Division	Category	Section	Division Name	DFCM Standard
01	91	15	BECx Specification	Provide a specific and separate Building Enclosure Commissioning (BECx) section (01 19 15) separate from the General Commissioning Requirements section (01 19 13) for all High Performance Structures.
01	91	15	BECx Specification	The Owner shall contract directly with the Building Enclosure Commissioning Authority (BECxA) to maximize independence.
01	91	15	BECx Specification	Specification sections, 01 91 15 "Building Enclosure Commissioning" shall be drafted by the BECxA for review, comment, and ultimately incorporation into the contract documents by the Architect of Record (AOR).
01	91	15	BECx Specification	The BECx process shall be in general compliance with ASTM E 2813-12 "Standard Practice for Building Enclosure Commissioning" for Fundamental BECx as defined within the standard. The BECx process may deviate from the requirements of ASTM E 2813-12 with the acceptance from DFCM, AOR, and BECxA of a technical justification provided for each deviation.
01	91	15	BECx Specification	This specification section must provide the roles and responsibilities of each team member within the BECx process, address the general timeline of the process, outline key building enclosure milestones/deliverables, and outline how the building enclosure commissioning process fits into the requirements of the contract for construction.
01	83	16	Exterior Enclosure Performance Requirements	Acoustic Controls: STC-45/OITC-40 based on standard performance values reported for assemblies.
01	91	17	BECx FPT Spec.	Specification sections, 01 91 17 "Building Enclosure Functional Performance Testing" shall be drafted by the BECxA for review, comment, and incorporation into the contract documents by the AOR.
01	91	17	BECx FPT Spec.	Provide a Building Enclosure Functional Performance Testing (FPT) requirements for: 1) the laboratory or on-site-off-building performance mock-up(s) and 2) the phased in situ field specimen for all High Performance structures.
01	91	17	BECx FPT Spec.	The Building Enclosure Functional Performance Testing (FPT) shall be in general compliance with ASTM E 2813-12 "Standard Practice for Building Enclosure Commissioning" for Fundamental BECx as defined within the standards Annex A2, "BECx Performance Testing Requirements". The BECx process may deviate from the requirements of ASTM E 2813-12 with the acceptance from DFCM, AOR, and BECxA of a technical justification provided for each deviation.
01	91	17	BECx FPT Spec.	The BECxA may be the same agency the building enclosure testing agency (BETA) or the BETA may be a subcontractor to the BECxA.
01	91	17	BECx FPT Spec.	The costs for specified Building Enclosure FPT shall be the responsibility of DFCM as a direct cost or within the scope of the contract for construction. Costs to the project in time and/or money due to retesting or reinsertion as a result of non-conforming FPT results will be the responsibility of the Contractor.
01	91	17	BECx FPT Spec.	The Building Enclosure FPT protocol shall identify the minimum size, number of specimen, and progression phasing for each system and interface for each test protocol required by the contract for construction.
01	91	17	BECx FPT Spec.	The Building Enclosure FPT protocol shall identify the number of additional successful FPT specimen required as a result of each non-conforming FPT result. Additional test specimen shall not be tested until the source and cause of the non-conformance is identified; documented; repaired; and successfully retested. Upon successful retesting of the specimen the repair procedure shall be formally documented by the Contractor and installed as required on the remaining installed portions of the system. The Contractor shall also provide documentation of a revision to the system and/or processes for the remainder of the system to be fabricated or installed in response to the non-conformance FPT.
01	91	17	BECx FPT Spec.	Mock-up testing per ASTM E 1105 or AAMA 501.1 and ASTM E 783 is required for both High Performance and Standard structures.
01	91	17	BECx FPT Spec.	The performance mock ups for High Performance structures shall require the installation of complete water, air, thermal, and vapor control systems as designed, specified, and approved through the submittal process with project specific detailing. If the assemblies and systems of the structure include the use of an interior air or air and vapor barrier to achieve the performance of the wall assembly the interior air or air and vapor barrier systems shall also be included in the performance mock-up. The interior air and/or vapor barrier may be fully or partially removed for to conduct portions of the FPT.

01	91	17	BECx FPT Spec.	Water testing on a facade surface, including fenestration and opaque walls, shall be in general accordance with ASTM E 1105 or AAMA 511. A minimum 6.24 psf differential pressure should be used for Standard structures with 8.00 psf being the minimum for High Performance structures. Individual project test pressures will be based on the exterior environment and rated performance of specified products. High Performance structures should test a minimum of 10% of windows and surface area unless otherwise dictated by the building envelope commissioning Authority. Standard structures shall test a minimum of one typical fenestration assembly. Water penetration resistance testing for High Performance Structures shall be provided at the full test pressure without the typical 1/3 reduction allowed by industry standards.
01	91	17	BECx FPT Spec.	High Performance structures should test a minimum of 10% of windows and opaque wall surface area unless otherwise recommended by the BECxA and documented in the BECx FPT Specification section. Standard structures shall test a minimum of one typical specimen for each unique fenestration assembly.
01	91	17	BECx FPT Spec.	Roofs on High Performance Structure which include a continuous air and vapor barrier (i.e. a vapor barrier or temporary roof to remain within the assembly) separate from the roof membrane, the air and vapor barrier portion of the assembly shall be tested with Electronic Leak Detection (ELD), ASTM D5957-98(2003) Flood Testing, or ASTM E 1186-03(2009) utilizing the *Chamber Pressurization in Conjunction with Leak Detection Liquid.* Standard structures do not require testing of this portion of the roof assembly.
01	91	17	BECx FPT Spec.	High Performance structures require flood testing in accordance with ASTM E5957-98(2013) or Electronic Leak Detection (ELD) to be performed on all green roof, plaza deck, or roof assembly with substantial overburden on membrane when installed over occupied space.
01	91	17	BECx FPT Spec.	High Performance structures shall have long duration (minimum 8 hour) modified ASTM E1105-00(2008) test at a specimen of each type of below grade waterproofing with occupied space to the interior. There are no in situ blow-grade waterproofing testing requirements for Standard structures.
