be designed in order to obtain a total system warranty from the Manufacturer. It is critical that the roofing Manufacturer supplying the system shall have a long history of responding quickly to warranty claims and making satisfactory repairs. Evidence shall be submitted of warranty response from other similar institutions.

22. Conferences

- A. Prior to the commencement of any roofing construction, a Pre-Roofing Conference shall be held. It shall include the following attendees: the Contractor's superintendent and representatives from the Owner, HVAC, plumbing, electrical, masonry and other trades that may impinge on the roofing system. This meeting will initiate the coordination process for the installation of the roofing system and will include a review of the specifications of the roofing system and the sequence of events leading to roof installation, including all accessories to be installed, prior to the roof work and the installation of mechanical equipment.

- B. During the roofing project, a manufacturer's representative shall attend a minimum of 50% of the construction meetings and submit construction notes to the Owner.

23. Decking

- A. Inspection of the structural elements of the roof deck (such as fasteners, welding, hardness, and dryness) is critical. The Consultant shall determine the acceptability of the roof deck construction prior to installation of the roofing system. Deck selection should be made in close regard to the assembly category selected and may often dictate system component type. Because the deck is the foundation of the roof system, consideration for design should be based on stability.

24. Execution

- A. Consultant shall specify that all roof drains, penetrations and adjacent walls must be complete and installed prior to the start of the roofing system. A temporary roofing system shall be installed if there will be any construction activities on the roof prior to the final roofing system installation. All construction activities must be completed before the final roofing system is installed. A membrane less than the ultimate permanent required roofing system may be applied for weather protection when installation of the permanent system might be compromised due to weather conditions, work activities on the roof, or partial project completion.
- B. If all penetrations, curbs, parapets and major mechanical equipment are not installed and ready for roofing operations, the Consultant should notify the Contractor that all roof work should be complete prior to application of the roofing system. If the Contractor proceeds with the roofing operations prior to acceptance by the Consultant and the Owner, roof areas worked on shall be rejected. These areas shall be designated by the Consultant and the Owner and replaced at no cost to the Owner.
- C. Extensive use of sealant patching is not acceptable. Areas with extensive patching shall be replaced at no cost to the Owner.

25. Drawings

- A. The scale of roofing details should be 3 inches = 1 foot (minimum). Details must be provided that clearly indicate terminations or transitions of the roofing systems to adjacent assemblies. Isometric drawings shall be provided to show intersections of metal flashings and junctions of roofing materials. Project details should include but not be limited to corners, penetrations, joints and terminations. Shop drawings are required when tapered insulation is specified. Specify that each individual piece of tapered insulation be indicated on the shop drawing.