1. ROOFING

a. GENERAL

1. Consultation with the HMS Roofing Contracted Consultant is mandatory for all projects with new roofing as well as reroofing projects.
2. All roof assemblies shall be constructed according to the commercial building roof assembly code in 780 CMR (Code of Massachusetts Regulations).
3. Calculations are required for all projects that include roofing and shall be provided on the drawings:
    a. Roof drainage system calculations for primary and secondary drain capacity and sizing.
        - The current FM Global requirement for roof drainage in this geographic area is to design roof drains to provide drainage for a rainfall intensity of 2.5 inches per hour.
    b. Wind uplift design pressures calculations for both the current building code and the most up-to-date FM Global Property Loss Prevention Data Sheets for the applicable roof type.
4. Plans shall include basic roof information separated into discernible sections, each including: square feet area, roof type, slope directions, insulation thickness and type (when used), elevation, and deck type.
5. If utilized and where warranted by manufacturers, fasteners into concrete and masonry shall be of a type that can be easily removed without damage during future roof replacements.
6. Any conditions found to be not as designed or not as expected shall be reported to the Owner and the HMS Roofing Contracted Consultant prior to work continuing.
7. All areas of the substrate (decking or existing insulation to be re-used) found to be wet must be allowed to dry prior to the installation of any materials. The contractor shall notify the Owner and the HMS Roofing Contracted Consultant of these conditions.
8. Consultation with the HMS Roofing Contracted Consultant is mandatory at the conclusion of roofing and shall include presentation of:
    a. Roofing contractor's guarantee.
    b. Manufacturer's warranty.
    c. Manufacturer's certification that roofing materials used comply with specified ASTM standards.
    d. Final roofing survey report from the roofing manufacturer.
    e. Final roofing survey report from the HMS Roofing Contracted Consultant.

b. LOW-SLOPE ROOFS AND ACCEPTABLE ROOFING SYSTEMS

I. WARRANTY

1. All low-slope roofs shall obtain primary and secondary roofing and insulation materials from the roof system manufacturer to ensure a single-source responsibility for the entire roofing system.
2. Manufacturer's total system warranty period shall be thirty years; all detailing will be

designed and specified to meet thirty-year warranty requirements.

3. All wind warranties shall fall under the Massachusetts State Building Code (780 CMR), the ultimate design wind speed for Risk Category III (e.g., schools, public assembly with high occupancy): 128 mph.
4. Roofing contractor's guarantee period shall be two years.

II. ROOF SLOPE

1. Specify that all saddles and crickets shall have a slope twice that of the roof field.
2. Ensure there is proper slope around the high side of all units 18" and larger to prevent trapped water behind units.
3. Specify that all valleys shall slope a minimum of 1/8" per foot.

III. WIND UPLIFT

1. Complete roof assemblies shall comply with ANSI/SPRI WD-1 and ASCE 7.
2. All of the most current editions of the FM Global Property Loss Prevention Data Sheets for the appropriate roof system (low slope, steep slope, metal roofing, etc.) shall be used to provide wind uplift values for the design of the new roof covering.
3. If required by the FM Global Property Loss Prevention Data Sheet 1-52, the selected roof system will undergo testing at the completion of the project as outlined in the Data Sheet. All repairs and costs associated with any destructive testing shall be borne by the roofing contractor.

IV. VAPOR BARRIER

1. All roofs shall be designed to incorporate a 40 mil (minimum thickness) self-adhering vapor barrier direct to the roof decking in all applications except the steel decking.
2. For steel deck applications a thermal barrier capable of spanning the flute distance **may** need to be employed (dens deck prime or similar). If there is no thermal barrier designed, the vapor barrier will need to be one that can be applied directly to the steel deck and meet the FM Global requirements for fire spread and flaming adhesive dripping.
3. The vapor barrier shall be required to be installed per the manufacturer's requirements as well as good construction practices.
4. Roofnav assemblies shall be derived from the Roofnav numbers provided by the HMS Roofing Contracted Consultant will be followed and no deviation in material will be acceptable without a review by FM Global, the Building Owner and the HMS Roofing Contracted Consultant. This includes but is not limited to the adhesives used, the fasteners and fastener rate for the installation of the insulation, etc..

V. THERMAL BARRIER

1. All roofs with wood decks shall be designed to incorporate a ½" thick, flame-resistant barrier (dens deck prime or approved equal) installed directly over the wood decking to provide a class A roof system.
2. For steel deck applications a thermal barrier capable of spanning the flute distance **may**

need to be employed (dens deck prime or similar).

3. Roofnav assemblies shall be derived from the Roofnav numbers provided by the HMS Roofing Contracted Consultant will be followed and no deviation in material will be acceptable without a review by FM Global, the Building Owner and the HMS Roofing Contracted Consultant. This includes but is not limited to the adhesives used, the fasteners and fastener rate for the installation of the insulation, etc..

VI. INSULATION

1. All roofs shall be designed to incorporate a ½" thick, high density (100 psi or greater), polyisocyanurate cover board over the remainder of the roof system. This applies to recover applications as well. This coverboard shall be a coated fiberglass faced (CGF) insulation board. No paper faced insulation will be allowed in this layer.
2. Polyisocyanurate board insulation shall be used and have a nominal average compressible strength of 20 psi.
3. In roof systems where the existing decking is considered to be potentially wet, a coated fiberglass faced (CGF) insulation board shall be utilized throughout. No paper faced insulation will be allowed in this assembly.
4. Board insulation shall be installed with a minimum of two layers per manufacturer's installation instructions. Fit boards together with no gaps and stagger joints in both directions to achieve a complete thermal envelope.
5. The following items require preapproval by the HMS Roofing Project Manager: CFC (chlorinated fluorocarbons) insulation blowing agent.
6. At no time shall phenolic foam insulation or organic fiberboard insulation (including use as tapered edges) be used in these assemblies.
7. At no time shall mechanical fasteners for terra cotta decks, post-tensioned concrete decks or pre- or post-stressed concrete panels. Utilize low-rise foam-adhesive in these applications to the greatest extent possible.
8. Mechanical fasteners shall be used in a limited manner when the existing roof decking is either gypsum or tectum. Utilize low-rise foam-adhesive in these applications to the greatest extent possible unless otherwise directed by the Building Owner or the HMS Roofing Contracted Consultant.
9. Pull tests shall be provided for all mechanically fastened or low-rise foam adhered roof systems.
10. Roofnav assemblies shall be derived from the Roofnav numbers provided by the HMS Roofing Contracted Consultant will be followed and no deviation in material will be acceptable without a review by FM Global, the Building Owner and the HMS Roofing Contracted Consultant. This includes but is not limited to the adhesives used, the fasteners and fastener rate for the installation of the insulation, etc..

VII. ACCEPTABLE LOW SLOPE ROOFING SYSTEMS

1. **Single-Ply Membrane (SPM):** Acceptable systems include:
   a. Solar Reflective Membranes: New low-slope roofing projects shall utilize materials that meet a three-year aged SRI value of 64. If three-year aged value information is not

available, use materials that meet an initial SRI value of 82. The membrane specified shall contain KEE HP or have a KEE molecular weight of greater than 50%. The roof must be protected from discoloration during construction, washed, and left clean at the completion of work. TPO roofs are not permitted on Academic Division Buildings.

b. Single-ply, fully-adhered, reinforced white or energy grey PVC or TPO thermoplastic membrane, 80-mil thickness.

c. Single-ply, Rhinobond attached, reinforced white or energy grey PVC or TPO thermoplastic membrane, 80-mil thickness (steel decks only).

d. With prior approval from the Building Owner: Single-ply, fully-adhered, non-reinforced black EPDM membrane, 90-mil thickness.

e. The HMS Roofing Project Manager and HMS Facilities Roofing Consultant must approve single-ply membrane roof systems that do not match these standards.

2. **Built-Up Roof (BUR):** A hybrid BUR is acceptable for heating plants and similar facilities where documented preapproval is provided by the HMS Roofing Project Manager. The acceptable system is a 3-ply asphalt built-up roof with a granule-surfaced modified bitumen cap sheet having a minimum cap sheet thickness of 150 mils.

3. For all membranes: Roofnav assemblies shall be derived from the Roofnav numbers provided by the HMS Roofing Contracted Consultant will be followed and no deviation in material will be acceptable without a review by FM Global, the Building Owner and the HMS Roofing Contracted Consultant. This includes but is not limited to the adhesives used, the fasteners and fastener rate for the installation of the insulation, etc..

c. STEEP-SLOPE ROOFS AND ACCEPTABLE ROOFING SYSTEMS

I. GENERAL REQUIREMENTS

1. 60 mil, self-adhesive, high temperature, polymer-modified bituminous sheet ice and water barrier with slip resistant mineral granule surface shall extend continuously: from outer edges of eaves and gutters to 60” minimum beyond the line of the exterior wall below, 15” from rake edges and roof penetrations, and 36” to both sides of valleys.

