V SPECS VERIFIED SPEC NOTE: The affixed digital V SPECS VERIFIED Seal indicates this Product Master Specification has been 3rd-Party Verified to meet guidelines published by North American Specification Associations, and signifies contents within the Section appear complete, and ready for Tender, once all edits and selections have been made, and SPEC NOTES have been removed.

V SPECS VERIFIED SPEC NOTE: This Section has been scored against "Industry Standard Practices", using V SPECS proprietary 35pt Inspection and Scoring Methodology within its Product Master Specification Report Card.

V SPECS VERIFIED Seal is Valid for 12 months beginning: ***February 1, 2025***

PETRA PREFACE SPEC NOTE: This Product Master Specification Section includes PETRA SPEC NOTES for information purposes and to assist the editor in making appropriate decisions. PETRA SPEC NOTES always immediately precede the text to which it is referring.

PETRA PREFACE SPEC NOTE: Optional text is indicated by square brackets [ ]; Delete the optional text including the brackets in the final copy of the Specification. Delete all PETRA SPEC NOTES in the final copy of the Specification, prior to Project Tendering/Pricing. The Section content serves as a guideline only and should be edited (by additions, deletions, and modifications) to meet specific project requirements.

PETRA PREFACE SPEC NOTE: This Specification Section follows the recommendations of the Construction Specifications Canada (CSC), Manual of Practice including MasterFormat names and numbers, SectionFormat layout guidelines, and PageFormat paragraph numbering.

PETRA PREFACE SPEC NOTE: This Specification includes the materials and installation procedures for Ultra High-Performance Concrete (UHPC). UHPC is a specialized form of concrete manufactured from portland cement, aggregate, and additives with alkali-resistant glass fibers. PETRA offers UHPC products in different colours and textures that can be used in following applications:

- New construction and renovation/re-clad building enclosures
- Unitized and Prefabricated Wall Systems
- Interior applications such as interior wall cladding and feature wall finishes.
- Open Joint Cladding for Back Ventilated and Drained Cavity Walls (Rainscreen)

PETRA PREFACE SPEC NOTE: PETRA has the capabilities to perform in-house testing to CSA A23.2 standards, ensuring compliance with industry quality and performance benchmarks. PETRA is able to conduct in-house testing of the following:

- Air content of freshly mixed plastic concrete
- Compressive strength testing of concrete cylinders
- Temperature of freshly mixed plastic concrete
- Slump of freshly mixed plastic concrete.

1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions, the Supplementary Conditions, the Instructions to Bidders and Division 1 General Requirements shall be read in conjunction with and govern this section.

PETRA SPEC NOTE: Edit the following paragraph to select either Contractor or Construction Manager, and Subcontractor or Trade Contractor, depending on the Contract Type used on the Project.

.2 The Specification shall be read in its entirety by all parties concerned. Each Section may contain more or less than the complete work of any trade. The [Contractor] [Construction Manager] is solely responsible to make clear to the [Subcontractor] [Trade Contractor] the extent of their work.

.3 The Consultant and Owner assume no responsibility to act as arbiters or to establish subcontract limits between Sections or Divisions of the Work. Any references to related work items contained in this Section are provided for convenience only.

1.2 SUMMARY

.1 The Work of this Section includes, but is not limited to the following:

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Furnish all labour, materials, services, and equipment necessary to supply, fabricate and install ultra high-performance concrete (UHPC) precast components including:

.1 Exterior Cladding Panels

.2 [Exterior Feature Wall Elements]

1.3 REFERENCE STANDARDS

PETRA SPEC NOTE: Edit the following paragraph to reflect reference standards for this Project.

.1 The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

.2 All reference amendments adopted prior to the bid closing date of this Project shall be applicable to this Project.

.3 All materials, installation and workmanship shall comply with all applicable requirements and standards.

