PART 1 GENERAL

1.01 SECTION INCLUDES
A. Thermoplastic membrane roofing system, including all components specified.
B. Disposal of construction waste is the responsibility of Contractor. Perform disposal in manner complying with all applicable federal, state, and local regulations.
D. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 RELATED REQUIREMENTS
A. Section 06.10.00 - Rough Carpentry: Wood nailers associated with roofing and roof insulation.
B. Section 07.50.35 - Roof System Warranty Execution: Warranty documentation requirements.
C. Section 07.50.36 - Roof System Warranty: Roof warranty document.
D. Section 07.71.00 - Roof Specialties: Manufactured copings, fascias, gravel stops, and other flashing-related items.
E. Section 07.72.00 - Roof Accessories: Roof hatches, vents, and manufactured curbs.

1.03 DEFINITIONS
A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.
B. LTTR: Long Term Thermal Resistance, as defined by CAN-ULC S770.

1.04 REFERENCE STANDARDS
F. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting; 2013.
O. FM DS 1-29 - Roof Deck Securement and Above-Deck Roof Components; Factory Mutual System; 2006.
P. PS 1 - Structural Plywood; 2009.

1.05 ADMINISTRATIVE REQUIREMENTS
A. Pre-Installation Conference: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.
   1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work.
   2. Notify Architect well in advance of meeting.

1.06 SUBMITTALS
A. See Section 01.30.00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.
   2. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.
   3. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.
C. Samples: Submit samples of at least the following:
   1. Sample of roof membrane.
   2. Sample of walkway pads.
   3. Sample of each insulation type.
D. Shop Drawings: Provide:
   1. The roof membrane manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.
   2. For tapered insulation, provide project-specific layout and dimensions for each board.
E. Specimen Warranty: Submit prior to starting work.
F. Installer Qualifications: Letter from manufacturer attesting that the roofing installer meets the specified qualifications.
G. Pre-Installation Notice: Copy to show that manufacturer's required Pre Installation Notice (PIN) has been accepted and approved by the manufacturer.
H. Executed Warranty.

1.07 QUALITY ASSURANCE
A. Installer Qualifications: Roofing installer shall have the following:
   1. Current approval, license, or authorization as applicator by the manufacturer.
   2. Fully staffed office within 100 miles of the job site.
   3. At least five years experience in installing specified system.
   4. Capability to provide a payment performance bond.

1.08 DELIVERY, STORAGE AND HANDLING
A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.
B. Store materials clear of ground and moisture with weather protective covering.
C. Keep combustible materials away from ignition sources.

1.09 WARRANTY
A. See Section 07.50.35 - Roof System Warranty Execution
B. Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.
C. Warranty: Firestone Limited Warranty covering membrane, roof insulation, and other indicated components of the system, for the term indicated.
   1. Limit of Liability: No dollar limitation.
   2. Scope of Coverage: Repair leaks in the roofing system caused by:
      a. Ordinary wear and tear of the elements.
      b. Manufacturing defect in Firestone brand materials.
      c. Defective workmanship used to install these materials.
      d. Damage due to winds up to 55 mph.
   3. Not Covered:
      a. Damage due to winds in excess of 55 mph.
      b. Damage due hurricanes or tornadoes.
      c. Hail.
      d. Intentional damage.
      e. Unintentional damage due to normal rooftop inspections, maintenance, or service.
D. Insulation Warranty: Separate Firestone ISO 95+ Insulation Warranty with warranty term coinciding with Red Shield Warranty.
   1. Limit of Liability: No dollar limitation
   2. Scope of Coverage: Provide replacement for insulation that warps, bows, or is on the point of causing a roof leak as a result of manufacturing defect.
PART 2 PRODUCTS

2.01 MANUFACTURERS

   1. Roofing systems manufactured by others are acceptable provided the roofing system is completely equivalent in materials and warranty conditions and the manufacturer meets the following qualifications:
      a. Specializing in manufacturing the roofing system to be provided.
      b. Minimum ten years of experience manufacturing the roofing system to be provided.
      c. ISO 9002 certified.

B. Manufacturer of Insulation and Cover Boards: Same manufacturer as roof membrane.

C. Manufacturer of Metal Roof Edging: Same manufacturer as roof membrane.
   1. Field- or shop-fabricated metal roof edgings are not acceptable.
   2. Factory fabricated products by other manufacturers are acceptable provided they are completely equivalent in materials and performance.