2. Over the entire roof system, a synthetic underlayment for the shingles or a 30# felt for copper and slate will be installed. This includes over the ice and water barrier listed above. This is to prevent the finish materials from adhering to the ice and water barrier.

3. Closed valleys are prohibited. Exceptions may be applicable for historic structures. Verify the requirements of the valleys with the specified roofing manufacturer.

4. For all non-slate and non-metal roofs, ventilation shall be designed and provided as designed by the HMS Roofing Contracted Consultant.

II. ACCEPTABLE STEEP-SLOPE ROOFINGSYSTEMS

1. Slate

a. Specify genuine unfading slate, ASTM C406, Grade S-1, of size, thickness, texture, exposure style, shape and color to match existing. All slate shall be hard, dense, sound, and rock pre-punched for two nails.

b. No cracked slate shall be used. No broken corners on covered ends shall be allowed. All exposed corners shall be partially full. No corner break shall exceed 1/2" in either dimension. Slates shall have the following physical properties:
    - Modulus of rupture: 9,000 psi per ASTM C120
    - Water absorption rate: 0.25% per ASTM C121
    - Depth of softening/acid resistance: 0.001 inches per ASTM C217

c. New slate roofs shall be installed over 3/4" tongue and groove, solid lumber decking. Use of plywood as a nailing deck is prohibited.

d. Smooth shank copper nails are to be used to hang slate.

e. All slate shall be collated throughout all of the pallets once delivered to the site to ensure that the colors are mixed and blended to prevent areas from being installed as one solid variation of the slate. This includes pre-collated from the quarry orders.

f. Snow retention or fencing shall be installed in the locations as designed and designated by the HMS Roofing Contracted Consultant.

2. Metal
    a. Terne-coated stainless steel; field-formed double-lock standing-seam
    b. Terne-coated copper; field-formed double-lock standing-seam
    c. Copper; field-formed double-lock standing-seam
    d. Copper; field-formed batten style to match existing historic roof designs
    e. Copper; flat seam and soldered. Pre-tin the pieces to the greatest extent possible prior to bring the materials on site to ensure full coverage and limited contamination. Tape off the edges of the soldered areas on site to limit the flow of the solder off of the seams.
    f. Aluminum or steel; architectural standing seam manufactured roof panel system, PVDF finish

3. Shingles (other than slate)
    a. Architectural asphalt shingles are the preferred material. Certainteed or GAF Timberline are the standard. No deviation without prior written approval from the HMS facilities team.
    b. All asphalt shingles shall be installed with 6 fasteners per shingle and have all high wind installation techniques used in the manufacturer's published literature (asphaltic caulking at valleys, rakes, etc.).
    c. Minimum warranty accepted for asphalt shingles is thirty years; lifetime warranty is preferred. High wind, organic growth and all other available warranties are also required for these applications.
    d. Use of wood shingles or shakes is prohibited, except for in-kind replacement of existing roofing.
    e. Three-tab fiberglass or dimensional shingles may be used with preapproval from HMS.

d. ROOFTOP-MOUNTED PHOTOVOLTAIC SYSTEMS

1. Coordinate with the HMS Facilities to determine the feasibility of solar photovoltaic installations on all low-slope roofs.
2. The following guidelines shall be followed for PV installations:
    a. FM Global Property Loss Prevention Data Sheet 1-15 Roof-Mounted Solar Photovoltaic Panels.
    b. NRCA Guidelines for Rooftop-Mounted Photovoltaic Systems.
    c. Single Ply Roofing Industry (SPRI) Technical Bulletin 1-13.
    d. Roof system manufacturer's requirements.

e. UNACCEPTABLE ROOFING SYSTEMS

The following roofing systems are not permitted for use at HMS unless pre-approved by the HMS Roofing Project manager:

1. Vegetate/Terrace roofs
2. Ballasted single-ply membranes.
3. Mechanically fastened single-ply membranes.
4. Sprayed-on polyurethane foam.
5. Modified bitumen systems, except the Built-Up Roofing system noted in Section 1.b.7.2.
6. Cold applied roof systems.
7. Any roof systems that are torch applied.
8. Protected roof membrane (PMR) systems, also referred to as inverted roof membrane assemblies (IRMA), except as noted in Section 1.e.
9. Application of a new roofing system over an existing roof membrane in a recover. The existing roof membrane is required to be removed in its entirety including all flashings and edges.

f. STEEL ROOF DECK

1. Corrosion protection is critical to maintain the structural integrity of the roof deck from moisture leaks through the roofing membrane. NRCA Bulletin 15-91 provides guidance on protection.
2. The steel roof deck is required to be Factory Galvanized, G-60 or G-90 (ASTM A924-94) or Factory coating with aluminum zinc alloy (ASTM A792).
3. 'Primer paint' coated deck is not permitted.

g. BLOCKING AND MISCELLANEOUS CARPENTRY

1. Oriented strand board (OSB) or particleboard shall be permitted only with specific approval by the HMS Roofing Project Manager.
2. All panel materials shall be rated for exterior use when in contact with masonry or partially

exposed to any of the elements. Wood blocking to be untreated southern yellow pine, except where required by code to be fire retardant treated lumber.

3. All unit supports shall be pre-fabricated curbs and not built up wood blocking.
4. All roof blocking shall be installed as required by the building code and the FM Global Property Loss Prevention Data Sheets 1-28, 1-29 and 1-49.
5. Power-driven screw-type fasteners shall be used to fasten wood to wood, or wood to masonry.

2. ROOF DRAINAGE, EQUIPMENT, AND ACCESSORIES

a. GENERAL

1. The current Massachusetts State Building Code requirement for primary roof drainage in this geographic area is to design roof drains to provide drainage for a rainfall intensity of 4.0 inches per hour.
    a. This requirement is from the Massachusetts State Plumbing Code (248 CMR) as directed by the building code.
    b. The Massachusetts State Plumbing Code provides a maximum square foot area to be covered by each vertical roof drain.
    c. A specific area is provided for the common roof drain diameters. This information can be found in Massachusetts 248 CMR Uniform State Plumbing Code.
    d. Overflow drainage is not currently required by these codes.
2. During construction, new roofs and major renovations must have access via an enclosed stairway. In renovations, ladder or hatchway access is acceptable only if stairway is impractical. Means for safe access to all adjacent roof levels shall be provided from the main roof.
3. OSHA updated its fixed ladder standards to effectively phase out ladder cages as the primary means of fall protection. Now, fixed ladders extending over 24 ft must be equipped with a Personal Fall Arrest System (PFAS) or Ladder Safety System.
4. All buildings shall have a positive means of conducting rainwater from the roof to a stormwater management practice, cistern, or the storm sewer system. Roof drain inserts are not allowed as they limit the volume of water able to be drained from the roof.
5. Metal flashing, counter flashing, cleats, clips, drip edges, exposed metal trim/ridge cap, cant strips, scuppers, eyebrow roof vents, and exposed metal valleys shall be one of the following materials:
    a. Terne-coated stainless steel
    b. Terne-coated copper
    c. Copper
6. Continuous cleats are required.
7. All metal shall have a minimum of a 3/8” hem. No sharp exposed edges will be allowed.
8. All metal shall be protected from being in contact with other metal that could cause galvanic reactions.

9. All edges shall be designed to meet the FM Global Property Loss Prevention Data Sheet 1-29 as well as the ES-1 standard for metal edging as set forth in the building code.
10. Built-in reglets shall be provided for new wall-flashing terminations. Surface applied reglets shall only be provided on existing buildings where installation of built-in reglets is not possible. To facilitate future roof replacements or recoveries two-piece counter flashings shall be provided at terminations.
11. Solder all non-expansion joints in metal work. Avoid lap joints where possible.

b. ATTACHED GUTTERS

1. On sloped roofs, adequately sized and securely installed gutters of minimum 16-gauge metal shall be specified. Stainless steel or PVDF-coated steel may be used on additions to existing buildings with similar existing gutters and may be used on new buildings where the context does not heavily reference traditional style and/or materials. A minimum slope of 1/16-inch per foot for gutters is required. A minimum of two downspouts for each drain area shall be provided.
2. Gutter spikes are not allowed.
3. All gutter edges shall be designed to meet the FM Global Property Loss Prevention Data Sheet 1-29 as well as the GT-1 standard for metal edging as set forth in the building code.

c. BUILT-IN GUTTERS

Built-in gutters are only permitted with an approved HMS. Where approved the following shall apply:

1. Built-in metal gutter liner shall be terne-coated stainless steel, terne-coated copper, or copper.
2. Lap joints are not permitted.
3. Expansion joints are required.

d. DOWNSPOUTS

1. Downspouts shall be a minimum of 16-gauge, shall be adequately sized and securely fastened to the vertical plane, and shall empty into a cast iron boot at grade connected to a storm water management practice, cistern or the storm sewer system. For existing facilities where this is not possible, water will be directed away from the building and new splash blocks will be provided.
2. Where a building is located near trees, down leader protective baskets shall be provided to keep leaves from entering drain inlets in gutters.

e. SNOW GUARDS

1. Snow guards are required for all roofs with a slope of 6 in 12 or greater and over all entrances regardless of slope.
2. On slate roofs and historic hand-formed standing-seam roofs a minimum of three staggered rows of guards are required. Snow guards shall be butterfly type: copper, stainless steel, or bronze.
3. Wire snow guards are not acceptable.

4. On new/modern standing-seam metal roofs, use metal snow rail systems that are attached to the standing seams. Butterfly type snow guards mounted on top of the standing seams are not acceptable.

f. ROOFTOP SAFETY

1. OSHA approved fall protection shall be provided for 100% coverage on all new and replacement roofs and considered in the following order:
   a. Elimination of Hazard: Remove maintained equipment from the roof, provide a 39" to 42" minimum height barrier (e.g. parapet, railing); provide an equipment screen; or keep necessary equipment and drains away from roof edge. Non-penetrating roof mounted railing system is preferred.
   b. Protection by Fall Restraint
   c. Protection by Fall Arrest
2. Consultation with the HMS Roofing Project Manager and the Office of Environmental Health and Safety is required for all fall protection designs.
3. When HMS Facilities Management has specified/required that exterior elements are to be maintained or cleaned by suspension methods (such as boatswain's chair, rope descent, or temporary scaffolding), then designs shall incorporate support systems (anchors, davits, outriggers, etc.) which allow access to the building elements to be maintained.

g. ROOFTOP EQUIPMENT

1. Rooftop mounted equipment (excluding fume hood exhausts, power roof ventilators, and similar equipment functionally required on the roof) is discouraged. Rooftop equipment in new construction is subject to approval by the HMS and must be screened from view of other buildings, streets and walkways.
2. All roof top equipment shall be installed to prevent overturning as required by the building code and the FM Global Property Loss Prevention Data Sheet 1-29.
3. All roof top equipment shall be installed to allow flashing as required by the building code and the FM Global Property Loss Prevention Data Sheet 1-49.
4. Abandoned equipment shall be removed and the decking repaired on re-roofing projects.
5. Where new rooftop equipment or repair/replacement of existing rooftop equipment is approved, the project must incorporate the following:
   a. Provide adequate space and appropriate lighting for access and maintenance of the equipment. Elevated equipment must have permanently installed ladders and platforms to all equipment access panels and items requiring ongoing maintenance.
   b. Provide durable walk pads from roof access point to and around all rooftop equipment. Walk pads must be at least 2' wide and extend 6' from the equipment on the sides requiring service accessibility.
   c. Provide 12" clearance under rooftop equipment and horizontal supporting members to finished roof (24" clearance if the equipment is > 24" wide). Supports shall be mounted and fastened to structural deck or framing, not insulation.

d. Use of wood sleepers for rooftop equipment is prohibited.

e. Equipment curbs shall not be placed in drainage valleys. Crickets shall be installed on upslope sides of equipment curbs.

h. ROOF HATCHES

1. Where roof hatches are utilized, they shall be insulated, lockable, and feature thermal breaks.
2. Design of roof hatches shall meet OSHA standard for fall protection. Fall protection measures including but not limited to: hand grips outside of the hatch with walking access between, safety railing systems, tie-off anchors, self-closing gate and orientation that enables opening the hatch without turning around.

i. SKYLIGHT STRUCTURES AND CLERESTORY WINDOWS

1. The use of skylight structures, unit skylights and clerestory windows shall be approved as part of the Schematic or Preliminary Design process by HMS.
2. Design of skylights and roof replacements at existing skylights shall meet OSHA standards for fall protection.
3. Drawings and specifications for skylights or clerestory windows shall indicate dimensioning, flashing, sealants, gaskets, joints and other quality criteria intended to prevent leaks and minimize maintenance. All skylights shall have a minimum 5” high curb on sloped roofs; 12” on flat roofs.
4. In Massachusetts, fall protection for skylights is governed by the state building code (780 CMR) and aligned with federal OSHA standards. Any skylight or roof hole located 4 feet above a lower level must be protected by a fixed guardrail, a structural cover, or personal fall arrest systems.
    - Skylight Screens/Covers: Covers or screens must be able to support at least twice the maximum intended load and withstand a downward force of 200 pounds applied perpendicularly to any area. Deflection cannot cause the screen to break the glass below.
    - Guardrails: If perimeter guardrails are used around the skylight opening, they must be standard railings (42 inches high with a midrail and toe board) on all exposed sides.
    - Curbs: All skylights shall have a minimum 5” high curb on sloped roofs; 12” on flat roofs, which provides a physical barrier and visual cue. However, this curb alone does not satisfy fall protection for personnel walking on the roof.