01	91	17	BECx FPT Spec.	Field measurement of air leakage through facade surfaces, including fenestration and opaque walls, is required to be in general compliance with ASTM E783-02(2010). Test chamber shall be constructed air tight and sealed to the air barrier plane of air tightness when practicable. Test specimen shall include minimum of 75 square feet of opaque wall and an interface with a representative fenestration assembly. Test chamber typically encompasses entire punched opening and out of sequence installations may be necessary to accommodate testing. All penetrations shall be installed through the air barrier (masonry ties, girts/cladding supports, etc.). High Performance structures require a minimum of 1 test per building, which may be accomplished on the mock-up. Quantitative air testing on opaque wall assemblies is encouraged on Standard performance structures, but only fenestrations are required to be verified.
01	91	17	BECx FPT Spec.	Field testing of air leakage through facade surfaces, including fenestration and opaque walls, is also required per ASTM E 1186-03(2009) per section 4.2.6 Chamber Pressurization or Depressurization in Conjunction With Smoke Tracers. This testing program should include representative specimen of each typical interface between systems (claddings, fenestrations, roofing, etc.) that exists on High Performance structures. Standard structures require testing a minimum of one specimen, which represents the most common fenestration and cladding type.
01	91	17	BECx FPT Spec.	Air testing of opaque roof/wall assemblies are required to comply with ASTM E 1186-03(2009), per section 4.2.7*Chamber Depressurization in Conjunction with Leak Detection Liquid,* without evidence of air penetration. The testing is performed on penetrations through the air barrier and laps, patches, etc. at single ply roofing membranes. At a minimum, perform the test at 20 locations for High Performance Structures. Air testing of opaque roof/wall assemblies is encouraged on Standard performance structures, but only fenestrations are required to be verified
01	91	17	BECx FPT Spec.	Field measurement of air leakage through fenestration is required to comply with ASTM E783-02(2010). Testing can typically be performed on entire fenestration assemblies less than 12' by 12' (i.e., testing may not be effective on portions of continuous systems without significant coordination). This test can often be accomplished simultaneously with opaque wall assemblies and interface with fenestration testing above. If test cannot be performed due to specimen size, testing per ASTM E 1186-03(2009) section 4.2.6 Chamber Pressurization or Depressurization in Conjunction With Smoke Tracers may be specified as an alternative. At a minimum, perform one test for each type of fenestration for all High Performance structures and one representative specimen for Standard structures.
01	91	17	BECx FPT Spec.	The AOR shall design a mockup to be built by the contractor and shall include drawings for such mockup in the construction documents. The mockup shall be used to establish a standard for appearance, workmanship and approval of installation methods in addition to functional performance testing for air and water penetration resistance. The AOR and DFCM must approve the installation of all the systems on the mockup for workmanship, performance and appearance. All High Performance structures require a laboratory or off-building-on-site field mock-up. Standard structures may use in-situ (on-building) mock-up specimen.

01	91	17	BECx FPT Spec.	The mockup design shall meet the following criteria: -Dimensions shall be 5' minimum in each horizontal direction and 7' tall and sufficient in size and scope to include representative details. -Built on a concrete pad or other structurally sound, air tight substrate of sufficient design to remain in place through the construction period. -Mockup shall be fully sealed to allow for quantitative air testing; this often requires construction of "chamber walls" to contain the space. - Access must be accommodated through a door or reasonable access opening so that a person or persons may enter to evaluate performance during FPT or observe installation. -Environmental control layers (water, air, vapor and thermal) shall be installed per the building details and product specifications, complete with flashings and seam tape. -All conditions (wall types, roof types, parapets/cornices, windows, etc.) must be represented in the mockup with transition and penetration details that occur on the building. Refer to the building details in the mockup drawings so that installation is completed in the same manner as it will be on the building. - Building doorways should not be installed on the mockup. -A minimum of two adjoining sides of the mockup shall be completed with exterior finishes as well as the roof. The other two sides have to be enclosed by the Contractor to accommodate pressure testing. -All penetrations that occur on the building shall be represented including structural attachments and masonry/ veneer ties and connections. -No interior finishes are to be installed prior to baseline air and water testing so as to help identify potential problems. - Passed mock-up testing is required prior to proceeding with fabrication or installation of included assemblies.
01	91	17	BECx FPT Spec.	Building Pressure / Air Leakage Testing: - All High Performance structures that are not additions or contain significant connectivity with existing buildings shall be whole building air tested in accordance with USACE Air Leakage Test Protocol for Building Envelopes, incorporating ASTM E779-10. - For all High Performance structures, design and construct the building enclosure such that a whole building pressure test results do not exceed 0.10 cfm/sq. ft. of building enclosure surface area at 1.57 lb./sq. ft. (0.30 in. wc. or 75 Pa). The building enclosure surface area shall be equal to sum of roof area, wall area including below grade, and floor area including slab on grade separating interior conditioned space of the building from the outside environment. - Standard performance structures are required to meet 0.25 cfm/Sq. ft. of surface area at 1.57 psf. - Care must be taken to ensure integrity at all penetrations and at window, door, floor, and roof connections. - If air leakage requirements are not met, determine air leakage pathways using ASTM E1186-03 Standard Practices for Air Leakage Site Detection in Building enclosures and Air Barrier Systems and perform corrective work as necessary to achieve air leakage rate specified. - DFCM to provide periodic isolated smoke and pressure tests during construction phase of the project to assist the contractor in the identification of potential problem areas. - Contractor to facilitate coordination of in progress testing between DFCM, the Contractor, and the Building Enclosure Testing Agency. - The Contractor's final payout for project completion is subject to compliance with air leakage standard; penalties may be identified in the contract documents in the event that the air leakage standard is not met.
01	91	17	BECx FPT Spec.	Masonry through-wall flashing should be tested to confirm watertight construction in general conformance with ASTM C1715-09 *Standard Test Method for Evaluation of Water Leakage Performance of Masonry Wall Drainage Systems*. At selected specimen locations, after three (3) courses of masonry has been installed above the level of the flashing, apply water on top of the flashing at each lap joint and end dam.
01	91	17	BECx FPT Spec.	During the initial installation process, perform periodic testing of the air barrier system, including pull adhesion testing and Air Leakage Site Detection Testing per ASTM E 1186-03(2009), per section 4.2.7 Chamber Depressurization in Conjunction with Leak Detection Liquid. The number and frequency of testing shall be recommended by the BECxA for review, comment, and ultimately incorporated into the contract documents by the AOR.
01	91	17	BECx FPT Spec.	During the installation process, perform testing of the fenestration systems, including air infiltration (ASTM E783), water penetration testing using both static (ASTM E1105) and dynamic (AAMA 501.1) test methods.
03	00	00	Concrete	For building designated as high performance where Architectural Precast Concrete is selected to serve as the primary air, water, and vapor control layer, the Precast shall be either fully insulated without concrete edge returns or installed with an air and vapor impermeable thermal insulation in direct contact with and fully adhered to the inside face of the architectural precast system, including anchors and detail that may constitute a thermal bridge, to mitigate interior condensation concerns and energy loss.

03	00	00	Concrete	Continuous concrete from interior to exterior that bisects more than 30% building insulation R-Value, shall not be permitted on High Performance structures. Measures are taken to minimize thermal bridging in structural concrete penetrations, such as including a structural thermal break. All locations of thermal bridging should be identified by the energy modeler such that appropriate U-Factor reductions may be applied or thermal bridging otherwise accounted.
04	00	00	Masonry	Concrete Masonry Units: ASTM C 90, Lightweight, minimum unit strength of 2800 psi average or stronger. (fm=2000 psi). High Performance Structures shall not incorporate single wythe CMU exterior wall assemblies that separate interior and exterior conditions. In structures where singly-wythe construction has been approved by DFCM, a high build vapor permeable elastomeric coating shall be provided on the exterior in conjunction full depth through wall flashing, including a back leg and end dams, and an interior air and vapor impermeable thermal control layer is provided in direct contact with and fully adhered to the interior face of the CMU.
04	00	00	Masonry	Mortar Joints: Joints shall be "concave", "V-joint" or "weathered raked" for structural members and surfaces exposed to weather. When CMU forms the substrate for an air barrier or coating, mortar joints shall be struck flush.
04	00	00	Masonry	The exposed face of all embed plates shall be set flush with the face of masonry wall or column.
04	00	00	Masonry	Stainless steel anchor ties should be used for all buildings with a services life in excess of 50 years. All anchors should be installed prior to installation of the exterior air barrier, such that the penetration of the air barrier can be evaluated prior to concealment. Anchors applied after the air barrier shall include sealant applied to the threads prior to installation and sealant applied over the fastener head, under the fastener head, under the anchor, and additionally detailed per the air barrier manufacturer recommendations. Fastening anchors through insulation and then through the air barrier blindly is not permitted on High Performance Structures. For all High Performance structures, the performance expectations of the veneer ties should meet or exceed the life expectancy of the building.
04	00	00	Masonry	Masonry Veneer Attachment and Reinforcing: Other methods of attachment may be used after written acceptance by the AOR and structural engineer. Stainless steel anchor ties should be used for all buildings with a service life in excess of 50 years. All ties should be either embedded in the substrate or shot in prior to installation of the exterior air barrier, such that the penetration of the air barrier can be evaluated prior to concealment. For all High Performance structures, the performance expectations of the veneer ties should meet or exceed the life expectancy of the building.
04	00	00	Masonry	All buildings with exterior insulation within a masonry cavity shall utilized mechanical attachment in conjunction with the lateral masonry anchors, such as insulation washers, as a secondary means of secured attachment for the exterior insulation. Insulation attachment shall be in stalled in a manner to prevent the attachment from becoming dislodged due to the long term expansion and contraction of the insulation material.
04	00	00	Masonry	Steel Lintels: Provide steel angle lintels at all openings through the masonry veneer. Provide one inch of bearing for each foot of width of opening, with a minimum bearing of six inches. Include a Steel Angle Lintel Schedule on the drawings. For all High Performance structures, the performance expectations of the lintel (including any coating) should meet or exceed the life expectancy of the building. Floating Lintel, that minimize thermal bridging, should be evaluated for use on all High Performance Structures.
04	05	00	Common Work Results for Masonry	Water Penetration Resistance - Design and Detailing Wall System Selection: • Drainage walls provide maximum protection against water penetration and shall be used for all High Performance and Standard structures with masonry veneer. • Drainage wall systems include cavity walls (metal-tied and masonry-bonded hollow walls in historical applications), and anchored-veneer walls • Single-wythe masonry walls to separate conditioned space from exterior conditions are not permitted without approval from DFCM, especially when exposed to rain. • All flashings and cavities shall be sloped to drain.
04	05	00	Common Work Results for Masonry	Water Penetration Resistance - Materials Water-Resistant Barriers: • Install when brick veneer is anchored to wood, steel studs or CMU back-up • Protect from or avoid prolonged ultraviolet (UV) exposure • Coordinate with Division 07 non- and vapor-permeable barrier materials over water-resistant sheathings deemed equivalent or conforming to AC 38 • Weather resistant barriers shall also serve as air barrier and must be either fluid applied or self-adhered. Taped boards, tapered insulation, interior sheet rock, grouted CMU, or mechanically fastened air barrier are not acceptable for High Performance structures
04	05	00	Common Work Results for Masonry	Water Penetration Resistance - Construction and Workmanship General: • Store materials on the job site to avoid wetting, contamination, and contact with soil • For drainage walls, keep the air space free of mortar droppings • Do not disturb newly laid masonry • Cover tops of unfinished walls until adjacent construction protects them from water entry

04	05	00	Common Work Results for Masonry	Effloresence - Prevention General • Design and construct brickwork to maximize water penetration resistance • Consider materials that contain fewer soluble salts - efflorescence is usually caused by excessive moisture built up on the inside of the brick drying to the outside bringing salts with it • Isolate exterior brick wythe with an air space -provide vents top and bottom for air flow in conjunction with adequate drainage • Waterproof the exterior of walls that extend below grade -provide though wall flashing to avoid rising damp • Store masonry materials off the ground and cover with waterproof materials to protect them from groundwater and precipitation • Protect unfinished masonry from weather during construction • Install through-wall flashing at appropriate locations and intervals to divert water from cavity as soon as practical. • Provide deigned and intentional drip edges at all flashings and under all horizontal projections; slope horizontal projections aware from the exterior wall • Provide adequate hygrothermal design and consideration for the exterior wall design to mitigate efflorescence due to vapor diffusion and condensation • Provide adequate detailing, quality control, and functional performance testing to ensure the air tightness of the structure to mitigate efflorescence due to moisture-laden air flow and condensation
04	05	13	Masonry Mortaring	Water Penetration Resistance - Materials: Mortar: • Choose mortar materials and types that are compatible with the brick selected • Use mortar type with lowest compressive strength meeting project requirements
04	05	13	Masonry Mortaring	Water Penetration Resistance - Construction and Workmanship: Mortar: • When mixing mortar, use accurate batching measurements and maximum amount of water that produces a workable mortar • For brick with an IRA exceeding 30 g/min over 30 square inches, increase water or maximize water retention by increasing lime proportions within limits of ASTM C 270 • For brick with an IRA lower than 5 g/min over 30 square inches, reduce water or minimize water retention by decreasing lime proportions within limits of ASTM C 270
04	05	13	Masonry Mortaring	Water Penetration Resistance - Construction and Workmanship: Joints: • In exterior wythes, completely fill all mortar joints intended to have mortar • Minimize furrowing of bed joints and prohibit slushing of head joints • Fill collar joints completely with grout; do not slush collar joints, do not use mortar • Tool mortar joints when thumbprint hard with a concave joint
04	05	13	Masonry Mortaring	Mortars for Brickwork General: • Use mortar complying with ASTM C270 • For typical project requirements, use proportion specifications of ASTM C270 • Use Type N mortar for normal use, including most veneer applications • Do not combine more than one air-entraining agent in mortar • Use Portland cement-lime-sand mortar
04	05	13	Masonry Mortaring	Mortar Materials Cementations: Use Portland Cement • Use cement complying with ASTM C150 (Portland cement), ASTM C595 (blended hydraulic cement), or ASTM C1157 (hydraulic cement) in combination with either hydrated lime complying with ASTM C207, Type S, or lime putty complying with ASTM C1489 • Use mortar cement complying with ASTM C1329 • Use masonry cement complying with ASTM C91
04	05	13	Masonry Mortaring	Mortar Materials Aggregate: • Use natural sand complying with ASTM C144
04	05	13	Masonry Mortaring	Mortar Materials Water: • Use potable water, free of deleterious materials
04	05	13	Masonry Mortaring	Mortar Materials Mortar Admixtures: Only as required • Use admixtures complying with ASTM C1384 • When using a bond enhancer admixture, do not use an air-entraining agent • When using a set retarding admixture, do not re-temper mortar • Do not use water-repellent admixtures

04	05	19.1	Masonry Anchors	WATER PENETRATION RESISTANCE - MASONRY MATERIALS Ties and Anchors: • Use galvanizing, stainless steel, or epoxy coatings to provide corrosion resistance • Ensure that the life of the tie/anchor and corresponding warrantee matches the life expectancy of the building.
04	05	23.1	Masonry Control and Expansion Joints	Water Penetration Resistance - Materials: Sealant Joints: • Use backer rods in joints wide enough to accommodate them • Use sealants meeting the requirements of ASTM C920 for joints subject to large movements -use only closed cell baker rod, unless a dual joint is used in combination with a moisture cure sealant. In this case an open cell rod is permissible only for the interior joint. -use primer on all porous substrates:-required on all horizontal -use silicone on non-porous substrates, use urethane on porous -used plural component sealants in temperatures below 45F and dropping • Ensure that masonry sealant joint prevents bulk water intrusion, but does not interfere with primary sealant joining between air barrier and fenestration/penetrations
04	05	23.1	Masonry Control and Expansion Joints	Accommodating Expansion of Brickwork Vertical Expansion Joints in Brick Veneer: • For brickwork without openings, space no more than 25-feet on center • For brickwork with multiple openings, consider symmetrical placement of expansion joints and reduced spacing of no more than 20-feet on center • When spacing between vertical expansion joints in parapets is more than 15-feet, make expansion joints wider or place additional expansion joints halfway between full-height expansion joints • Extend to top of brickwork, including parapets • Place as follows: - at or near corners - at offsets and setbacks - at wall intersections - at changes in wall height - where wall backing system changes - where support of brick veneer changes - where wall function or climatic exposure changes
04	05	23.1	Masonry Control and Expansion Joints	Accommodating Expansion of Brickwork Horizontal Expansion Joints in Brick Veneer: • Locate immediately below shelf angles • Minimum 1/4-inch space or compressible material recommended below shelf angle • For brick infill, place between the top of brickwork and structural frame
04	05	23.1	Masonry Control and Expansion Joints	Accommodating Expansion of Brickwork Brickwork Without Shelf Angles: • Accommodate brickwork movement by: - placing expansion joints around elements that are rigidly attached to the frame and project into the veneer, such as windows and door frames - installing metal caps or copings that allow independent vertical movement of wythes - installing jamb receptors that allow independent movement between the brick and window frame - installing adjustable anchors or ties
04	05	23.1	Masonry Control and Expansion Joints	Accommodating Expansion of Brickwork Expansion Joint Sealants: • Comply with ASTM C 920, Grade NS, Use M • Class 50 minimum extensibility recommended; Class 25 alternate • Consult sealant manufacturers' literature for guidance regarding use of primer and backing materials
04	05	23.1	Masonry Control and Expansion Joints	Accommodating Expansion of Brickwork Bond Breaks: • Use flashing to separate brickwork from dissimilar materials, foundations and slabs -Use only through wall flashing not building paper
04	05	23.1	Masonry Control and Expansion Joints	Accommodating Expansion of Brickwork Load-bearing Masonry: • Use reinforcement to accommodate stress concentrations, particularly in parapets, at applied loading points and around openings • Consider effect of vertical expansion joints on brickwork stability -use primer on all porous substrates:-required on all horizontal -use silicone on non-porous substrates, use urethane on porous -used plural component sealants in temperatures below 45F and dropping

04	05	23.1	Masonry Embedded Flashing	Water Penetration Resistance - Design and Detailing: Through Wall Flashing Locations: • Install at wall bases, window sills, heads of openings, shelf angles, tops of walls, roofs, parapets, above projections such as bay windows, and at other discontinuities in the cavity • Ensure that air barrier runs continuously with through wall flashing subsequently stripped in.
04	05	23.1	Masonry Embedded Flashing	Water Penetration Resistance - Design and Detailing: Through-Wall Flashing Installation: • Lap continuous flashing pieces at least 6-inches and seal laps • Turn up the ends of discontinuous flashing to form end dams at the next head joint beyond the end of the area needing protection • Extend flashing beyond the exterior wall face • Use a metal drip edge to extend flashings that degrade when exposed to UV light; consider full metal pan flashing for added durability • Provide a continuous air barrier with the through wall flashing subsequently striped in
04	05	23.1	Masonry Embedded Flashing	Water Penetration Resistance - Materials: Flashing: • Select flashing that is waterproof, durable, UV resistant and compatible with adjacent materials • Flashing materials should conform to applicable ASTM specifications • Do not use aluminum, sheet lead, polyethylene sheeting or asphalt-saturated felt, building paper or house wraps • Where flashings are anticipated to experience elevated temperatures (e.g. in contact with metal) ensure that flashings are high temperature rated
04	05	23.1	Masonry Cavity Drainage, Weepholes, and Vents	Water Penetration Resistance - Design and Detailing: Weeps: • Design open head joint weeps spaced at no more than 24-inches on center • Most building codes permit weeps no less than 3/16-inch diameter and spaced no more than 33-inches on center • Design weep spacing at no more than 16-inches on center. • Rope weeps are not permitted
04	05	23.1	Masonry Cavity Drainage, Weepholes, and Vents	Water Penetration Resistance - Construction and Workmanship: Flashing and Weeps: • Do not stop flashing behind face of brickwork • Where required, turn up flashing ends into head joint a minimum of 1-inch to form end dams at head joint beyond the area being protected • Lap continuous flashing pieces at least 6-inches and seal laps at edges and with two continuous beads of sealant • Where installed flashing is pierced, make watertight with sealant or mastic compatible with flashing. No blind penetration of flashings are permitted • Install weeps immediately above flashing
04	21	13	Brick Masonry	Water Penetration Resistance - Masonry and Materials: Brick: • Select brick from the appropriate ASTM standard, designated for exterior exposures, with a rating of "no efflorescence".
04	21	13	Brick Masonry	Water Penetration Resistance - Masonry Construction and Workmanship: Brick: • Pre-wet brick with a field measured initial rate of absorption (IRA) exceeding 30 g/min over 30 square inches
05	00	00	Metals	Stud Gauge: Non-load bearing steel studs shall be minimum 18 gauge where the unsupported stud length exceeds 10’-0". Non-load bearing steel studs shall be minimum 20 gauge where the unsupported stud length is less than 10’-0"
05	52	00	Metal Railings	All hand rail penetrations should be through vertical not horizontal surfaces. If horizontal surfaces are mandated, an "island" should be created to prevent water accumulation at the anchor penetration location
05	52	00	Metal Railings	Exterior Handrails: All exterior ferrous handrails and railings shall be hot-dip galvanized after fabrication. Galvanizing holes shall be filled in before installation.
07	00	00	Thermal and Moisture Protection	For roof drain lines that do not enter into conditioned space, an ice melt system, including its associated power, sensors, and controls, will be required for primary and secondary roof drain lines. Coordinate with electrical requirements for ice melt system.
07	00	00	Thermal and Moisture Protection	Secondary Roof Drains: -Secondary roof drains shall be located adjacent to primary drains. Scuppers or overflow off roof are not acceptable for secondary drainage unless servicing very limited roof areas for areas such as entrance canopies. All scupper or overflow-type secondary drainage must be approved by DFCM -Secondary roof drains shall daylight just above grade near a prominent entrance of the building so they are easily visible. An appropriate means of diverting/collecting water from a secondary drain shall be made so as to prevent excessive flooding or ice on walkways in the event of discharge.

07	00	00	Thermal and Moisture Protection	Building Wall / Enclosure Modeling: AOR shall provide Hygrothermal performance evaluation of typical wall section assemblies and interface details and all proposed wall types and other building enclosure systems. Evaluation shall include considerations for local weather data, unique microclimate considerations, and interior design conditions including operating conditions such as setbacks and shutdown scenarios as applicable. If necessary based on the unique nature of the design conditions or assemblies analyze the transient Hygrothermal and thermal behavior of the various multilayer building components utilizing software modeling e.g., Transient Heat and Moisture Transport (WUFI) or THERM. In the event that Hygrothermal or thermal modeling is utilized, material properties and boundary conditions shall be provided for each comparative scenario utilized in decision making or to show compliance. Analysis should demonstrate bi-directional drying of the assembly unless all thermal controls are located exterior of the WRB and air control layer or moisture accumulation is acceptable due to other means such as material storage capacity (also code compliance is mandated). In many cases material testing of the proposed components of the assembly maybe required due to variations in various products. Approval of wall types and modeling is subject to review by DFCM, AOR, and BECxA.
07	00	00	Thermal and Moisture Protection	Energy Models should accommodate for building enclosure thermal point and linear bridging (e.g. steel protrusions or protruding concrete slabs) by reducing the overall facade or roof U factor correspondingly. The building enclosure commissioning agent shall provide input to the energy modeler as to the extent of anticipated thermal bridging.
07	00	00	Thermal and Moisture Protection	Moisture Control: Design against water penetration, above and below grade, with clearly conceived redundant systems. The A/E is responsible for the integrity of the overall moisture control system. Construction documents must clearly define continuous air, water, thermal and vapor barriers for the entire building enclosure (e.g. Facade, roofs, below grade) Detail in three dimensions where practical, indicating critical corner terminations, interface of all differing systems, proper sealant methodologies, etc.
07	00	00	Thermal and Moisture Protection	Wall Assembly: A typical wall assembly would be comprised of the following layers (see additional guideline information for each component): 1-Exterior finish (brick, metal, stone, precast, etc.) acting at weathering layer and initial drainage plane. 2-Exterior Insulation/Thermal Control Layer 3-WRB/Air Control Layer/Vapor Control Layer 4-Sheathing (as required) 5-Structure layer (without cavity insulation) 6-Interior finishes *Environmental control layers (water, air, thermal, and vapor) may vary in location within assembly depending on type of barrier and overall wall assembly but the wall system above shall be used when feasible.
07	00	00	Thermal and Moisture Protection	Environmental Barriers: -Design and drawings shall clearly identify continuous environmental barriers (air, water, vapor, and thermal) in all components that comprise the building enclosure (walls, roofs, soffits, etc.). Attention to the barrier location within an assembly and connection to the barrier in adjacent assemblies is fundamental (e.g. transitions, terminations and penetrations). The environment separation barriers shall be shown graphically on all plans. -Design should allow for the barrier layers to be continuous throughout the entire building enclosure. All applicable details and wall/roof types shall clearly show each barrier and demonstrate this continuity. -One material/layer may serve as multiple types of barrier when properly specified and located within an assembly. -All environmental barriers shall be incorporated in the building mockup and tested for air and water prior to construction on the project. -Barrier layers are subject to repeated inspections and testing by DFCM and/or the BECxA. -Air and weather barriers should be sealed to the fenestrations prior to concealment by claddings. Technical justification is required whan claddings are installed prior to fenestrations.
07	00	00	Thermal and Moisture Protection	Silicone sheet should be used where a flashing can be glazed into a curtain wall. For storefront assembles, utilize a min. 40 min. rubberized asphalt to treat all window surrounds. Fluid applied flashings are only permissible on Standard structures.
07	00	00	Thermal and Moisture Protection	For air barrier assemblies, the following performance criteria must be met: -For both liquid applied and self adhered air barrier materials, the air permeability of the material cannot exceed 0.004 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. pressure difference per ASTM E 2178. -For all air barrier assemblies, leakage cannot exceed 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., ASTM E 2357. For the entire structure, which includes opaque wall air barriers, fenestration products, roofing materials, and below grade barriers, the air permeability of the whole building should not exceed 0.1 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., ASTM E 779 for moderate and high performance structures. Leakage rates for Standard structures shall not exceed 0.25 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., ASTM E 779. -Air barrier products without the required testing above will not be acceptable or used on DFCM projects.

07	00	00	Thermal and Moisture Protection	• Weather resistant barriers shall also serve as air barrier and must be either fluid applied or self-adhered. Taped boards, taped insultaion, interior sheet rock, grouted CMU, or mechanically fastened air barrier are not acceptable to serve as air barriers for High Performance structures. • Barrier EIFS systems and barrier metal panel systems are not permited to serve as the sole air and water barriers.
07	00	00	Thermal and Moisture Protection	Roof Vapor Barrier / Wall Air Barrier Interface: Roof and wall air and vapor retarder systems must interface and seal together at the appropriate interfaces, including but not limited to parapet walls. For the vapor retarder to function properly it must be designed in an airtight manner This continuity between the roof and wall control layers shall be shown in all applicable details and the AOR shall specify compatible transition materials.
07	01	00	Operation and Maintenance of Thermal and Moisture Protection	Roof Access: -Access to roof is required in the following circumstances: (1) To provide access to mechanical equipment on roofs for servicing, and (2) For roof surfaces 16-feet or higher above grade (with or without mechanical equipment). -If the roof of a building has several levels, access must be provided to each level. Access must be provided by (in order of general preference): stairways within the building and roof access doorways, stairs or ladders on the roof extending between levels, or a roof hatch. -Roof access is preferred through a doorway of 36" minimum width unless access for larger equipment is required. -Where doorway access is not practical for the building design and location, roof hatches may be used. -Roof access shall be reviewed and DFCM-approval obtained at DD
07	21	00	Thermal Insulation	Thermal Barrier Integrity: Specify and detail on drawings a complete and continuous thermal barrier for roofs, walls, windows, etc., including interfaces and miscellaneous penetrations. Design should provide thermal breaks where feasible to avoid thermal conduction between interior and exterior to mitigate energy loss and condensation potential. Special attention should be paid to limit thermal conduction at structural penetrations/connections through the facade and cladding attachments connections.
07	21	00	Thermal Insulation	Wall Insulation: Wall insulation types that will be considered by DFCM include XPS, spray-applied closed-cell polyurethane, high-density rock wool, and fiber glass, in the appropriate locations. In locations of possible high heat build-up from the exterior materials and geometries, special care should be taken to protect affected insulation materials from exposure to temperatures above their published in service limitations during construction and within the final assembly to avoid excessive deformation and/or damage to the materials.
07	21	00	Thermal Insulation	Wall Parapet Insulation / Air Barrier: All parapet walls shall be capped at deck level with closed cell spray polyurethane foam (e.g. assuming fire codes requirements are met) or other acceptable manner to prevent thermal bridging and conditioned air transport into the parapet cavity to mitigate energy loss and condensation potential.
07	21	00	Thermal Insulation	Provide laboratory testing per ASTM 1503 of manufacture's typical assemblies, to be included in both High Performance and Standard structures to confirm the NFRC 500 modeling, as necessary.
07	21	13	Board Insulation	Exterior Wall Insulation: All wall systems shall have insulation on the exterior side of the air, water and vapor barrier unless technical justification is provided. The thickness of the exterior insulation shall be such that the dew point occurs within the exterior insulation. Any gaps greater that 1/8" shall be filled with expanding foam or insulation slivers. In locations of possible high heat build-up from the exterior materials and geometries, special care should be taken to protect affected insulation materials from exposure to temperatures above their published in service limitations during construction and within the final assembly to avoid excessive deformation and/or damage to the materials.
07	24	19	Drainage EIFS	EIFS shall be installed as a drainage system; no barrier EIFS allowed on High Performance or Standard Buildings.
07	25	00	Weather Barriers	Weather Barrier Integrity: Specify and detail on drawings a complete and continuous weather barrier for all roofs, walls, doors, windows, etc., including miscellaneous penetrations. Particular emphasis shall be placed on the continuity of barrier at transitions of windows/openings to vapor and/or air barrier, between the barriers located on the roof and walls and the assembly connections of associated components. Moisture which may penetrate the finish layer and reach the weather barrier must have a means to exit the system to the exterior through weeps and flashings located at material transitions, soffits, wall bases, etc.. "Condensation Pans" without weeps to the exterior are not an acceptable design strategy.

07	26	00	Vapor Retarders	Vapor Barrier Integrity: Where a vapor barrier or retarder is utilized, specify and detail on drawings a complete and continuous vapor barrier. Particular emphasis shall be given to properly detail all transitions between differing materials, wall types, windows, doorways, floor/wall, roof/wall, etc. Include details for miscellaneous penetrations and attachments where the vapor barrier is also serving as an air barrier. Sealing around/over attachments and penetrations shall be provided. Location of the vapor barrier, when recommended or required within the wall/roof assembly, shall be appropriate per the Hygrothermal analysis.
07	27	00	Air Barriers	Air Barrier Integrity: Specify and detail on drawings a complete and continuous air barrier for entire building enclosure including roofs, walls, soffits, etc.. Particular emphasis shall be given to properly detail all transitions between differing materials, wall types, windows, doorways, floor/wall, roof/wall, etc. Include details for miscellaneous penetrations and attachments. Sealing around/over attachments shall be provided. The air barrier may also serve as the vapor barrier provided that it is properly specified as vapor impermeable and located appropriately within the wall assembly per the Hygrothermal analysis. (see 07 00 00 for additional air barrier requirements)
07	27	00	Air Barriers	Air Barrier: -Air penetration performance of 0.001 cfm/ft2 at 1.56 psf or 0.3-inches of water is to be specified per ASTM E2128. -An air barrier that also serves as the vapor barrier (preferred) shall be specified as vapor non-permeable, as determined by Hygrothermal analysis. Air barriers that do not serve as the vapor barrier shall be specified as vapor-permeable. -Air barrier installation shall be subject to repeat periodic and representative testing throughout the construction process to ensure performance. -Contractor shall coordinate with DFCM to schedule testing.
07	27	00	Air Barriers	Air barrier shop drawings are required on all projects.
07	50	00	Membrane Roofing	Roof Assembly: A typical membrane roof assembly would include the following layers: 1. Metal Deck (could also be a concrete deck) 2. Roof Board (typ. gypsum hardboard; optional) 3. Air/vapor Barrier (peel & stick, self sealing, per membrane roofing manufacturer, must not contact single ply membrane; if used over concrete, ensure a vented metal deck is used) 4. Stainless steel wire screen (for ELD testing) 5. Minimum 3" providing a minimum slope of 0.25 inch per foot (where roof deck is flat) of Polyiso Rigid Insulation in a minimum of two layers with all joints staggered. Non-organic facer on the rigid insulation is required of high performance structures. 6. 1/2" Cover Board (typ. gypsum hardboard; optional) 7. Single-ply Membrane (fully adhered) 8. Filter fabric or drainage composite 9. Pavers, ballast, walking pads (as required)
07	50	00	Membrane Roofing	Roof Drainage / Slope: All roofs shall be designed so that there is a minimum slope of 0.25-inch slope per foot. It is preferred to provide roof slope through sloping of the structure. In High Performance structures, roof membranes shall be fully adhered to the sloped structural deck whenever practical. Tapered insulation may be used where sloping the structure is not practical. The roof design and construction shall not have any flat spots or ponding of water on the surface of the roof at initial construction or with anticipated design load deflection, creep, or other movements with may create ponding. When practical drains shall be located away from columns and structural support to mitigate detrimental effects of structural movement over time. Supplemental slopes shall be provided by tapered insulation. Crickets shall be installed at all large penetrations (such as mechanical equipment and screen walls) for drainage around the obstruction.
07	50	00	Membrane Roofing	Roof surfaces that are highly visible from inside of the building may need to be ballasted with gravel or have pavers installed over membrane. Review with DFCM visible roof surfaces and determine what treatment is desired for these roofs.
07	50	00	Membrane Roofing	Walking system (pavers or walking pads) shall be installed on unprotected roof membrane providing access to all rooftop equipment, roof access points, or other maintenance locations.
07	50	00	Membrane Roofing	Review with users possible rooftop use for research activities and provide necessary access and fall protection.
07	50	00	Membrane Roofing	Roof Penetrations: -Two or more objects shall not extend through the roofing closer than 18-inches unless both objects are flashed with integral flashing. -No objects shall extend through the roof closer than 18-inches from parapets, firewalls, etc. where there is a height transition on the roof. -Roof penetrations include structure, pipes, chases, roof hatches, equipment, etc. -All flashing, counter flashing, roof jacks, etc. are to be installed by the roofing contractor and shall be installed per roofing manufacturer's recommendations.

07	50	00	Membrane Roofing	Roofing Type: DFCM preference is minimum 200 mil fully reinforced, monolithic membrane directly adhered to the sloped structural deck. Minimum 60-mil reinforced single ply membrane with welded seams may be acceptable with DFCM approval if technically justified. Attachment Method: Fully adhered membrane roofing shall be used unless specific reasons merit mechancial attachement. All other attachment methods must be approved by BECxA and DFCM.
07	50	00	Membrane Roofing	BECxA to verify installation and witness testing per ASTM C1601-05 or NRCA Manual Guideline: "Quality Assurance and Water Test".
07	50	00	Membrane Roofing	Roofing Specifications/Warranty: Specifications shall include the following: 1-Full coverage 20-year bonded roofing warranty, non-prorated, no dollar limit is required 2-All installation of roofing, insulation, flashings, and accessories shall be applied in strict accordance with the approved roofing materials manufacturer's latest printed specifications for the 20-year bonded-type roof for the applicable substrate and deck type. 3-"General contractor and roofing sub-contractor shall jointly agree, for a period of two (2) years after the date of substantial completion, to inspect and make immediate emergency temporary repairs as required to stop leaks or correct defects in the roofing system work, including attachments to metal flashings forming an integral part of the roofing, within three working days of notice received from the owner; and further agree to make permanent repairs to restore the affected items to the standards of construction required by these specifications within a reasonable time and as weather conditions permit; and further agree to make such temporary and permanent repairs without reference to or consideration of the cause or nature of such leaks or defects in the waterproofing work. In case of defective roofing system work, damage caused by leaks or by their repair, shall also be repaired. Work required within the period shall be completed without cost to the owner, except that repair work is required Because of Acts of God, abuse or alteration by owner, alterations or failure of the substrate or supporting structure (other than that caused by defects in the roofing work). This agreement and the enforcement of its provisions shall not deprive the owner of any action, right or remedy otherwise available to him."
07	00	00	Below Grade Waterproofing	Design Requirements: - Relieve hydrostatic pressure on substructure walls and allow water drainage to the level of the drain. - Membrane waterproofing must be fully bonded to the substrate and seamless. - Below-grade waterproofing must be applied to the positive pressure side and must be covered by a protection drainage and protection course. - In the presence of water table, completely encapsulate the structure in waterproofing and drainage medium to minimize hydrostatic head.
07	00	00	Below Grade Waterproofing	Testing Requirements: High Performance structures shall have long duration (minimum 8 hour) hydrostatic water test at a specimen of each type of below grade waterproofing with occupied space to the interior, which often requires the fabrication of a temporary dam. There are no in situ blow-grade waterproofing testing requirements for Standard structures.
07	00	00	Metal Panels	Metal Panels shall be installed as a drainage system; no barrier systems allowed on High Performance or Standard Buildings.
08	00	00	Openings	Glass areas shall be reasonably minimized to conserve energy during winter and summer. Glazing area in excess of prescriptive table allowances of IECC or ASHRAE 90.1 shall be reviewed by the BECxA and approved by DFCM. Higher SHGC or U-Factor (lower R-Values) than those required in the IECC and ASHRAE 90.1 prescriptive tables shall not permitted without review by the BECxA and DFCM and approval by DFCM.
08	00	00	Openings	Contractor Points Coordinate a walkthrough with BECxA within 24 hours before the first framework and before the first glass is set.
08	01	40	Operation and Maintenance of Entrances, Storefronts, and Curtain Walls	All buildings must be designed with a maintenance plan for cleaning and maintenance of inside and outside glass areas. Plan may include a built-in system or a portable lift system as is most appropriate for the circumstances. Also consider cleaning of exterior painted or anodized surfaces (in accordance with the MFG recommendations and warranty requirements. Maintenance plans include survey or building condition reports. These observations are performed to evaluate the performance of weather seals.
08	01	40	Operation and Maintenance of Entrances, Storefronts, and Curtain Walls	Windows Sidewalks used as pathways for the window washing lift should be 12-ft wide or as required and approved by DFCM based on project specific requirements or configuration for future maintenance. Sidewalks should be designed to support the weight and operating forces of a typical lift required to access project specific geometry.
08	40	00	Entrances, Storefronts, and Curtain Walls	All glazed systems shall include a project specific written and detailed deglaze and re-glaze procedure with step-by-step photographic documentation which shall be executed on a minimum of one IGU prior to any pre-construction performance mock-up test procedure; excluding periodic field performance testing during installation.

08	40	00	Entrances, Storefronts, and Curtain Walls	All submittals and warranties are to be included in O & M manuals
08	50	00	Windows	Aluminum thermally broken frames and sashes are to be used in all windows. Wood or steel is not acceptable. Standard Performance structures shall utilize windows with a minimum performance rating of CW40 per AAMA 101-2011*North American Fenestration Standard/Specification for Windows, Doors, and Skylight;* High Performance structures shall utilize a minimum performance rating of AW40.
08	80	00	Glazing	IGU's shall be double-glazed and dual sealed with minimum 1" IGU thickness. Typical IGU basis of design shall consist of PPG Solarban 70XL #2 (outboard F2), clear (inboard), spandrel coating: F4 when concealed, F3 when visible. Project specific IGU lay up may vary based on performance requirements and design intent with approval of DFCM and review by the BECxA. All low e coatings shall be edge deleted. Maximum acceptable roll wave distrortion is 0.006".
08	80	00	Glazing	Tempered glass shall be utilized as required by code for safety glazing. Heat strengthened (non-tempered) glass or laminated glass shall be utilized in locations above walking surfaces where potential glass fragmentation is not captured or otherwise prevented from impacting the walking surface below upon breakage.
09	70	00	Wall Finishes	Wall coverings are generally not acceptable. Limited applications may be allowed when approved by DFCM. Vapor permeability of wall coverings on interior portions of exterior wall or of interior partitions designed and constructed to function as a air or vapor barrier shall conform with the recommendations or assumptions of the appropriate Hygrothermal analysis.