D. Substitutions: See Section 01.60.00 - Product Requirements.

2.02 ROOFING SYSTEM DESCRIPTION

A. Roofing System: Thermoplastic polyolefin (TPO) single-ply membrane.
   1. Membrane Attachment: Fully adhered.
   2. Warranty: Full system warranty; Firestone 20 year Red Shield Limited Warranty covering membrane, roof insulation, and membrane accessories.
   3. Slope: Deck is flat, provide slope of 1/8 inch per foot by means of tapered insulation at skybox structure; deck is sloped 1/4" per foot elsewhere.
   4. Comply with applicable local building code requirements.
   5. Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.
   6. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.

B. Roofing System Components: Listed in order from the top of the roof down:
   1. Membrane: Thickness as specified.
   2. Base Sheet Over Insulation: Cold adhesive attached.
   3. Insulation:
      a. Maximum Board Thickness: 3 inches; use as many layers as necessary; stagger joints in adjacent layers.
      b. Tapered: Slope as indicated; provide minimum R-value at thinnest point; place tapered layer on top.
      c. Total R-value of 19, minimum.
      d. Maximum Thickness: 6 inches.
      e. Top Layer: Polyisocyanurate foam board, non-composite; mechanically fastened.
      f. Intermediate Layer(s), If Any: Polyisocyanurate foam board, non-composite; mechanically fastened.
      g. Bottom Layer: Polyisocyanurate foam board, non-composite; mechanically fastened.
      h. Crickets: Tapered insulation of same type as specified for top layer; slope as indicated.
2.03 MEMBRANE MATERIALS

A. Membrane: Flexible, heat weldable sheet composed of thermoplastic polyolefin polymer and ethylene propylene rubber; complying with ASTM D6878/D6878M, with polyester weft inserted reinforcement and the following additional characteristics:
   1. Thickness: 0.045 inch plus/minus 10 percent, with coating thickness over reinforcement of 0.018 inch plus/minus 10 percent.
   2. Puncture Resistance: 265 lbf, minimum, when tested in accordance FTM 101C Method 2031.
   3. Solar Reflectance: 0.84, minimum, when tested in accordance with ASTM C1549.

B. Slip Sheet: Coated glass fiber mat, qualified as part of Class A assembly over combustible and non-combustible decks, complying with ASTM D828 tensile testing.

C. Membrane Fasteners: Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.

D. Curb and Parapet Flashing: Same material as membrane, with encapsulated edge which eliminates need for seam sealing the flashing-to-roof splice; precut to 18 inches wide.

E. Formable Flashing: Non-reinforced, flexible, heat weldable sheet, composed of thermoplastic polyolefin polymer and ethylene propylene rubber.
   1. Thickness: 0.060 inch plus/minus 10 percent.
   2. Tensile Strength: 1550 psi, minimum, when tested in accordance with ASTM D638 after heat aging.
   3. Elongation at Break: 650 percent, minimum, when tested in accordance with ASTM D638 after heat aging.
   4. Tearing Strength: 12 lbf, minimum, when tested in accordance with ASTM D1004 after heat aging.

F. Tape Flashing: 5-1/2 inch nominal wide TPO membrane laminated to cured rubber polymer seaming tape, overall thickness 0.065 inch nominal; TPO QuickSeam Flashing by Firestone.

G. Bonding Adhesive: Neoprene and SBR rubber blend, formulated for compatibility with the membrane other substrate materials, including masonry, wood, and insulation facings; UltraPly Bonding Adhesive by Firestone.

H. Pourable Sealer: Two-part polyurethane, two-color for reliable mixing; Pourable Sealer by Firestone.

I. Seam Plates: Steel with barbs and Galvalume coating; corrosion-resistance complying with FM 4470.

J. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches wide by 0.10 inch thick; Firestone Termination Bar by Firestone.

K. Cut Edge Sealant: Synthetic rubber-based, for use where membrane reinforcement is exposed; UltraPly TPO Cut Edge Sealant by Firestone.

L. General Purpose Sealant: EPDM-based, one part, white general purpose sealant; UltraPly TPO General Purpose Sealant by Firestone.

M. Molded Flashing Accessories: Unreinforced TPO membrane pre-molded to suit a variety of flashing details, including pipe boots, inside corners, outside corners, etc.; UltraPly TPO Small and Large Pipe Flashing by Firestone.