.4 American Society for Testing and Materials (ASTM):

.1 ASTM C31/C31M: Standard Practice for Making and Curing Concrete Test Specimens in the Field

.2 ASTM C33/C33M: Standard Specification for Concrete Aggregates

.3 ASTM C39/C39M: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

.4 ASTM C138/C138M: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

.5 ASTM C192/C192M: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

.6 ASTM C494/C494M: Standard Specification for Chemical Admixtures for Concrete

.7 ASTM C642: Standard Test Method for Density, Absorption, and Voids in Hardened Concrete

.8 ASTM C666/C666M: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

.9 ASTM C979/C979M: Standard Specification for Pigments for Integrally Concrete

.10 ASTM C1202: Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

.11 ASTM C1218/C1218M: Standard Test Method for Water-Soluble Chloride in Mortar and Concrete

.12 ASTM C1240: Standard Specification for Silica Fume Used in Cementitious Mixtures

.13 ASTM C1437: Standard Test Method for Flow of Hydraulic Cement Mortar

.14 ASTM C1602/C1602M: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

.15 ASTM C1778: Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete

.16 ASTM C1856/C1856M: Standard Practice for Fabricating and Testing Specimens of Ultra-HighPerformance Concrete

.5 Canadian Standards Associations (CSA):

.1 CSA A23.1/A23.2: Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete

.2 CSA A23.4: Precast Concrete – Materials and Construction

.3 CSA A3001: Cementitious materials use in concrete

.6 Precast/Prestressed Concrete Institute (PCI):

.1 PCI MLN-116: Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

.2 PCI MNL 117-13: Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.

1.4 DEFINITIONS

PETRA SPEC NOTE: Retain terms that remain after Section has been edited for the project.

.1 Acceptance Testing: Verifies UHPC compliance with project specifications during production, considering materials, batch proportions, procedures, and methods used.

.2 Batch: Volume of materials mixed and discharged uniformly.

.3 Binder: Combination of hydraulic cement, supplementary cementitious materials, and mineral fillers in a UHPC mixture.

.4 Flexural Strength: Maximum tensile stress during bending per ASTM C1856.

.5 Flow Spread: Lateral flow distance of UHPC in a flow test per ASTM C1437, modified by ASTM C1856.

.6 Informational Testing: Non-required testing for additional UHPC material properties or durability info.

.7 Material Identity Card: Document detailing constituent materials, proportions, mixing, curing methods, and hardened mechanical properties of UHPC mixture.

.8 Mineral Filler: Finely divided inorganic material from quarried stone, used to improve UHPC properties.

.9 Preblend: Uniform mixture of powder constituents to which water and admixtures are added; may include fibers.

.10 Qualification Testing: Pre-production testing to demonstrate UHPC mixture performance and compliance with project requirements.

.11 Thermal Treatment: Heating UHPC above normal hydration temperature in high humidity, holding it, and cooling slowly to promote hydration, post-initial curing.

.12 Total Water: Combined batched water, ice, aggregate moisture, and liquid from admixtures and silica fume slurry.

.13 Ultra-High-Performance Concrete (UHPC): Fiber-reinforced cementitious material with a refined microstructure, high tensile/compressive strength, impermeable, high ductility and excellent durability.

.14 Water-Binder Ratio (w/b): Weight of total water divided by weight of total binder in UHPC.

.15 Working Time: Time after adding water during which UHPC maintains at least a (220 mm ± 20 mm) flow spread, varying with conditions and procedures.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Coordination: Coordinate site dimensions affecting work of other Sections and provide data, dimensions and components installed by other Sections in sufficient time for installation of products specified in this Section.

.1 Coordinate sizes and locations of framing, blocking, furring, and reinforcements provided by work that is specified in other Sections, ensuring their completeness before starting work of this Section.

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.2 Pre-Construction Meeting: Arrange a preconstruction meeting in accordance with [Division 01] [Section 01 31 19 Project Meetings], attended by [Contractor] [Construction Manager], Consultant, and the panel [Subcontractor] [Trade Contractor] to discuss the following:

.1 Establishing procedures to maintain optimum working conditions and to coordinate Work of this Section with related and adjacent work.

.2 Installation requirements;

.3 Coordination of structural support requirements in relation to the Work;

.4 Installation of any separate air/water barriers, and treatment of fenestration;

.5 Special surface effects and finishing;

.6 Installation of specialty architectural elements offered by the manufacturer;

.7 Coordination of work with adjacent finishes and wall assemblies;

.8 Protection of finishes; and

.9 Acceptability of substrates and quality of materials being used for the project.

1.6 INFORMATIONAL SUBMITTALS

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Provide submittals as indicated in [Division 01] [Section 01 33 00 Submittal Procedures].

.2 Action Submittals: Provide the following submittals before starting work of this Section:

.1 Product Data: Manufacturer's data sheets on each product to be used, including:

.1 Detailed technical data for materials, fabrication, and installation, including anchors, hardware, fasteners, and accessories.

.2 Storage and handling requirements and recommendations.

.3 Installation instructions.

.2 Samples:

.1 Submit 305 mm x 305 mm (12” x 12”) panel sample indicating finish, colour, and texture, supplied by the manufacturer.

.3 Shop Drawings: Submit detailed drawings showing the following:

.1 Panel elevation, sections, and dimensions.

.2 Joint and connection details.

.3 Erection details.

.4 Location and details of connection hardware attached to structure.

.5 Size, location, and details of flex, gravity, and seismic anchors for panels.

.6 Locations and type of sealants.

.7 Relationship to adjacent materials.

.8 Loose, cast, and field hardware.

.9 Coordination Drawings: Provide elevation drawings and building sections which show panels in relationship to required locations for structural support. Include panel details and details showing attachment to structural support.

.10 Other details as may be required for a weathertight installation.

.11 Prepare Shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the place where the Project is located.

.3 Information Submittals:

.1 Material Identity Card: Submit material identity car for each mixture used on the project. The material identity car shall include the following:

.1 Type and source of each constituent material.

.2 Mixing procedures

PETRA SPEC NOTE: Retain the following if used on the project.

.3 Curing procedures, including thermal treatment procedures.

.2 Strength Test Record: Submit documentation indicating proposed mixture proportion of minimum compression test of 120 MPa at 28 days of age.

.3 Material Test Report: Submit compliance test report for the following:

.1 Cementitious materials

.2 Mineral fillers.

.3 Aggregates.

.4 Chemical admixtures.

.5 Fibers.

.6 Other components specified in Contract Document with applicable standards.

1.7 SUSTAINABLE DESIGN SUBMITTALS

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Provide substantial design submittals in accordance with [Division 01] [Section 01 33 00 Submittal Procedures].

.2 Provide LEED documentation for Product [regional materials] [recycled content].

.1 [Recycled Content: Submit product data indicating percentage by weight of post-consumer and post-industrial recycled content for Products having recycled content. Include statement indicating costs for each Product having recycled content. Ensure forms are completed in accordance with Division 01.]

.2 [Regional Materials: Submit product data indicating location of material manufacturer and location of extraction for regionally manufactured and extracted materials. Ensure forms are completed in accordance with Division 01].

.3 Manufacturer's Certificate: Certify that Products meet or exceed [specified requirements].

1.8 CLOSEOUT SUBMITTALS

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Closeout Submittals: In accordance with [Division 01] [Section 01 78 00].

.2 Operating and Maintenance Data: Submit care and maintenance instructions for system description to be included in building operation and maintenance manual.

.3 Warranty Documentation: Submit copy of extended warranties specified in this Section.

1.9 QUALITY ASSURANCE

.1 Manufacturer/Supplier Qualifications:

.1 Performed by a fully experience and recognized manufacturer having minimum 5 years experience of UHPC Products and whose manufacturing plant and facilities are currently certified to CSA Precast requirements at the time of bidding and maintain that certification throughout the duration of the Contract.

.2 Must be designated a CSA-Certified Plant under CSA Precast requirements, and having minimum 5 years experience in manufacturing of Products specified in this Section.

PETRA SPEC NOTE: Retain subparagraph below if requiring manufacturer to install UHPC.

.1 Manufacturer's responsibility includes fabricating [and installing] UHPC panels and providing professional engineering services needed to assume engineering responsibility for UHPC panels, including preparation of Shop Drawings and engineering analysis, based on production test values.

.3 Have adequate financing, equipment, plant, and skilled personnel to detail, fabricate and erect the work of this Section as required by the Specifications and Drawings.

PETRA SPEC NOTE: Retain subparagraph below if installation is performed by trades other than UHPC manufacturer.

.2 Erector Qualifications:

.1 Installers shall be authorized by the manufacturer and the work shall be supervised by a person having a minimum of 5 years experience installing similar type and size projects.

PETRA SPEC NOTE: Mock-ups establish quality of the work for the materials indicated in this Section. Delete the following paragraph if the scope of work in this Section is minimal and a mock-up is not required.

1.10 MOCK-UP:

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Mock-Ups: In accordance with [Division 01] [Section 01 43 39].

.2 Construct mock-ups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

.3 Build integrated mock-ups using products, installers and construction methods that will be used in completed construction of this Section.

.4 Coordinate installation of materials and products specified in other Sections of the Project Manual, that are required to be integrated into mock-ups of this Section, to provide a complete system.

.5 Prior to commencing work, erect a sample panel mock-up consisting of specified materials and including the following:

.1 Substrate support framing;

.2 Attachment to building structure;

.3 Joint sealants;

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.4 [Air and weather barriers;]

.5 [Thermal insulation;]

.6 Flashing and sheet metal trim;

.7 Adjacent wall facades that require tie-in with this Section.

.6 Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements.

.1 Obtain Consultant's approval for all modifications prior to proceeding with work.

PETRA SPEC NOTE: Panels supplied for Mock-ups are "Project Panels", and therefore should remain part of the Work once workmanship, quality control measures, and finishes have been approved.

PETRA SPEC NOTE: If Mock-ups are required on the Project, keep the following subparagraphs.

.7 Mock-up Review Meeting:

.1 Schedule mock-up review meeting, attended by [Contractor] [Construction Manager], [Subcontractor] [Trade Contractor], Panel Manufacturer's Representative and Consultant.

.2 Review mock-up for quality of workmanship, detailing and fastening, adjacent materials tie-in, and accessories installation. Do not proceed with remaining work until workmanship, colour, and texture are approved by [Architect] [Consultant].

.3 Retain approved mock-ups constructed in place as part of the Work. Seamlessly incorporate approved mock-up panels into remaining Work.

PETRA SPEC NOTE: PETRA will coordinate the shipping and delivery of panels to site with the Installer. Material must be checked by the site supervisor on receipt at site.

PETRA SPEC NOTE: PETRA must be informed in writing within a reasonable time of any deficiencies.

1.11 DELIVERY, STORAGE, HANDLING AND PROTECTION

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Follow packaging, shipping and product handling requirements recommended by the manufacturer, and as indicated in [Division 01] [Section 01 45 43].

.2 Coordinate deliveries to comply with construction schedule and arrange ahead for off the ground, under cover storage location. Do not load any area beyond the design limits.

.3 Materials shall be carefully checked, unloaded, stored, and handled to prevent damage. Protect materials with suitable non-staining waterproof coverings.

.4 Store material in original, undamaged containers or wrappings with manufacturer's seals and labels intact, protected from exposure to harmful weather conditions and at temperature levels as recommended by manufacturer.

.5 Delivery: At the time of delivery, visually inspect all materials for damage. Note any damaged to materials on the receiving ticket and immediately report to the shipping company and the material manufacturer.

.1 Remove damaged materials from the site immediately.

.6 Storage and handling:

.1 Comply with the requirements of PCI MNL-116 for storage and handling of materials on site.

.2 Store materials as recommended by manufacturer and conforming to applicable safety regulatory agencies. Refer to all applicable data including but not limited to Safe Use Instruction Sheets, Product Data sheets, product labels, and specific instructions for personal protection.

.3 Store materials in original packaging, on a dry, level, firm, and clean surface. Stack no more than two bundles high. Elevate one end of bundle to allow moisture run-off, cover and ventilate to allow air to circulate and moisture to escape.

.4 Store fibers in covered and dry location to prevent oxidation/corrosion of steel fibers or ultraviolet (UV) degradation of non-metallic fibers.

.5 If storing pre-blended materials on site, oven-dry aggregates before blending to limit pre-hydration of cementitious materials.

.6 Material shall be handled in accordance with sound material handling practices and in accordance with manufacturer's written instructions, and applicable health and safety guidelines for the location of the Project.

.7 Lifting Device:

.1 Use lifting devices capable of maintaining unit shape during manufacture, storage, transportation, erection, and in position for fastening.

1.12 SEQUENCING

.1 Ensure that locating templates and other information required for installation of products of this Section are furnished to affected trades in time to prevent interruption of construction progress.

.2 Ensure that products of this Section are supplied to affected trades in time to prevent interruption of construction progress.

1.13 SITE CONDITIONS

.1 Site Measurements: Verify dimensions by site measurements before fabrication and indicate measurements on Shop Drawings where Work of this Section is indicated to fit walls and other construction.

.1 Coordinate fabrication schedule with construction progress to avoid delaying the Work.

.2 Locate all concealed framing, blocking, anchoring, plates, and reinforcements that support Work of this Section by site measurements before being enclosed and indicate measurements on Shop Drawings.

.2 Established Dimensions: Establish dimensions and proceed with fabricating Work of this Section without confirmed site measurements where site measurements cannot be made without delaying the Work.

.1 Coordinate with the construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.14 WARRANTY

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Provide extended warranties in accordance with [Division 01] [Section 01 78 36].

.2 Manufacturer's Material Warranty: Provide a manufacturer's Limited Liability Material Warranty, executed by the authorized company official. The warranty shall commence upon successful completion of Manufacturer's project inspection and the Date of Substantial Completion.

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.3 Workmanship Warranty: Manufacturer agrees to repair or replace UHPC [panel] [components] that fail in workmanship within the warranty period identified below.

.1 Items covered by the warranty include cracking, deformation, and discoloration.

PETRA SPEC NOTE: The manufacturer offers a standard 5 warranty. Extended warranties up to 10 years can be selected, if required, at additional expense.

PETRA SPEC NOTE: Select one of the following warranty options below and delete the warranty option not required.

.4 Warranty Type and Duration:

.1 Standard Warranty Period: 10 years from date of [Substantial Completion] [Ready-for-Takeover].

.5 General Warranty Information:

.1 The manufacturer or the installer shall not be liable for any consequential or incidental damages as defined within the Manufacturer's Warranty document.

.2 Manufacturer's liability shall be limited to repair, replacement, or correction of defective workmanship and materials, as defined within the terms of the Manufacturer's Warranty.

.3 The Manufacturer's warranty excludes leaks or other defects due to causes stated within the warranty document, including but not limited to structural failure, and movement of the structure.

2 Products

2.1 MANUFACTURER

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the project; additional manufacturers offering similar products may be incorporated into the work of this Section provided they meet the performance requirements established by the named products, and provided they submit requests for substitution in accordance with [Division 01] [Section 01 33 00 Submittal Procedures].

.2 Acceptable Materials Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include but are not limited to, the following:

.1 Petra Design Inc.
47 St. Regis Crescent, Toronto, ON, M3J 1Y6
Phone:1-416-746-9668

2.2 DESCRIPTION

PETRA SPEC NOTE: PETRA's UHPC has compressive strengths surpassing 120 MPa with fire-resistant properties and is environmentally friendly.

.1 Ultra High-Performance Concrete (UHPC) has a high compressive strength. It is a low water absorption concrete due to its dense matrix manufactured from the following materials:

.1 Portland cement.

.2 Fine Aggregates (i.e. silica sand).

.3 Water-Reducing Admixtures (i.e. superplasticizers).

.4 Glass-Fibers (i.e. alkali-resistant AR glass fibers).

.5 Polyvinyl alcohol (PVA) fiber or Steel fibers.

PETRA SPEC NOTE: PETRA has in-house capability to test to CSA A23.2 for the following:
- Compressive strength testing of concrete cylinders
- Air content of freshly mixed plastic concrete
- Temperature of freshly mixed plastic concrete
- Slump of freshly mixed plastic concrete.

.2 UHPC shall meet or exceed the following properties and values:

.1 Density: 2350 kg/m3

.2 Compressive Strength (CSA A23.1): 120-140 MPa

PETRA SPEC NOTE: Select the tensile strength of 7-10 MPa when 2% Steel Fibers are used in the UHPC Concrete design. Use Steel Fibers to maximize flexural strength, resist heavy loads and provide excellent crack-bridging capacity. Delete this option if not required on the Project.

PETRA SPEC NOTE: Select the tensile strength of 5-7 MPa when 2.5% PVA Fibers are used. Use PVA Fibers in non-structural or architectural elements where toughness isn't the main goal, as PVA Fibers are smaller and often invisible. Delete this option if not required on the Project.

.3 Tensile Strength (CSA A23.1): [7-10 MPa] [5-7 MPa]

.4 Flexural Strength (CSA A23.1): 15-20 MPa

.5 Thermal expansion coefficient: $1.18 \times 10^{-5 / c}$

.6 Water Absorption (CSA A23.2): 1-2%

2.3 MATERIALS

.1 Hydraulic Cement: Conforming to CSA A3001, ASTM C150 or ASTM C595.

Other supplementary cementitious materials and mineral fillers must demonstrate adequate mechanical and durability performance when used in UHPC.

.2 Supplementary cementitious materials and mineral fillers:

.1 Raw or calcined natural pozzolan: Conforming to CSA A3000 or ASTM C618, Class N.

.2 Silica Fume: Conforming to ASTM C1240.

.3 Slag cement: Conforming to ASTM C989.

.4 Ground calcium carbonate and aggregate mineral fillers: conforming to ASTM C1797.

.3 Fine aggregates: Conforming to ASTM C33 or ASTM C144.

.4 Water:

.1 Potable; Free from deleterious material that may affect colour stability, setting, or strength of UHPC.

.1 Water may be replaced with ice by more than 20% of its total weight to control the UHPC Temperature while mixing.

.5 Chemical Admixtures:

.1 Water-reducing admixture: Conforming to ASTM C494/C494M, Type A and F.

.2 Water-reducing and retarding admixture: Conforming to ASTM C494/C494M, Type B & D.

.3 Shrinkage-reducing admixture: Conforming to ASTM C494/C494M, Type S.

PETRA SPEC NOTE: Retain the following if the Tensile Strength for Steel Fibers was selected above in paragraph 2.2.2.3. Delete the following paragraph if Steel Fibers were not selected above.

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets.

.6 Steel Fibers:

.1 Conforming to ASTM A820/A820M, with a minimum tensile strength of 290 ksi (2000 MPa) and a minimum nominal aspect ratio of 60, unless otherwise approved by the [Consultant] [Architect] [Engineer] based on demonstrated adequate performance of the steel fibers when used in UHPC.

PETRA SPEC NOTE: Retain the following if the Tensile Strength for PVA Fibers was selected above in paragraph 2.2.2.3. Delete the following paragraph if PVA Fibers were not selected above.

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets.

.7 PVA Fibers:

.1 Conforming to ASTM C1116/C1116M-09 with a minimum tensile strength of 127 ksi (800 MPa), unless otherwise approved by the [Consultant] [Architect] [Engineer] based on demonstrated adequate performance of the PVA fibers when used in UHPC.

.8 Colouring Admixture:

.1 Conforming to ASTM C979/C979M, synthetic mineral-oxide pigments or coloured water-reducing admixtures, temperature stable, nonfading, and alkali resistant.

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets.

.2 [Colour: As selected by [Consultant] [Architect] [As indicated on Drawings] [As indicated in the Finishes Schedule] [Colour: _____.]

2.4 UHPC MIXTURES

.1 Mixture Proportions:

.1 Maximum Water-Binder Ratio (W/B): 0.2

.2 Minimum Fiber Content:

PETRA SPEC NOTE: Select one of the following and remove the option not required on the Project.

.1 Minimum Steel Fiber Content: 2% steel fibers, by volume of concrete (263 lb/yd3 [156 kg/m3]).

.2 Minimum Polyvinyl Alcohol (PVA) Fiber Content: 2.5% PVA fibers, by volume of concrete (55 lb/yd3 [32.5kg/m3])

.3 Maximum Water-Soluble Chloride Ions: ASTM C1218/C1218M, 0.06% by weight of cement.

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets.

.4 Minimum Fresh Properties: As defined in article [2.5.2] of this specification.

.5 Working Time: As needed for element being fabricated. Refer to manufacturer instructions.

.6 Minimum Hardened Properties: As defined in article [2.5.3] of this specification.

.7 Minimum Durability Properties: As defined in article [2.5.3.2] of this specification.

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets.

.2 Fresh UHPC Requirements:

.1 Fresh UHPC shall have the following properties:

.1 Temperature: between 10°C and 27°C at time of placement, unless otherwise approved by [Consultant] [Engineer] [Architect].

.2 Flow Spread: ASTM C1437 as modified by ASTM C1856; (220 mm ± 20 mm) measured after 2 minutes before placement time.

.3 Hardened UHPC Requirements:

.1 Hardened UHPC shall have the following mechanical properties:

.1 Compressive strength: ASTM C39 as modified by ASTM C1856, with exception that 3- or 4-inch (75 to 100 mm) diameter specimens may be used.

.1 At release: 70 MPa minimum.

.2 At 28 days: 120 MPa minimum.

.2 Flexural Performance: ASTM C1609 as modified by ASTM C1856; at service (28 days):

.1 First peak (first-crack) flexural strength: 10.34 MPa minimum

.2 Peak flexural strength: 13.79 MPa minimum

.2 Hardened UHPC shall have the following durability characteristics:

.1 Indication of resistance to chloride ion penetration: ASTM C1202 as modified by ASTM C1856 at 28 days; 250 coulombs maximum.

.2 Resistance to freezing and thawing: ASTM C666 as modified by ASTM C1856; minimum relative dynamic modulus of 95 after 300 cycles.

.3 Absorption: conforming to ASTM C642 at 28 days; 3.0% maximum.

2.5 FABRICATION

.1 Fabricate panels and other precast components in accordance with manufacturer's recommendations and these specifications.

.2 Formwork:

.1 Conform to the requirements in Section 03 11 00 Concrete Forming.

.2 Construct formwork to withstand the following:

.1 Pressures due to concrete placement, operation and temperature changes.

.2 Full hydrostatic pressure of fresh UHPC.

.3 Minimum clear spacing shall be greater than 1.5 times the fiber length and 1.5 times the maximum aggregate size.

.3 Panels:

.1 Fabricate panels and other components complying with profiles, dimensions, and tolerances indicated on Shop Drawings and in this Section, without damaging during stripping to site and during erection.

PETRA SPEC NOTE: Select only the options below that apply for the Project and delete all items not required on this Project.

2.6 PANEL FASTENING TYPES

PETRA SPEC NOTE: UHPC Panels can be mechanically fastened using concealed embedded undercut anchors as an alternative method to visible fastened requiring no complex undercut hole or special tools required. Holes can be drilled on site.

.1 Concealed fastening with undercut anchor.

PETRA SPEC NOTE: Face fastening provides a quick and permanent means of fastening. UHPC panels are fastened with floating and fixed points to cancel out thermal length variations in the materials used.

.2 Face Fastened System.

2.7 MIX TOLERANCES

PETRA SPEC NOTE: Total weight of dry materials shall not exceed ±2% of target.

.1 Produce batch materials within the following tolerances:

.1 Water: ±1%

.2 Cement: ±1%

.3 Silica fume: ±1%

.4 Cementitious materials or mineral fillers: ±1% or ±5 lb, whichever is greater.

.5 Aggregates: ±2%

.6 Chemical admixtures: ±2%

.7 Fiber: -2%, +4%

2.8 MIXTURE QUALIFICATION

.1 Testing for mixture qualification shall include at minimum, the following properties:

.1 All test specimens shall be fabricated from UHPC mixtures produced with the same materials mixture proportions, batching equipment, and mixing sequence intended for the Project.

.2 Document temperature, flow spread for one batch produced in accordance with ASTM C1437, as modified by ASTM C1856 at 15 minutes intervals.

2.9 FINISHES

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.1 Finish exposed-face surface of UHPC to match approved [design reference sample] [and] [mock-ups]. Strike off or screed the surfaces of the UHPC product to the required level immediately after placement.

.2 Finish Types:

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets. Please note that Cast and Light sandblast are standard finishes.

PETRA SPEC NOTE: Polish and aggregate finishes are premium grade finishes.

.1 [Cast finish]

.2 [Light Sandblast finish]

.3 [Polished coloured]

.4 [Aggregate finish]

2.10 SOURCE QUALITY CONTROL

.1 Quality-Control Testing: Establish and maintain a quality control program for manufacturing of UHPC in accordance with CSA A23.1-19 Annex U.

.1 Test materials and inspect production techniques.

.2 Prepare test specimens and test according to ASTM C31 or ASTM C192, as modified by ASTM C1856.

.3 Perform temperature, flow spread, unit weight, compressive strength, and flexural strength testing as defined in CSA A23.1-19 Annex U.

.4 Unit weight shall be evaluated in accordance with ASTM A138, except the measure shall be filled in a single, continuous pour, and self-consolidated.

.2 Concrete Reports: maintain records of concrete operations in accordance with the requirements of PCI MNL-116, including the following:

.1 Record all testing performed.

.2 Maintain report of each batch of UHPC produced, including quantities of materials weighed, the batch sequence used, type of element fabricated, temperature of each batch, flow spread of each batch, time concrete discharged from mixer and time concrete is placed into forms.

PETRA SPEC NOTE: Revise below to suit Project requirements and remove square brackets.

.3 Maintain record of additional testing performed including strength testing performed at ages other than at release and at an aged defined by the [Consultant] [Engineer] [Architect].

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions:

.1 Examine substrates to receive work and surrounding adjacent surfaces for conditions affecting installation. Coordinate with related sections to ensure proper dimensions are maintained.

.2 Verify site dimensions by accurate field measurements, true and level, so that work will be accurately designed, fabricated, and fitted to the structure.

.3 Verify that framing members and structural alignment are within recommended tolerances and ready to receive panel system.

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.2 Notify [Architect] [Consultant] in writing of any conditions that are not acceptable.

.3 Proceed with installation after verification and correction of surface conditions acceptable to manufacturer.

3.2 PREPARATION

.1 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

.2 Perform additional preparation procedures as required by manufacturer's instructions.

3.3 MIXING

.1 Equipment and mixing shall comply with the requirements of CSA A23.1-19 Annex U.

.2 UHPC mixing to placement shall not exceed 25 min.

.3 Mixer shall be cleaned between consecutive batches of UHPC, if not loaded within working time of previous batch.

.4 Aggregate: measure aggregate moisture content for each batch.

.5 Visually inspect fresh UHPC at all times once mixing begins.

.6 Mixture adjustment:

.1 Chemical Admixtures might be adjusted as long they remain in the allowable range during the mixing time.

.2 No adjustment to the mixture shall be made after the concrete is discharged from the mixer.

3.4 TRANSPORTING, PLACING AND CONSOLIDATING CONCRETE

.1 Comply with the requirements of PCI MNL-116 for transporting and placing concrete.

PETRA SPEC NOTE: Edit the following paragraph to make the required selections and remove square brackets indicated below.

.2 UHPC shall be between 10°C and 27°C at time of placement, unless otherwise specified or approved by [Consultant] [Engineer] [Architect].

.3 Place UHPC in a continuous operation that prevents cold joints or planes of weakness from forming, limits fiber segregation, and reduces the entrapment of air and to ensure proper fiber orientation.

.4 Use placement methods to ensure One-Way Casting to assist fiber alignment where possible.

.5 Thoroughly consolidate UHPC without dislocating or damaging the reinforcement and built-in items.

.6 Do not use internal vibration.

3.5 CURING

.1 Cure concrete either by moisture retention without heat or by accelerated heat curing live stream or radiant heat and moisture in accordance with PCI MNL-116.

.1 Maintain relative humidity of 95% if curing by live stream or radiant heat and moisture.

.2 Accelerated heat curing method, if used, shall be started after the concrete has attain initial determined in accordance with CSA A23.1, Annex U.

.2 After finishing, immediately cover all surfaces with plastic, wet burlap or curing compound to prevent dehydration.

3.6 ERECTION

.1 Install clips, hangers, and other accessories required for connecting UHPC panels to supporting members and backup materials.

.2 Lift UHPC panels and install without damage after the UHPC has reached at least 100 MPa compressive strength.

.3 Install UHPC panels level, plumb, square, and in alignment, shim where necessary. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.

.1 Maintain horizontal and vertical joint alignment and uniform joint width.

.2 Remove projecting hoisting devices.

3.7 CUTTING

.1 Panel shall be precisely cut using a water jet or dry cut methods, using tools as recommended by the manufacturer.

.2 Clean panels with water and allow to dry after cutting. Do not handle panel or stack panels while wet.

.3 Promptly remove dust generated from cutting or drilling to prevent damage or staining of the surfaces.

3.8 REPAIRS

.1 Repairs are permitted provided the structural adequacy of UHPC panel is not impaired.

.2 Repairs to be consistent with the colour, texture, uniformity, and appearance of adjacent exposed surfaces. Surface shall be clean and dry prior to applying finish.

.3 Use wire brush to clean welded areas on prime-painted components. Use same type of shop primer on prime-painted components.

.4 Remove and replace damaged panels or component when repairs do not comply with requirements.

3.9 CLEANING

.1 Perform cleaning procedures, if necessary, according to UHPC manufacturer's written instructions.

.2 Clean soiled panel surfaces with detergent and water, using soft fibre brushes and sponges, and rinse with clean water.

.3 Progress Cleaning: Leave work area clean at the end of each workday, ensuring safe movement of passing pedestrians.

.1 Remove excess sealant with solvent recommended by manufacturer.

.2 Clean installation of residue and remove unused materials and products. Remove site cuttings from finish surfaces.

.3 Touch-up, repair or replace panels and trim that have been damaged.

.4 Final Cleaning:

.1 At completion of installation, clean all surfaces so they are free of foreign matter using cleaners recommended by panel manufacturer.

.2 Do not use cleaning materials or processes that could change the appearance of exposed finishes. Clean and wash prefinished surfaces with mild soap and water. Rinse with clean water.

.3 After panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

.5 Waste Management:

.1 Coordinate recycling of waste materials and packaging at appropriate facility, diverting waste from landfill.

.2 Certified installer shall be responsible for ensuring waste management efforts are practiced.

3.10 PROTECTION

.1 Protect installed products until completion of project.

.2 Clean all exposed surfaces of wall panels and touch-up, repair or replace damaged products before Substantial Completion. Do not use abrasive cleaners.

END OF SECTION