N. Roof Walkway Pads: Non-reinforced TPO walkway pads, 0.130 inch by 30 inches by 40 feet long with patterned traffic bearing surface; UltraPly TPO Walkway Pads by Firestone.
2.04 ROOF INSULATION AND COVER BOARDS

A. Polyisocyanurate Board Insulation: Closed cell polyisocyanurate foam with black glass reinforced mat laminated to faces, complying with ASTM C1289 Type II Class 1, with the following additional characteristics:

1. Thickness: As indicated elsewhere.
2. Size: 48 inches by 96 inches, nominal.
3. R-value (LTTR):
   a. 1.0 inch Thickness: 6.0, minimum.
   b. 1.25 inch Thickness: 7.5, minimum.
   c. 1.5 inch Thickness: 9.0, minimum.
   d. 1.75 inch Thickness: 10.5, minimum.
   e. 2.0 inch Thickness: 12.1, minimum.
   f. 3.0 inch Thickness: 18.5, minimum.
   g. 4.0 inch Thickness: 25.0, minimum.
4. Compressive Strength: 20 psi when tested in accordance with ASTM C1289.
5. UL-Classified and FM-approved for direct to steel deck applications.
6. Ozone Depletion Potential: Zero; made without CFC or HCFC blowing agents.
7. Recycled Content: 19 percent post-consumer and 15 percent post-industrial, average.

B. Gypsum-Based Cover Board: Non-combustible, water resistant gypsum core with embedded glass mat facers, complying with ASTM C1177/C1177M, and with the following additional characteristics:

1. Size: 48 inches by 96 inches, nominal.
   a. Exception: Board to be attached using adhesive or asphalt may be no larger than 48 inches by 48 inches, nominal.
2. Thickness: As indicated elsewhere.
3. Surface Water Absorption: 2.5 g, maximum, when tested in accordance with ASTM C473.
4.Spanning Capability: Recommended by manufacturer for following minimum flute spans:
   a. 5/8 inch Thickness: 8 inches, minimum.
5. Surface Burning Characteristics: Flame spread index of 0 (zero), smoke developed index of 0 (zero), when tested in accordance with ASTM E84.
6. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
7. Factory Mutual approved for use with FM 1-60 and 1-90 rated roofing assemblies.
8. Mold Growth Resistance: Zero growth, when tested in accordance with ASTM D3273 for minimum of 4 weeks.

C. Insulation Fasteners: Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.

2.05 METAL ACCESSORIES

A. Parapet Copings: Formed metal coping with galvanized steel anchor/support cleats for capping any parapet wall; watertight, maintenance free, without exposed fasteners; butt type joints with concealed splice plates; mechanically fastened as indicated; Firestone PTCF.

1. Wind Performance:
   a. At least the minimum required when tested in accordance with ANSI/SPRI/FM 4435/ES-1 Test Method RE-3, current edition.
   b. Provide product listed in current Factory Mutual Research Corporation Approval Guide with at least FM 1-90 rating.
2. Description: Coping sections allowed to expand and contract freely while locked in place on anchor cleats by mechanical pressure from hardened stainless steel springs factory attached to
anchor cleats; 8 inch wide splice plates with factory applied dual non-curing sealant strips capable of providing watertight seal.

3. Material and Finish: 22 gage, 0.03 inch thick galvanized steel with Kynar 500 finish in manufacturer's standard color; matching concealed joint splice plates; factory-installed protective plastic film.

4. Dimensions:
   a. Wall Width: As indicated on the drawings.
   b. Piece Length: Minimum 144 inches.
   c. Curved Application: Factory fabricated in true radius.

5. Anchor/Support Cleats: 20 gage, 0.036 inch thick prepunched galvanized cleat with 12 inch wide stainless steel spring mechanically locked to cleat at 72 inches on center.

6. Special Shaped Components: Provide factory-fabricated pieces necessary for complete installation, including miters, corners, intersections, curves, pier caps, and end caps; minimum 14 inch long legs on corner, intersection, and end pieces.

7. Fasteners: Factory-furnished; electrolytically compatible; minimum pull out resistance of 240 pounds for actual substrate used; no exposed fasteners.

2.06 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
   2. Thickness: Same as thickness of roof insulation.

B. Cant Strips and Tapered Edge Strips: 45 degree face slope and minimum 5 inch face dimension; provide at all angle changes between vertical and horizontal planes that exceed 45 degrees.
   1. Type: Non-flammable perlite, complying with ASTM C728.
   2. Install using hot asphalt (Type IV), roofing mastic, or mechanically fastened using fasteners and plates approved by roofing manufacturer.

PART 3 INSTALLATION

3.01 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

D. Perform work using competent and properly equipped personnel.

E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F.

G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
1. Protect from spills and overspray from bitumen, adhesives, sealants and coatings.
2. Particularly protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within the range of wind-borne overspray.
3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.
I. Consult membrane manufacturer's instructions, container labels, and Material Safety Data Sheets (MSDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.02 EXAMINATION
A. Examine roof deck to determine that it is sufficiently rigid to support installers and their mechanical equipment and that deflection will not strain or rupture roof components or deform deck.
B. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.
C. Examine roof substrate to verify that it is properly sloped to drains.
D. Verify that the specifications and drawing details are workable and not in conflict with the roofing manufacturer's recommendations and instructions; start of work constitutes acceptable of project conditions and requirements.
E. Verify that wood nailers have been properly installed.

3.03 PREPARATION
A. Take appropriate measures to ensure that fumes from adhesive solvents are not drawn into the building through air intakes.
B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.
C. Fill all surface voids in the immediate substrate that are greater than 1/4 inch wide with fill material acceptable insulation to membrane manufacturer.
D. Seal, grout, or tape deck joints, where needed, to prevent bitumen seepage into building.
E. Wood Nailers: Provide wood nailers at all perimeters and other locations where indicated on the drawings, of total height matching the total thickness of insulation being used.
   1. Install with 1/8 inch gap between each length and at each change of direction.
   2. Mechanically fasten to deck to resist force of 200 lbf per linear foot.

3.04 VAPOR RETARDER
A. Before installing insulation install vapor retarder directly over the deck.
B. Install modified bitumen base sheet using the appropriate deck fasteners and insulation plates. Apply a second layer of modified bitumen base sheet in solid mopping of asphalt. Apply a glaze coat of asphalt over the base sheet.
C. Ensure that all penetrations and edge conditions are sealed to prevent moisture and air drive into the roofing system.

3.05 INSULATION AND COVER BOARD INSTALLATION
A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roofing System.
B. Install insulation in a manner that will not compromise the vapor retarder integrity.

C. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

D. Lay roof insulation in courses parallel to roof edges.

E. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch. Fill gaps greater than 1/4 inch with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch.

F. Mechanical Fastening: Using specified fasteners and insulation plates engage fasteners through insulation into deck to depth and in pattern required by Factory Mutual for FM Class specified in PART 2 and membrane manufacturer, whichever is more stringent.

3.06 SINGLE-PLY MEMBRANE INSTALLATION

A. Beginning at low point of roof, place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.

B. Lay out the membrane pieces so that field and flashing splices are installed to shed water.

C. Install membrane without wrinkles and without gaps or fishmouths in seams; bond and test seams and laps in accordance with membrane manufacturer's instructions and details.

D. Install membrane adhered to the substrate, with edge securement as specified.

E. Adhered Membrane: Bond membrane sheet to substrate using membrane manufacturer's recommended bonding material, application rate, and procedures.

F. Edge Securement: Secure membrane at all locations where membrane terminates or goes through an angle change greater than 2 in 12 inches using mechanically fastened reinforced perimeter fastening strips, plates, or metal edging as indicated or as recommended by roofing manufacturer.

1. Exceptions: Round pipe penetrations less than 18 inches in diameter and square penetrations less than 4 inches square.

2. Metal edging is not merely decorative; ensure anchorage of membrane as intended by roofing manufacturer.

3.07 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.

1. Follow roofing manufacturer's instructions.

2. Remove protective plastic surface film immediately before installation.

3. Install water block sealant under the membrane anchorage leg.

4. Flash with manufacturer's recommended flashing sheet unless otherwise indicated.

5. Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.

6. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.

7. When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.
3.08 FINISHING AND WALKWAY INSTALLATION
   A. Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.
   B. Walkway Pads: Adhere to the roofing membrane, spacing each pad at minimum of 1.0 inch and maximum of 3.0 inches from each other to allow for drainage.
      1. If installation of walkway pads over field fabricated splices or within 6 inches of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches on either side.
      2. Prime the membrane, remove the release paper on the pad, press in place, and walk on pad to ensure proper adhesion.

3.09 FIELD QUALITY CONTROL
   A. Inspection by Manufacturer: Provide final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes (i.e. not a sales person).
   B. Perform all corrections necessary for issuance of warranty.

3.10 CLEANING
   A. Clean all contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.
   B. Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.
   C. Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

3.11 PROTECTION
   A. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION