National Research Council Canada | Conseil national de recherches Canada

Administrative Services and Property Management Branch | Direction des services administratifs et gestion de l'immobilier

NRC · CNRC

Addendum / Addenda

No./N^{o} 4

Project Description / Description de projet		
M-22 Aircraft Cabin Comfort and Environmental Research Facility		
Solicitation No./ No de sollicitation 15-22004	Project No./N^{o} de projet M-22 3788	W.O. No./N^{o} d'ordre de travail
Departmental Representative / représentant ministériel Maurice Richard		Date July 20, 2015

Notice:	**Nota**:
This addendum shall form part of the tender documents and all conditions shall apply and be read in conjunction with the original plans and specifications.	Cet addenda fait partie intégrale des dossiers d'appel d'offres; toutes les conditions énoncées doivent être lues et appliquées en conjonction avec les plans et les devis originaux.

The bid requirements, contract requirements, specifications, schedules and drawings for

Cabin Comfort & Environmental Research Facility

are amended as follows:

GENERAL

A4.1 ADDENDUM NUMBER SHOWN ON DRAWINGS

.1 Where drawings attached to this addendum show "issued for addendum 03" in the revision table, they actually refer to this addendum no 4.

SPECIFICATIONS

A4.2 REVISED SPECIFICATIONS

.1 The following revised specifications issued with this addendum supersede previously issued specifications of the same title and number

- .1 Section No.00 01 30_R1, List of Materials
- .2 Section No. 01 33 00_R1, Submittal Procedures
- .3 Section No. 01 35 29.06_R1, Health and Safety Requirements
- .4 Section No. 01 52 00_R1, Construction Facilities
- .5 Section No. 01 78 00_R1, Closeout Submittals

.6 Section No. 01 91 31_R1, Commissioning (CX Plan

.7 Section No. 01 91 41_R1, Commissioning Training

.8 Section No. 02 41 16_R1, Structure Demolition

.9 Section No. 03 54 16_R1, Self Levelling Floor Underlayment

.10 Section No. 05 12 23_R1, Structural Steel for Buildings

.11 Section No. 06 40 00_R1, Architectural Woodwork

.12 Section No. 07 27 10_R1, Air Barriers

.13 Section No. 08 33 23.01_R2, Overhead Coiling Doors and Grilles

.14 Section No. 09 21 16_R1, Gypsum Board Assemblies

.15 Section No. 09 91 23_R2, Interior Painting

.16 Section No. 10 28 10_R2, Toilet and Bath Accessories

.17 Section No. 12 50 00_R1, Furniture

.18 Section No. 22 42 01_R2, Plumbing Specialties and Accessories

.19 Section No. 22 42 03_R2, Commercial Washroom Fixtures

.20 Section No. 23 05 53.01_R1, Mechanical Identification

.21 Section No. 23 07 14_R1, Thermal Insulation for Equipment

.22 Section No. 23 07 15_R2, Thermal Insulation for Piping

.23 Section No. 23 22 13_R1, Steam and Condensate Heating Piping

.24 Section No. 23 22 14_R1, Steam Specialties

.25 Section No. 23 31 13.01_R2, Metal Ducts – Low Pressure to 500 PA

.26 Section No. 23 64 26_R2, Water chillers

.27 Section No. 25 05 00_R2, Common work for Building Automation

.28 Section No. 25 05 01_R1, EMCS: General Requirements

.29 Section No. 25 11 00_R1, Building Automation Workstation

.30 Section No. 25 12 00_R1, Building Automation Web server

.31 Section No. 25 13 00_R1, Building Automation Control and Monitoring Network

.32 Section No. 25 14 00_R1, Building Automation Local Control units

.33 Section No. 25 30 01_R1, EMCS: Building Controllers

.34 Section No. 25 35 00_R2, Building Automation Instrumentation &Terminal Devices

.35 Section No. 25 95 00_CS801_R1, Building Sanitary Exhaust

.36 Section No. 25 95 00_CS802_R1, Flexible Cabin Sanitary Exhaust

.2 The following specifications are revised by reference and are not re-issued with this addendum:

.1 M22 CCER IOS_2015 - Zone 27 HVAC HEATING SYSTEM

.1 Add steam meter 22SFM03 complete with AI (Analog Input) control point to the Input/Output summary table.

.2 Section No. 26 05 00 – Common Work Results for Electrical

.1 Item 18.1- Replace reference to section 26.05.01.00 with 26 05 00

.3 Section No. 26 24 01 – Common Work Results for Electrical

.1 Item 2.4.1-Delete reference to make/model for client supplied frecuency converter.

.4 Section No. 26 50 00 Lighting and controls

.1 Revise 265000.2.1.1.1 with the following:

1 Type A:

.1 120V, 300mm x 1219mm LED troffer, suitable for recessed mounting in T-bar ceiling.

.2 5-year warranty.

.3 Removable LED boards and drivers for ease of service/replacement.

.4 Rated to deliver a minimum of L70 performance for 50,000 hours.

.5 4000 K colour temperature, minimum 80 CRI, 4000 lumen output minimum.

.6 Standard of acceptance: Lithonia GTL-4-40L-120-EZ1-LP840, Philips CFI 1TG42L840-4-FS-02F-UNV-DIM, Columbia LLT14-40G-A12F-EU, CREE ZR14-40L-40K-10V or equivalent approved by NRC Departmental Representative.

.2 Replace 265000.2.1.1.2 with the following:

.2 Type A1:

.1 120V, 300mm x 1219mm, suitable for surface mounting.

.2 5-year warranty.

.3 Removable LED boards and drivers for ease of service/replacement.

.4 0-10V DC dimming.

.5 Rated to deliver a minimum of L80 performance for 50,000 hours.

.6 4000 K colour temperature, minimum 80 CRI, 4000 lumen output minimum.

.7 Standard of acceptance: Philips 4114S1STL8ADS11E, CREE ZR14-40L-40K-10V with surface mount kit SMK-ZR14 or equivalent approved by NRC Departmental Representative.

.3 Replace 265000.2.1.1.3 with the following:

.3 Type B:

.1 120V, 1140-1220mm long, LED linear strip light.

.2 5-year warranty.

.3 Rated to deliver a minimum of L70 performance for 100,000 hours.

.4 4000 K colour temperature, minimum 80 CRI, 3800 lumen output minimum.

.5 Standard of acceptance: Philips LF-4-FR-39-40-ULAG, Peerless Electric NSL-4-46-40k-RA-WH-MV , Cree LS4-40L-40K-10V or equivalent approved by NRC Departmental Representative.

.4 Replace 265000.2.1.1.4 with the following:

.4 Type C:

.1 120V, 600mm x 1219mm, suitable for surface mounting.

.2 5-year warranty.

.3 Removable LED boards and drivers for ease of service/replacement.

.4 0-10V DC dimming.

.5 Rated to deliver a minimum of L80 performance for 50,000 hours.

.6 4000 K colour temperature, minimum 80 CRI, 4000 lumen output minimum.

.7 Standard of acceptance: Philips 4124S1STL8ADS11E, CREE ZR24-40L-40K-10V with surface mount kit SMK-ZR14 or equivalent approved by NRC Departmental Representative.

.5 Replace 265000.2.1.1.5 with the following:

.5 Type D:

.1 120V, 600mm x 1219mm, LED troffer, suitable for recessed mounting in T-bar ceiling.

.2 5-year warranty.

.3 Removable LED boards and drivers for ease of service/replacement.

.4 Rated to deliver a minimum of L70 performance for 50,000 hours.

.5 4000 K colour temperature, minimum 80 CRI, 4000 lumen output minimum.

.6 Standard of acceptance: Lithonia 2GTL-4-40L-120-EZ1-LP840, CFI SpecPlus SPS24G-FS-VA-43A-40-U-LAG, Columbia LLT24-40G-A12F-EU, CREE ZR14-40L-40K-10V or equivalent approved by NRC Departmental Representative.

.6 Replace 265000.2.1.1.6 with the following:

.6 Type F:

.1 120V, 1140mm long, suitable for surface mounting with reflector.

.2 5-year warranty.

.3 Rated to deliver a minimum of L70 performance for 100,000 hours.

.4 4000 K colour temperature, minimum 80 CRI, 3700 lumen output minimum.

.5 Standard of acceptance: Philips LFR4FL-SLD-37-40-U-LAG or equivalent approved by NRC Departmental Representative.

.7 Replace 265000.2.1.1.7 with the following:

.7 Type G:

.1 120V, 150mm LED drum light, suitable for surface mounting.

.2 5-year warranty.

.3 3000k colour temperature, minimum 80 CRI, 1000 lumen output minimum.

.4 Standard of acceptance: Philips S7R830K10 or equivalent approved by NRC Departmental Representative.

.8 Replace 265000.2.1.1.8 with the following:

.8 Type H:

.1 Wall-mounted 45W, 120V, LED wall pack.

.2 Die-cast aluminum housing, bronze in colour.

.3 18 LEDs, type 3 optics, full cut-off. 3300 lumen output.

.4 Built in photo control.

.5 Standard of Acceptance: Hubbell outdoor lighting Laredo Series LNC2- 18LU-5K-3-1-PC.

.9 Replace 265000.2.1.1.9 with the following:

.9 Type H1:

.1 Wall-mounted 71W, 120V, LED wall pack.

.2 Die-cast aluminum housing, bronze in colour.

.3 30 LEDs, type 3 optics, full cut-off. 4600 lumen output.

.4 Built in photo control.

.5 Standard of Acceptance: Hubbell outdoor lighting Laredo Series LMC- 30LU-5K-3-1-PC1.

.10 Replace 265000.2.1.1.10 with the following:

.10 Type J:

.1 120V, 150mm open LED downlight.

.2 5-year warranty.

.3 Complete with all components, trim rings and any other components required to complete installation.

.4 Rated to deliver a minimum of L80 performance for 50,000 hours.

.5 4000 K colour temperature, minimum 80 CRI, 1500 lumen output minimum.

.6 Standard of acceptance: Philips Lightolier frame-in kit C6L-15-N-U-VB-Z10VLD + trim kit C6L-1520-DL-40K-W-WH-W-VB, Prescolite LiteFrame LC6LED-120-6LCLED-7-40K-8-WH-WT, CREE KR6-20L-40K-120-10V or equivalent approved by NRC Departmental Representative.

.11 Replace 265000.2.1.1.11 with the following:

.11 Type K1:

.1 120V, 100mm x 1200mm, LED linear, suitable for suspended mounting.

.2 5-year warranty.

.3 Removable LED boards and drivers for ease of service/replacement.

.4 Rated to deliver a minimum of L80 performance for 50,000 hours.

.5 4000 K colour temperature, minimum 80 CRI, 4000 lumen output minimum.

.6 Standard of acceptance: Philips Jump 1201-L-A-E-Q-P-04-7-1-E-B-Flat Endcap or equivalent approved by NRC Departmental Representative.

.12 Replace article 265000.2.1.1.12 to read as follows:

.12 Type L:

.1 120V, 170mm x 1200mm, 32W, LED under shelf valance for surface mounting complete with integral control switch.

.2 Baked white enamel steel housing.

.3 5-year warranty.

.4 Removable LED boards and driver for ease of service/replacement.

.5 4000k colour temperature, minimum Lumen output.

.6 Standard of acceptance: CFI TSL series or equivalent approved by NRC Departmental Representative.

.13 Add article 265000.2.1.1.13 to read as follows:

.13 Type M:

.1 120V, 600mm x 1219mm, suitable for recessed mounting in T-bar ceiling.

.2 5-year warranty.

.3 Removable LED boards and drivers for ease of service/replacement.

.4 Rated to deliver a minimum of L70 performance for 50,000 hours.

.5 4000 K colour temperature, minimum 90 CRI, 4000 lumen output minimum.

.6 Standard of acceptance: CREE ZR24-40L-40K-10V or equivalent approved by NRC Departmental Representative.

A4.2 NEW SPECIFICATIONS

.1 Add the following new specifications issued with this Addendum.

.1 Section No. 01 77 00, Closeout Procedure

.2 Section No. 08 36 13.02, Sectional Metal Doors

.3 Section No. 23 05 15, Variable Frequency Drives

.4 Section No. 23 31 13.02, Metal Ducts – High Pressure to 2500 PA

.5 Section No. 31 00 00.01, Earthwork – Short Form

.6 Section No. 33 36 00, Utility Septic Tanks

.7 Appendix 1-Draft – Geotechnical Investigation-Addition to Building M22

.8 Appendix 2-Draft – Geotechnical Investigation- Ramp Modification

A4.3 DELETED SPECIFICATIONS

.1 Delete the following specifications in their entirety.

.1 Section No. 01 73 00, Execution

.2 Section No. 08 14 16, Flush Wood Doors

.3 Section No. 23 05 14, Variable Frequency Drives

.4 Section No. 26 22 19 Control and Signal Transformer

DRAWINGS

A4.4 REVISED DRAWINGS

.1 The following drawings are revised and re-issued with this addendum:

.1 Drawing no. 3788-A01 Assemblies & Fire separation plans

.1 Replace Rev.No 0 with Rev. No 1

.2 Drawing no. 3788-A04 Roof Plan, Main level plan & Lower level plan

.1 Replace Rev.No 0 with Rev. No 1

.3 Drawing no. S03 – Typical Details - 3

.1 Typical details TDM-2 & 6 revised and TDS-21 deleted

.4 Drawing no. S04 - Roof Plan Main Level Plan Lower Level Plan

.1 Housekeeping Pad added.

.2 New staircase section mark completed (1/S06)

.3 Trenching from sump pit shown.

.4 Design load notes added

.5 Drawing no. S05 – Sections & Detail 1

.1 Missing structural dimension added and depth of new foundation added which is to be verified on site..

.2 Duplicate section mark number revised.

.3 Section marks 2A/S07 & 7G/S07 added.

.4 Reinforcing plate to HSS in Section 7, 7A, 7D/S05 revised.

.6 Drawing no. S06 – Sections & Details – 2

.1 1/S06 Depth of new foundation added which is to be verified on site.

.2 3/S06 Side plates in elevation added to man opening.

.7 Drawing no. S07 – Sections & Details – 3

.1 Section 10/S07 Foundation detail updated, wall thickness added.

.2 Additional wall plate dimension added to section 6/S07.

.3 Section details 2A/S07 & 7G/S07 added.

.8 Drawing no. 3788-M01 – MECHANICAL LEGEND

.1 All revisions have been bubbled. Refer to drawing for all changes.

.9 Drawing no. 3788-M02 – PLUMBING LAYOUT

.1 All revisions have been bubbled. Refer to drawing for all changes.

.10 Drawing no. 3788-M03 – HVAC LAYOUT

.1 All revisions have been bubbled. Refer to drawing for all changes.

.11 Drawing no. 3788-M04 – PIPING LAYOUT

.1 All revisions have been bubbled. Refer to drawing for all changes.

.12 Drawing no. 3788-M05 – BASEMENT AND FIRST FLOOR STEAM PIPING

.1 All revisions have been bubbled. Refer to drawing for all changes.

.13 Drawing no. 3788-M07 – MECHANICAL SCHEMATIC

.1 All revisions have been bubbled. Refer to drawing for all changes.

.14 Drawing no. 3788-M08 – MECHANICAL SCHEDULES

.1 All revisions have been bubbled. Refer to drawing for all changes.

.15 Drawing no. 3788-M09 – MECHANICAL DETAILS

.1 All revisions have been bubbled. Refer to drawing for all changes.

.16 Drawing no. 3788-M10 – MECHANICAL DETAILS

.1 All revisions have been bubbled. Refer to drawing for all changes.

.17 Drawing no. 3788-M11 – ENLARGED MECHANICAL ROOM PLANS

.1 All revisions have been bubbled. Refer to drawing for all changes.

.2 The following drawings are revised by reference, or as indicated on sketches attached with this addendum, but not re-issued:

.1 Drawing A02 Window & Door schedules

.1 Revise elevations 13/A02: Add window tag W04 to horizontal window without tag.

.2 Revise door schedule 1/A02: Door 140a: Delete door type “B”, Add door type “A”

.3 Revise door schedule 1/A02: Door 121: Delete door type “D”. Add door type “CW”. Delete door finish “PT”, Add door finish “AL” Delete frame type “HM”, Add frame type “CW”, Delete frame finish “PT”, Add frame finish “ AL”.

.4 Delete detail 11 /A02 and all references.

.5 9/A02: Remove reference to 10/A02 from interior glazed screen at door 121.

Clarification: This door and screen are now to be curtain wall type WI-1a (refer to revised list of materials).

.2 Drawing A03 Site Plan & Entrance Details

.1 1/A03: Revise note at new far south east exit (at Stair A) to read ‘NEW EXIT/ENTRANCE’

.3 Drawing A05 Demolition Plans

.1 Revise drawing title of elevation 2a to read: “Exterior East Elevation”

.2 Revise drawing title of elevation 2b to read: “Interior East Elevation”

.3 Remove all references to Consultant from General notes.

.4 Revise note 25 to read: “Prop existing roller door opening lintel. Carefully demolish strip of concrete & blockwork above as shown. Refer to struct for full details. Refer also to 19/A10. Cut back catwalk sufficient to allow access for the new HSS. High level exterior cladding, flashing, framing & insulation to be retained in place and new jamb flashing to match existing to be applied to both sides" .”

.4 Drawing A06 Building Elevations & Sections

.1 3/A06: Note “Patch and make good ex.lower wall exposed by earthworks” to be revised to read “Clean, Patch and make good ex.lower wall exposed by earthworks. Paint black to match existing”.

.2 1/A06: Between gridlines 7 and 8 revise note: “Patch/make good ex. lower wall exposed by earthwork” to read ““Patch/make good ex. lower wall exposed by earthwork. Apply W-4 (waterproof membrane to suit length of insulation) w/ galv flashing (prefin.- colour to match existing) at top edge/ corner”

.5 Drawing A08 Washroom Plans & Elevations & Millwork

.1 2 & 11/A08: Revise dimension 644mm to 529mm (due to new wall finishes)

.6 Drawing A09 Exterior details

.1 13/A09: Add note: Where ex.cladding continues below, cut back to allow for stair framing & install prefin.cap flashing to top edge on wood blocking to suit. (colour to match ex.cladding)

.2 14/A09: Add lower floor level 96.625, add dimension 912mm from existing threshold to lower floor level.

.3 15/A09: Add note: Steel plate box lintel, jambs & new HSS post to be shop primed with 2 coats of paint in gloss black to match existing.

.4 Revise note: “ Cladding to be removed & refitted following replacement of box lintel” To read

“Cladding, insulation& framing to be retained in place, patched and made good. New drip flashing to be fitted at base to match existing & lapped with any existing a/w/v membrane”

.7 Drawing A10 Plan details

.1 19/A10: Add note: Steel jambs, & head plates (at both doors) & new HSS post to be shop primed with 2 coats of paint in gloss black to match existing.

.8 Drawing A11 Reflected ceiling plans & Finishes Plans

.1 3/A11: Clarification – Self levelling concrete topping is to be applied throughout the lower existing floor, where the basin exists (does not include Chiller service room/ new addition) refer also to 10/A06

.9 Drawing A12 Millwork Plans, Sections and Elevations

.1 Refer to sketch SK-01 attached for additional check in counter detail

.10 Drawing A13 Interior details

.1 8/A13:Delete wall type F-1. Add wall type F-1a

.2 20/A13: Revise note to read " 40x40x4.8HSS steel tubing anchored to floor & wall…"

.11 Drawing no. E06 LIGHTING

.1 Revise location of valence light fixtures Type "L" withing exam rooms 130,131, 132 to millwork location. Refer to architectural drawing A12 for mounting details. Fixtures to suit millwork upper dimensions. Coordinate work with millwork installer and architectural mounting details.

.2 Provide new valene lighting at millwork location within screening room 129. Refer to architectural drawing A12 for mounting details. Connect to lighting circuit within room (L20-2) and provide line voltage switch on wall adjacent to millwork. Fixtures to suit millwork upper dimensions. Coordinate work with millwork installer and architectural mounting details.

.12 Drawing no. E02 POWER, FIRE ALARM & MISC SYSTEMS

.1 Delete electrical requirements for humidifier (equipment#: 22HUM04) indicated in the mechanical room. Delete requirements from equipment schedule on drawing and revise panel schedule accordingly.

.13 Drawing no. E03 POWER, FIRE ALARM & MISC SYSTEMS

.1 Provide 600V/3phase power connection complete with isolation switch disconnect to overhead door located between gridlines A-4. Provide new 15A/3P circuit breaker on panel P8 for connection to overhead door. Revise panel schedule accordingly. Provide conduit infrastructure and wiring to door controls. Overhead door motor and controls provided by others. Coordinate exact requirements with door provider prior to rough-ins.

.1 Provide 208V/3phase power connection complete with isolation switch disconnect to dock lift located between gridlines A-3. Provide new 15A/3P circuit breaker on panel L18 and connect to circuit L8-32-34-36. Revise panel schedule accordingly. Provide conduit infrastructure and wiring to duck lift controls. Equipment provided by others. Coordinate excact requirements with lift provider prior to rough-ins.

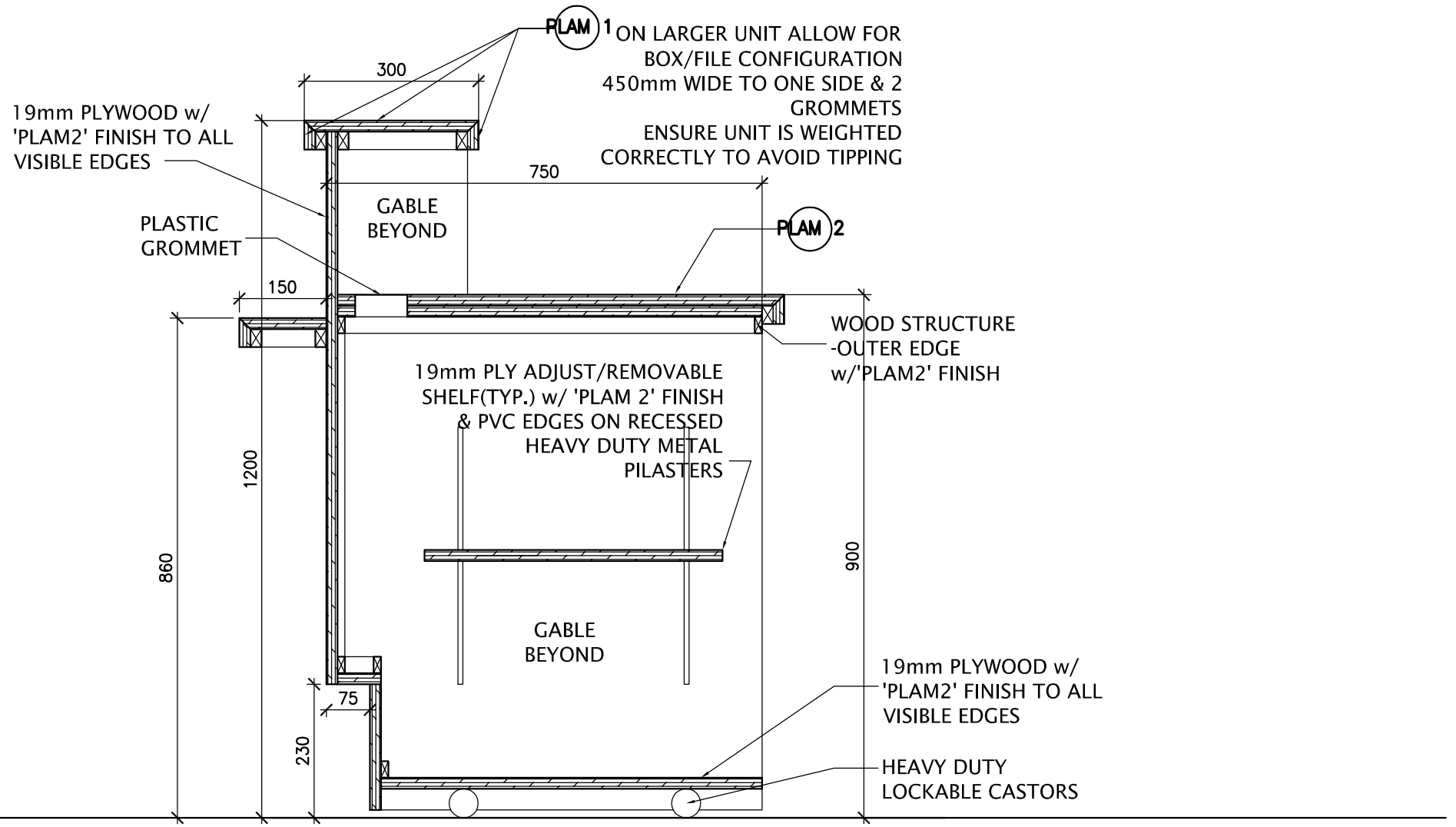
.14 Drawing no. E08 PANEL & SCHEDULES

.1 Revise connection type for mechanical equipment 22AHU04 on the equipment schedule from a starter to VFD. VFD to be provided by mechanical, installed and wired by electrical. Coordinate work with mechanical contractor.

.2 Revise circuits indicated as spare to read "space".

End of Addendum No. 4

NOTE: FOR AIRPORT TERMINAL
RM ALL SURFACES TO BE PLAM4



DATE	ISSUED FOR	REV
10/07/15	ISSUED FOR ADDENDUM #3	1

NORR
ARCHITECTS ENGINEERS PLANNERS
NORR Limited
An Ingenium Group Company
55 Murray Street,
Suite 600
Ottawa, Ontario, Canada K1N 5M3
www.norr.com

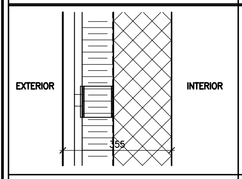
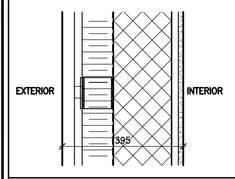
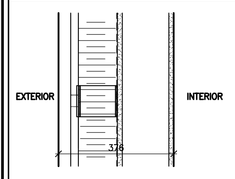
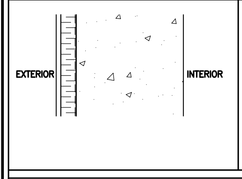
North Arrow

True North

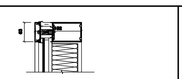
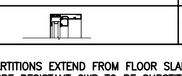
Project Manager: S.Dunderdale	Drawn: S.Dunderdale
Project Leader: A.Butler	Checked: A. Butler
Drawing Title: MOBILE CHECK IN COUNTER DETAIL	Project No.: ECOT13-0061
	Drawing No.: ASK-01

FILENAME: 3788-A12-MILLWORK PLOTSYLE TABLE: 1050C Greyscale.ctb PLOT DATE: July 15, 2015 TIME: 3:09 PM

EXTERIOR WALL TYPES

GRAPHICS (N.T.S.)	TYPE	CONSTRUCTION	NOTES
	W-1	METAL SHEET SIDING WITH EXPOSED FASTENERS ON BLOCKWORK • 38mm PREFINISHED VERTICAL METAL SHEET SIDING (PNL-1) • 25mm HORIZONTAL TOP HAT 20ga @ 600 o/c • 102mm CASCADIA FIBREGLASS THERMAL SPACERS @ 400 o/c HORIZONTALLY & 600 o/c VERTICALLY • 102mm MINERAL FIBRE INSULATION • AIR/VAPOUR BARRIER MEMBRANE • 190mm REINF. CONCRETE BLOCK	EXTERIOR WALL AT WEST ADDITION
	W-2 W-2a W-2b	METAL SIDING WITH HIDDEN FASTENERS ON BLOCKWORK • 40mm PREFINISHED VERTICAL METAL SIDING (PNL-2) • 25mm HORIZONTAL TOP HAT 20ga @ 600 o/c • 102mm CASCADIA FIBREGLASS THERMAL SPACERS @ 400 o/c HORIZONTALLY & 600 o/c VERTICALLY • 102mm MINERAL FIBRE INSULATION • AIR/VAPOUR BARRIER MEMBRANE • 190mm REINF. CONCRETE BLOCK • 22mm METAL FURRING CHANNELS @ 400mm O/C MAX. • 16mm GYPSUM BOARD • AS ABOVE WITHOUT 22mm FURRING & INTERNAL GYPSUM • AS W-2 WITH 127mm THERMAL SPACERS & 127mm MINERAL FIBRE INSULATION ON 200mm REINFORCED CONCRETE	EXTERIOR WALL AT EAST ADDITION
	W-3	METAL SIDING WITH HIDDEN FASTENERS ON LIGHTWEIGHT STEEL FRAMING • 40mm PREFINISHED VERTICAL METAL SIDING (PNL-2) • 25mm HORIZONTAL TOP HAT 20ga @ 600 o/c • 127mm CASCADIA FIBREGLASS THERMAL SPACERS @ 400 o/c HORIZONTALLY & 600 o/c VERTICALLY • 127mm MINERAL FIBRE INSULATION • AIR/VAPOUR BARRIER MEMBRANE • 16mm EXTERIOR GRADE SHEATHING • 152mm METAL STUD FRAMING @ 400mm O/C MAX. • 1 LAYERS 16mm GYPSUM BOARD	EXTERIOR WALL AT MAIN ENTRANCE
	W-4 W-4a	• 16mm PROTECTION BOARD (BELOW GRADE)/PARGING (ABOVE GRADE) & 50mm RIGID INSULATION (EXTENDS 1200mm BELOW GRADE) • WATERPROOFING MEMBRANE (TAKEN TO BASE OF FOOTING) • FOUNDATION WALL (REFER TO STRUCTURAL) • 16mm PROTECTION BOARD (BELOW GRADE)/PARGING (ABOVE GRADE) & 50mm RIGID INSULATION (EXTENDS TO FOOTING) • WATERPROOFING MEMBRANE (WRAPS FOOTING & LAPS SLAB MEMBRANE — WHERE PRESENT) • FOUNDATION WALL (REFER TO STRUCTURAL)	FOUNDATION INSULATION & WATERPROOFING MIN R10

WINDOW TYPES

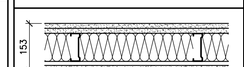
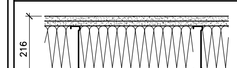
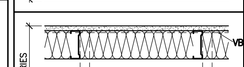
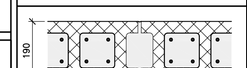
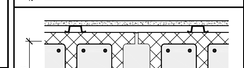
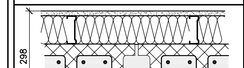
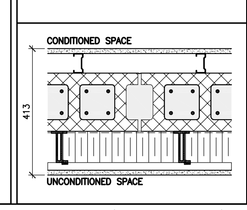
	W-1	• 152mm CURTAIN WALL FRAMING (CURTAIN WALL MEMBERS TO BE ENGINEERED) WITH DOUBLE GLAZED VISION PANELS, SPANDREL PANELS & INSULATED BACK PAN	ENTRANCE CURTAIN WALLING MIN R10
	W-2	• HIGH PERFORMANCE ALUMINUM WINDOW WITH DOUBLE GLAZED VISION PANELS	

NOTES:
1.ALL PARTITIONS EXTEND FROM FLOOR SLAB TO FLOOR SLAB/ROOF SLAB.
2.MOISTURE RESISTANT GWB TO BE SUBSTITUTED AS NECESSARY IN BATHROOMS.
3.WALLS EXTEND TO DECK OR SLAB WITH DEFLECTION TRACK OR CHANNEL.
4.INNER LAYERS OF GWB SHOULD BE CAREFULLY FITTED & TAPED BUT ARE NOT REQUIRED TO BE SANDED.
5.GWB JOINTS SHOULD BE STAGGERED.
6.NOTES IN BRACKETS SHOW ACTUAL PROPERTIES.
7.ALL INTERIOR PLYWOOD TO BE PRIMED AND PAINTED WITH TWO COATS OF FIRE RESISTANT PAINT ON BOTH FACES AND ALL EDGES.

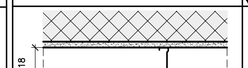
THE FOLLOWING NOTES APPLY TO ALL WALLS WITH 45+ STC RATING: (1)

1.INNER AND OUTER LAYERS OF GWB SHOULD HAVE NO GAPS OVER 6mm.
2.CAULKING SHOULD BE DONE ON EACH LAYER OF GWB AT TOP & BOTTOM & SIDES.
3.USE ONLY RED COLOURED FIRE RATED CAULK (ie. TREMSTOP ACRYLIC). WHERE CAULKING MAY BE VISIBLE, USE THE SAME FIRE RATED CAULK IN WHITE COLOUR.
4.CAULKING FOR ANY GAP OVER 6mm MUST BE OVER ROD BACKUP.
5.ELECTRICAL BOXES ON OPPOSING FACES OF A WALL SHOULD BE LOCATED IN SEPARATE STUD CAVITIES.
6.USE ONLY PRE-GANGED ELECTRICAL BOXES. DO NOT GANG ELECTRICAL BOXES.
7.FIBERGLASS BATT SHOULD BE RUN BEHIND & AROUND ALL ELECTRICAL BOXES WHERE POSSIBLE (ie. DOUBLE WALLS)
8. ALL PENETRATIONS THROUGH RATED WALLS MUST BE SEALED AIR-TIGHT WITH A COMBINATION OF JOINT COMPOUND AND FIRE RATED CAULK.
9. BLOCKING MUST NOT CONNECT ONE FACE OF THE WALL WITH THE OTHER.
10. CONDUIT PENETRATIONS SHOULD BE RESTRICTED TO THE SMALLEST DIAMETER POSSIBLE FOR THE APPLICATION. MULTIPLE SMALL CONDUITS SPACED TO ALLOW SEALING OF EACH IS PREFERABLE TO SINGLE LARGE DIAMETER CONDUITS OR ONES RUN TIGHT TO THE SLABS.
11. ALL CONDUIT PENETRATIONS MUST BE SEALED AIR TIGHT.
12.GWB CONTRACTOR TO MAKE FINAL INSPECTION OF PENETRATION SEALING AFTER ALL THE COMMUNICATION WIRING IS IN PLACE.

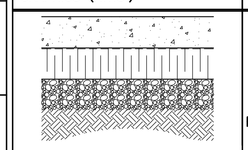
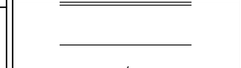
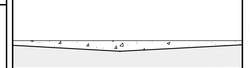
INTERIOR PARTITION TYPES

GRAPHICS (N.T.S.)	TYPE	CONSTRUCTION	REQ'D FRR/STC	NOTES
	P-1	• 16mm GYPSUM BOARD • 64mm STEEL STUDS @ 400mm O/C • 16mm GYPSUM BOARD		GENERAL USE
	P-2 P-2a	• 16mm GYPSUM BOARD • 92mm STEEL STUDS @ 400mm O/C • 16mm GYPSUM BOARD SAME AS P2 BUT WITH GYPSUM ONE SIDE ONLY		ULC DES W453 or W407 or UL DES U419 or U465
	P-3	• 16mm TYPE X– GYPSUM BOARD • 152mm STEEL STUDS @ 400mm O/C • 16mm TYPE – X GYPSUM BOARD	45min FRR	GENERAL USE NBC S7b (STC 41)
	P-4	• 2-LAYERS 16mm TYPE-X GYPSUM BOARD • 92mm STEEL STUDS @ 600mm O/C • 90mm MINERAL FIBRE INSULATION • 2-LAYERS 16mm TYPE-X GYPSUM BOARD VAPOUR BARRIER RQ'D BTWN RNS127/126 & 133, AND ALSO BTWN 122 & 123, TO BE INSTALLED TOWARDS RM 127/128/122.	STC 56	BETWEEN OFFICE AND CORRIDOR NBC S6a (2hr FRR) INSULATION TO HAVE MIN R VALUE 4.1/INCH
	P-4a	• AS P-4 WITH 19mm PLYWOOD BACKING FIXED TO STUDS BEHIND GWB ON BOTH SIDES (1)	STC 54	BETWEEN OFFICES NBC S12A (N/A)
	P-5	• 2-LAYERS 16mm TYPE-X GYPSUM BOARD • 92mm STEEL STUDS @ 400mm O/C • 90mm MINERAL FIBRE INSULATION • 13mm RESILIENT CHANNEL • 16mm TYPE-X GYPSUM BOARD		
	P-6 P-6a	• 2-LAYERS 16mm TYPE-X GYPSUM BOARD • 152mm STEEL STUDS @ 600mm O/C • 150mm MINERAL FIBRE INSULATION • 2-LAYERS 16mm TYPE-X GYPSUM BOARD • AS ABOVE WITH 19mm PLYWOOD BACKING FIXED TO STUDS BEHIND GWB IN RM 132	STC 59	NBC S9a (2hr FRR)
	P-7	• 16mm GYPSUM BOARD • 92mm STEEL STUDS @ 600mm O/C. • 75mm MINERAL FIBRE INSULATION • PLUMBING SPACE • 92mm STEEL STUDS @ 600mm O/C. • 75mm MINERAL FIBRE INSULATION (MIN R VALUE 4.1/INCH) • 16mm GYPSUM BOARD VAPOUR BARRIER RQ'D BTWN RNS128 & 133 ONLY. TO BE INSTALLED TOWARDS RM 128. SEE A04.	STC 61	BETWEEN WASHROOMS INSULATION TO HAVE MIN R VALUE 4.1/INCH UL 445 (1hr FRR)
	P-8	• 190mm REINFORCED CONCRETE BLOCK WALL	1hr FRR STC MIN 50	NBC B1b (1.5hr FRR)
	P-9 P-9a P-9b	• 16mm GYPSUM BOARD • 22mm METAL FURRING CHANNELS @ 400mm O/C MAX. • 190mm REINFORCED CONCRETE BLOCK • AS ABOVE WITH 19mm PLYWOOD BACKING IN LIEU OF GWB • AS P-9 WITH 19mm PLYWOOD BACKING FIXED TO CHANNELS BEHIND GWB	1hr FRR STC MIN 50	UL U914
	P-10 P-10a P-10b	• 16mm GWB • 92mm STEEL STUDS @ 400 O.C • 90mm MINERAL FIBRE INSULATION • 190mm REINFORCED CONCRETE BLOCK AS ABOVE WITH 19mm PLYWOOD BACKING FIXED TO STUDS BEHIND GWB AS P10a WITH • 22mm METAL FURRING CHANNELS @ 400mm O.C MAX • 19mm PLYWOOD BACKING • 16mm GWB ALL FIXED TO THE OPPOSITE SIDE OF B/WORK	1hr FRR STC MIN 53	
	P-11 P-11a	• 16mm GYPSUM BOARD • 64mm STEEL STUDS @ 400mm O/C • 190mm REINFORCED CONCRETE BLOCK • A/V BARRIER MEMBRANE • 102mm CASCADIA FIBREGLASS THERMAL SPACERS @ 400 o/c HORIZONTALLY & 600 o/c VERTICALLY • 102mm MINERAL FIBRE INSULATION (MIS-2) • 25mm HORIZONTAL TOP HAT 20ga @ 600 o/c • 16mm GYPSUM BOARD (CAVITY TO BE VENTED TOP AND BTM) AS ABOVE WITH 19mm PLYWOOD BACKING FIXED TO STUDS BEHIND GWB ON CONDITIONED SIDE	45 MIN FRR STC MIN 53	INTERIOR WALL WITH EXTERIOR WALL FEATURES (1hr FRR) NBC B7

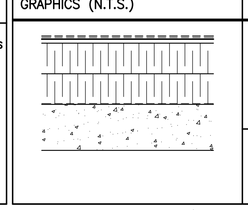
FURRING TYPES

GRAPHICS (N.T.S.)	TYPE	CONSTRUCTION	NOTES
	F-1	• 16mm GYPSUM BOARD • 22mm FURRING CHANNELS @ 400mm O/C • ON EXISTING EXTERIOR WALLS	
	F-1a	• AS ABOVE WITH 19mm PLYWOOD BACKING FIXED FRAMING BEHIND GWB	
	F-1b	• AS F-1 WITH 19mm PLYWOOD BACKING IN LIEU OF GWB & FIXED BACK TO NEW WALLS	
	F-1c	• AS F-1 FIXED BACK TO NEW WALLS	
	F-2	• 16mm GYPSUM BOARD • 64mm METAL STUDS @ 400mm O/C	
	F-2a	• AS ABOVE WITH POLYETHYLENE RETARDER ON INTERIOR OF 65mm MINERAL FIBRE INSULATION & MOISTURE BARRIER ON CONCRETE	
	F-2b	• AS F-2a WITH 19mm PLYWOOD BACKING FIXED TO STUDS BEHIND GWB	
	F-2c	• AS F-2 WITH 19mm PLYWOOD BACKING IN LIEU OF GWB	
	F-3	• EXTERIOR FRAMING, INSULATION & CLADDING REMOVED • 16mm GYPSUM BOARD • 102mm STEEL STUDS @ 400mm O/C WITH 64mm STEEL STUDS @ 400mm O/C BELOW • FIXED BACK TO EXISTING ASSUMED STRUCTURE	
	F-4	• 2 LAYERS 13mm TYPE-X GYPSUM BOARD • 64mm STEEL STUDS @ 600mm O/C • 65mm MINERAL FIBRE INSULATION • 2-LAYERS 13mm TYPE-X GYPSUM BOARD • FIXED BACK TO EXISTING STRUCTURE & ADJACENT TO EXISTING GLASS BLOCK WINDOW/PORTHOLE	45 min FRR/STC 53 FIRE & STC RATED INFILL ASSEMBLY TO SUIT SIZE OF EXISTING GLASS BLOCK WINDOW OPENINGS/PORTHOLE (1.5h) NBC S3c

FLOOR TYPES

GRAPHICS (N.T.S.)	TYPE	CONSTRUCTION	NOTES
	FL-1	NEW SLAB ON GRADE • REINFORCED CONCRETE FLOOR SLAB PER STRUCTURAL • VAPOUR BARRIER • 75MM RIGID INSULATION TAKEN 600MM INTO THE BUILDING PERIMETER • COMPACTED GRANULAR BASE PER STRUCTURAL	MIN R15
	FL-1a	NEW SLAB BELOW GRADE • REINFORCED CONCRETE FLOOR SLAB PER STRUCTURAL • WATERPROOF MEMBRANE • 75MM RIGID INSULATION TAKEN 600MM INTO THE BUILDING PERIMETER • 50MM COMPACTED GRANULAR BASE PER STRUCTURAL • 100MM OF 19MM CLEARSTONE • BEDROCK	
	FL-2	NEW INFILL FLOOR • REINFORCED POURED CONCRETE; REFER TO STRUCTURAL FOR THICKNESS	AT MAIN FLOOR LEVEL
	FL-3	NEW RECESSED FLOOR • REMOVABLE FLOOR PANELS & RAISED FLOOR SYSTEM – N.I.C • REINFORCED LOWER CONCRETE FLOOR SLAB– REFER TO STRUCTURAL	AT FLEXIBLE CABIN LABORATORY
	FL-4	• SELF LEVELLING CONCRETE TOPPING/FLOOR UNDERLAYMENT ON EXISTING BASIN FLOOR – REFER TO 03 54 16 (MIN 3mm THK)	AT LOWER FLOOR

ROOF TYPES

GRAPHICS (N.T.S.)	TYPE	CONSTRUCTION	NOTES
	R-1	NEW ROOF STRUCTURE • 2-PLY MOD-BIT ROOFING SYSTEM • 13mm PROTECTION BOARD • POLYISO INSULATION; MIN 2% GRADIENT, MIN 150mm THK (USE TAPERED INSULATION AS NECESSARY FOR CRICKETS/ROOF SLOPE) • VAPOUR BARRIER MEMBRANE • REINFORCED POURED CONCRETE ROOF SLAB/ CONCRETE ON STEEL DECK; REFER TO STRUCTURAL	MIN R30
	R-2	EXISTING ROOF STRUCTURE • 2-PLY MOD-BIT ROOFING SYSTEM • 13mm PROTECTION BOARD • SLOPED RIGID INSULATION; MIN 50mm AT LOW POINTS • VAPOUR BARRIER MEMBRANE • EXISTING CONCRETE ROOF SLAB	EXISTING ROOF BUILD UP TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION

NAME PROJECT- NRC CABIN COMFORT FIRE AND LIFE SAFETY AUDIT			
ITEM	2010 NATIONAL BUILDING CODE DATA MATRIX		NBC Reference References are to Division B unless noted (A) for Division A or (C) for Division C.
			NBC xfun 3
1	PROJECT DESCRIPTION: EXISTING BUILDING ADDITION & RENOVATION		1.1.2.[A]
2	MAJOR OCCUPANCY - BUSINESS & PERSONAL USE, SECONDARY: INDUSTRIAL		3.2.2.58/3.2.2.81
3	BUILDING AREA (m2)	Existing: 1908m2 Renovated plus addition: 884m2 Total: 2792 m2	1.4.1.2. [A]
4	NUMBER OF STOREYS Above grade: 1 Below grade: 1		1.4.1.2. [A] & 3.2.1.1.
5	NUMBER OF STREETS/ FIRE FIGHTER ACCESS: ONE REQUIRED ADJACENT TO THE PRINCIPAL ENTRANCE. FIRE DEPARTMENT ACCESS ROUTE IS PROVIDED AT THE SOUTH SIDE OF THE BUILDING		3.2.2.10. & 3.2.5.
6	BUILDING CLASSIFICATION -MAJOR GROUP D- BUSINESS& PERSONAL USE,UP TO 3 STOREYS; SECONDARY: GROUP F - DIVISION 3, UP TO FOUR STOREYS		3.2.2.58. Building area less than 3000m2, faces 2 streets 3.2.2.81. Building area less than 3000m2, faces 2 streets
7	SPRINKLER SYSTEM: THE BUILDING IS NOT SPRINKLERED		3.2.2.58/3.2.2.81
8	FIRE ALARM: THE BUILDING IS PROVIDED WITH A FIRE ALARM		3.2.4. This will be extended to cover the new additions
9	WATER SERVICE/SUPPLY. THE EXISTING BUILDING IS ON THE MUNICIPAL SUPPLY		3.2.5.7
10	HIGH BUILDING: THE BUILDING HEIGHT(AS PER NBC REQUIREMENT) IS LESS THAN 36m, NEW ADDITIONS ARE NOT CONSIDERED A HIGH BUILDING		3.2.6.
11	CONSTRUCTION RESTRICTIONS: REQUIRED TO BE OF COMBUSTIBLE /NONCOMBUSTIBLE CONSTRUCTION		3.2.2.58/3.2.2.81
12 13	OCCUPANT LOAD BASED ON NBC Lower Floor Occupancy: D/F Main Floor Total	m2/person Load: 21 persons Load: 106 persons Load: 127 persons	3.1.17.1.
14	REQUIRED FIRE RESISTANCE RATING (FRR)	Horizontal Assemblies FRR (Minutes) Floor shall be fire separations and require 45 minutes FRR if combustible Mezzanines 45 minutes if combustible Roof 45 minutes if combustible Supporting Members 45 minutes if combustible and supporting a FR assembly	3.2.2.58/3.2.2.81
15	SPATIAL SEPARATION- CONSTRUCTION OF EXTERIOR WALLS		3.2.3.

Wall	Area of EBF (m2)	L.D (m)	Permitted Max.% of Openings	Proposed % of Openings	FRR (Hours)	Type of Cladding required	Type of Construction req'd
North	approx 108m2	50m min approx to c/l of road	100%	37%	N/A	Combustible/ Non combustible	Combustible/ Non combustible
South	approx 50m2	N/A to ex. building only	N/A	22%	N/A	Combustible/ Non combustible	Combustible/ Non combustible
East	approx 444m2	25m min approx to c/l of road	100%	14%	N/A	Combustible/ Non combustible	Combustible/ Non combustible
West	(11.5m2 - new add) approx 493m2	(1.9m min - new add) 4.8m approx to c/l of alley	14% (new add) 18%	0 (new add) 3.6% (INC. ex windows)	1 hr	Non combustible	Combustible/ Non combustible

Note: Area of EBF includes existing building EBF aswell as new additions.

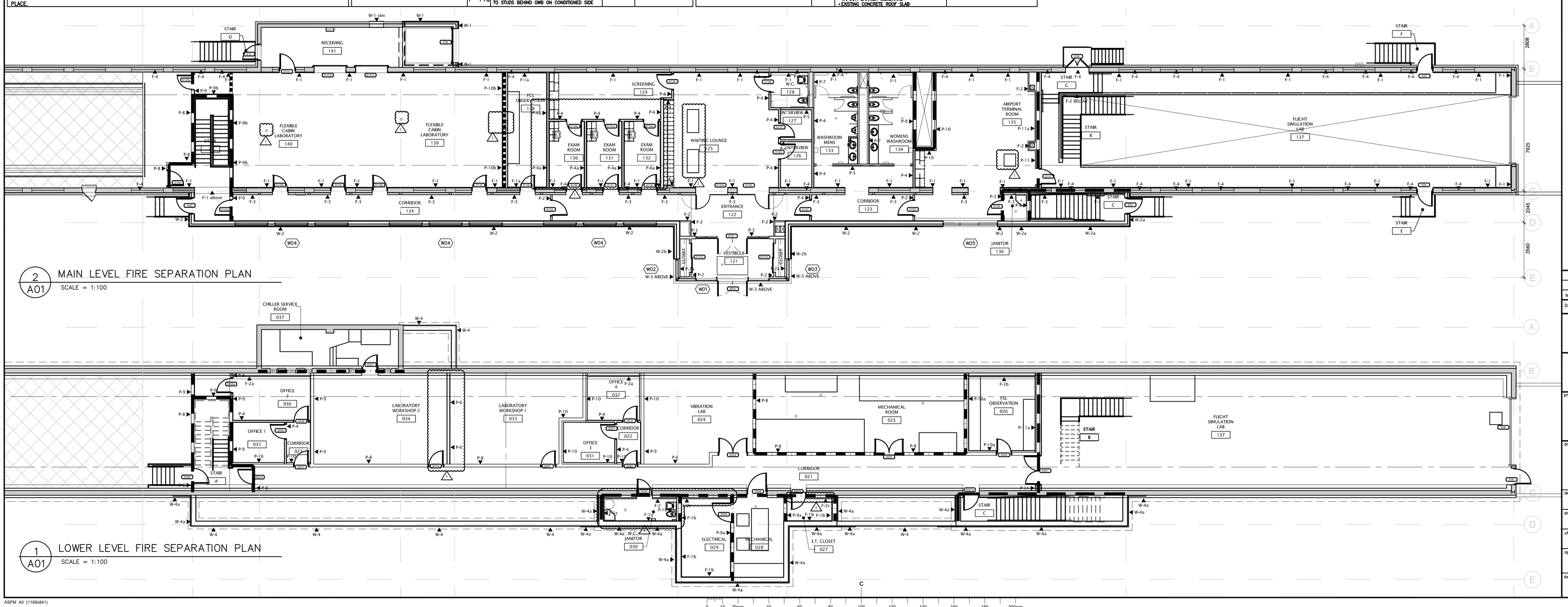
FIRE RESISTANCE RATING

1HR RATING
45 MIN RATING (BLOCK INFILL BETWEEN MAIN FL. & RECESSED FLOOR) SEE ALSO 10/A06 FOR SECTION

FIRE RATING
Floor shall be a fire separation, and requires 45 minutes if combustible
Mezzanines 45 minutes if combustible
Roof 45 minutes if combustible
Supporting Members
45 minutes if combustible or supporting a FR assembly

* NOTE:
ALL DOORS AND FRAMES BETWEEN RATED WALLS TO BE LABELLED TO IDENTIFY THE TESTING LABORATORY & INSTALLED IN CONFORMANCE WITH NFPA 80

All junctions between fire rated walls and other parts of the building to maintain the fire resistance of the fire rated wall.
Openings and service penetrations through these walls/ floors to be kept to a minimum.
Appropriate Fire-stopping to be applied to close any imperfection of fit or design tolerance between construction elements and components, service openings and ventilation ducts.
Building elements should not be built into, carried through or across the ends of, or over the top of a fire rated wall in such a way as to impair the fire resistance between relevant parts of the building.
The continuity of a *fire separation* shall be maintained where it abuts another fire separation, a floor, a ceiling, or an exterior wall assembly.



2 A01 MAIN LEVEL FIRE SEPARATION PLAN
SCALE = 1:100

1 A01 LOWER LEVEL FIRE SEPARATION PLAN
SCALE = 1:100

ASPM A0 (1189x841)

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GENERAL NOTES

- CONTRACTORS TO CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO DEMOLITION OR CONSTRUCTION AND REPORT ANY ERRORS OR OMISSIONS TO DEPARTMENTAL REPRESENTATIVE.
- CONTRACTORS MUST VISIT THE SITE & FULLY FAMILIARIZE THEMSELVES WITH THE SCOPE OF THE WORK.
- PREVENT THE SPREAD OF DUST & DEBRIS BEYOND THE WORK AREA AND CLEAN ALL SURFACES AT COMPLETION.
- MAKE GOOD ALL SURFACES AFFECTED BY THIS WORK.
- COORDINATE ALL SHUTDOWNS WITH THE DEPARTMENTAL REPRESENTATIVE.
- PROVIDE ALL LABOUR AND MATERIAL REQUIRED TO FORM A COMPLETE, FUNCTIONAL SYSTEM AS DESCRIBED ON DRAWINGS.

LEGEND :

AREA N.I.C.

EXISTING BUILDING ELEMENT

NORR
ARCHITECTS ENGINEERS PLANNERS
NORR Limited
An Ingenium Group Company

No.	Date	Revision	By/ Par.
1	10 07 2015	ISSUED FOR ADDENDUM # 3	SD
0	29 05 2015	ISSUED FOR TENDER	SD

Date Printed / Date imprimée

- Verify all dimensions and site conditions and be responsible for same
- Vérifier toutes les dimensions et l'etat des lieux et en assumer la responsabilité

A Detail no. No. du détail
B Location drawing no. sur dessin no.
C Drawing no. dessin no.

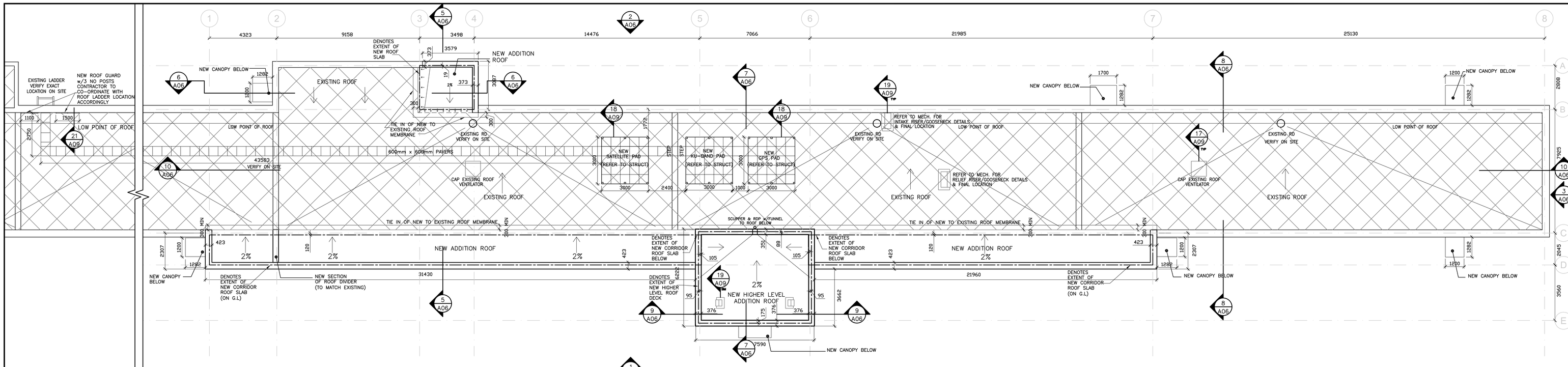
project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

MONTREAL ROAD CAMPUS

drawing / dessin
ASSEMBLIES & FIRE SEPARATION PLANS

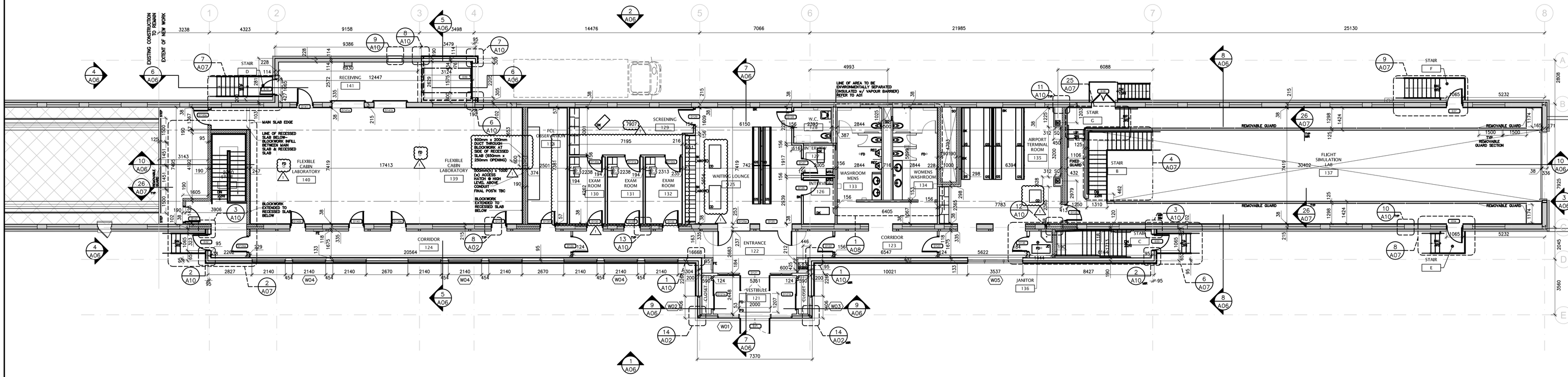
designed / conçu	S.DUNDERDALE	date	MAY '15
drawn / dessiné	S.DUNDERDALE	scale / échelle	1100
checked / vérifié	J.HUGHES	sheet / feuille	A01 of/de 14
approved / approuvé		W.O.no.	D.T.no.

dwg.no. / dessin no.
3788-A01



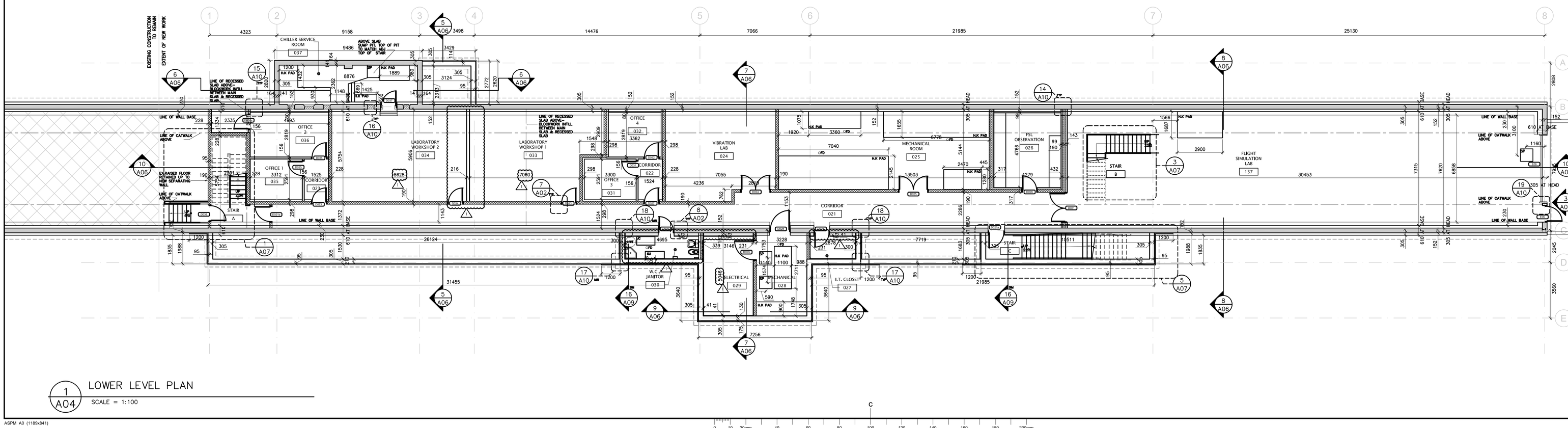
3 A04 ROOF PLAN

SCALE = 1:100



2 A04 MAIN LEVEL PLAN

SCALE = 1:100



1 A04 LOWER LEVEL PLAN

SCALE = 1:100

ASPM A0 (1189x841)

0 10 20mm 40 60 80 100 120 140 160 180 200mm

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NRC · CNRC

GENERAL NOTES

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- PREVENT THE SPREAD OF DUST & DEBRIS BEYOND THE WORK AREA AND CLEAN ALL SURFACES AT COMPLETION.
- MAKE GOOD ALL SURFACES AFFECTED BY THIS WORK. FOR CUTTING AND PATCHING IN OTHER AREAS OF THE EXISTING BUILDING IN RELATION TO ELECTRICAL/MECHANICAL TIE INS – PLEASE REFER TO M/E SERIES DRAWINGS.
- COORDINATE ALL SHUTDOWNS WITH THE DEPARTMENTAL REPRESENTATIVE.
- PROVIDE ALL LABOUR AND MATERIAL REQUIRED TO FORM A COMPLETE, FUNCTIONAL SYSTEM AS DESCRIBED ON DRAWINGS.
- FOR INTERNAL DRAINAGE, HEATING & VENTILATION REFER TO MECHANICAL. FOR STEELWORK/CONCRETE/SLABS/ FOUNDATIONS/REINFORCEMENT/LOAD BEARING PARTITIONS/ LINTELS & ALL STRUCTURAL ELEMENTS – REFER TO STRUCTURAL. FOR INTERNAL/EXTERNAL LIGHTING, POWER, FIRE ALARM, COMMS ETC REFER TO ELECTRICAL.
- CONTRACTOR TO ENSURE FULL CO-ORDINATION WITH MECHANICAL DUCT/SUMP PIT LOCATIONS, SIZES & TOLERANCES PRIOR TO FORMING ANY SLAB OPENINGS IN EXISTING /NEW ELEMENTS. CONTRACTOR TO ENSURE FULL CO-ORDINATION WITH MECH EQUIPMENT PRIOR TO FORMING HK PADS/ ROOFTOP CURBS. (ALL DIMS SHOWN ARE NOMINAL).

FLOOR PLANS

- ALL EXTERNAL DIMENSIONS TAKEN TO WINDOW/DOOR FRAMES & OUTSIDE EDGE OF STRUCTURAL CONCRETE/BLOCK WALLS
- ALL INTERNAL DIMENSIONS TAKEN TO OUTSIDE EDGE OF PARTITION/CWS
- ALL EXISTING BUILDING DIMENSIONS ARE APPROXIMATED ONLY AND TO BE VERIFIED ON SITE PRIOR TO COMMENCING WORKS
- REFER TO A05 FOR EXISTING BUILDING DEMOLITIONS.

ROOF PLANS

- EXACT ROOF BUILD UP; ROOF DRAIN, LADDER, VENTILATOR & OWSJ POSITIONS TO BE VERIFIED ON SITE PRIOR TO COMMENCING WORKS. CONTRACTOR TO ENSURE FINAL CO-ORDINATION BETWEEN PROPOSED OPENINGS & EXISTING ELEMENTS.
- CONTRACTOR TO ENSURE ALL PROPOSED ROOFING (MIN 2% GRADIENT) TIES IN WITH EXISTING & ALL SECTIONS ARE FULLY CO-ORDINATED WITH NO LARGE LEVEL DIFFERENCES BETWEEN AREAS.

LEGEND :

- AREA N.I.C.
- EXISTING BUILDING ELEMENT
- BLOCK/ CONCRETE INFILL – REFER TO A05 FOR FULL DETAILS

BK	19mm PLYWOOD BACKING RQ'D FOR TV MOUNTING. APPROX. 1M X 2M. MOUNTING HEIGHT & FINAL POSITION TBC BY CLIENT.
CD	CHECK IN TYPE DESK
DK	DESK
FD	FLOOR DRAIN
FE	FIRE EXTINGUISHER (RECESSED/SEMI RECESSED ONLY – FOR ALL OTHERS REFER TO MECH)
FG	RECESSED FLOOR GRILLE
GS	GANGED SEATING
H.K PAD	100mm THK CONCRETE HOUSE KEEPING PAD REFER TO MECH & STRUCT DETAIL TDC-18
HWT	HOT WATER TANK
JC	JANITORS CART
MSU	MOBILE STORAGE UNIT
REC	RECESS IN FLOOR SLAB FOR URINAL – REFER TO MANUFACTURERS DETAILS
RD	ROOF DRAIN
RDP	ROOF DRAIN PIPE
SO	SLAB OPENING
SP	SUMP PIT
SU	SHELVING UNIT

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No.	Date	Revision	By / Par
1	10 07 2015	ISSUED FOR ADDENDUM # 3	SD
0	29 05 2015	ISSUED FOR TENDER	SD

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project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY
MONTREAL ROAD CAMPUS

drawing / dessin
ROOF PLAN
MAIN LEVEL PLAN
LOWER LEVEL PLAN

designed / conçu	S.DUNDERDALE	date	MAY '15
drawn / dessiné	S.DUNDERDALE	scale / échelle	1:100
checked / vérifié	J.HUGHES	sheet / de / feuille	A04 of/de 14
approved / approuvé		W.O.no.	D.T.no.

dwg.no. / dessin no.
3788-A04

ABBREVIATIONS

PLUMBING/ FIRE PROTECTION

DESIGNATION	SERVICE
B	BATH
BD	BIDET
BFP	BACKFLOW PREVENTER
BMS	BUILDING MANAGEMENT SYSTEM
BOP	BOTTOM OF PIPE
CB	CATCH BASIN
CO	CLEAN OUT
CS	CUP SINK
CTE	CONNECT TO EXISTING
C/W	COMPLETE WITH
DCW	DOMESTIC COLD WATER
DHW	DOMESTIC HOT WATER
DHWR	DOMESTIC HOT WATER RECIRCULATION
DF	DRINKING FOUNTAIN
DN	DOWN
DPAV	DRY PIPE ALARM VALVE
DTW	DOMESTIC TEMPERED WATER
ELEV.	ELEVATION
ESH	EMERGENCY SHOWER
EEW	EMERGENCY EYE WASH
FA	FROM ABOVE
FB	FROM BELOW
FD	FLOOR DRAIN
FFD	FUNNEL FLOOR DRAIN
FS	WATER FLOW SWITCH
FE	FIRE EXTINGUISHER
HB	HOSE BIBB
HD	HUB DRAIN
INV.	INVERT
JS	JANITOR SINK
L	LAVATORY
LS	LABORATORY SINK
MH	MAINTENANCE HOLE
MS	MOP SINK
NPWH	NON FREEZE WALL HYDRANT
NIC	NOT IN CONTRACT
NPW	NON POTABLE WATER
PIV	POST INDICATOR VALVE
RD	ROOF DRAIN
RWL	RAIN WATER LEADER
S	SINK
SV	SUPERVISED VALVE
SFCV	SPRINKLER FLOOR CONTROL VALVE
SH	SHOWER
SS	SERVICE SINK
SST	SOIL STACK
STV	STACK VENT
TA	TO ABOVE
TB	TO BELOW
THB	THRUST BLOCK
T.O.P.	TOP OF PIPE
U	URINAL
U/C	UNDER CUT
V	VENT PIPE
VPTR	VENT PIPE THROUGH ROOF
VST	VENT STACK

ABBREVIATIONS

DESIGNATION	SERVICE
WC	WATER CLOSET
WM	WATER METER
WST	WASTE STACK
WFS	WATER FLOW SWITCH
WPAV	WET PIPE ALARM VALVE

HEATING

BBH	BASEBOARD HEATER
CBV	CIRCUIT BALANCING VALVE
CH	CABINET HEATER
COND.	CONDENSATE
FC	FAN COIL UNIT
HC	HEATING COIL
HWR	HEATING WATER RETURN
HWS	HEATING WATER SUPPLY
P	PUMP
PH	PREHEAT COIL
PRV	PRESSURE REDUCING VALVE
UH	UNIT HEATER
VB	VACUUM BREAKER
WF	WALL FIN
WH	WATER HEATER

ABBREVIATIONS

AIR CONDITIONING

DESIGNATION	SERVICE
AC	AIR CONDITIONING UNIT
AD	ACCESS DOOR
AH	AIR HANDLING UNIT
AP	ACCESS PANEL
BD	BALANCING DAMPER
BDD	BACK DRAFT DAMPER
CC	COOLING COIL
DG	DOOR GRILLE
EA	EXHAUST AIR
EF	EXHAUST AIR FAN
EG	EXHAUST AIR GRILLE
ER	EXHAUST AIR REGISTER
FMS	AIR FLOW MEASURING STATION
FSD	FIRE & SMOKE DAMPER
FD	FIRE DAMPER
FSF	FIRE STOP FLAP
GC	GLYCOL COIL
MAU	MAKEUP AIR UNIT
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
RA	RETURN AIR
RF	RETURN AIR FAN
RG	RETURN AIR GRILLE
RH	REHEAT COIL
RR	RETURN AIR REGISTER
SA	SUPPLY AIR
SD	SPLITTER DAMPER
SF	SUPPLY AIR FAN
SMD	SMOKE DAMPER
SR	SUPPLY AIR REGISTER
VAV	VARIABLE VOLUME BOX
VD	VOLUME DAMPER
WMS	WIREMESH SCREEN

CONTROLS

AI	ANALOG INPUT
AO	ANALOG OUTPUT
BI	BINARY INPUT
BO	BINARY OUTPUT

PLUMBING LEGEND

DESIGNATION	SERVICE
CA	COMPRESSED AIR
	DOMESTIC COLD WATER
	DOMESTIC HOT WATER
	DOMESTIC HOT WATER RECIRCULATION
D	DRAIN
PD	PUMPED DRAIN
SAN	SANITARY ABOVE GRADE OR FLOOR
SAN	SANITARY BELOW GRADE OR FLOOR
ST	STORM ABOVE GRADE OR FLOOR
ST	STORM BELOW GRADE OR FLOOR
V	VENT
VAC	VACUUM
WV	WET VACUUM LINE

HYDRONIC LEGEND

DESIGNATION	SERVICE
BHSS	BUILDING HEATING SYSTEM SUPPLY
BHSR	BUILDING HEATING SYSTEM RETURN
BCSS	BUILDING COOLING SYSTEM SUPPLY
BCSR	BUILDING COOLING SYSTEM RETURN
C	CONDENSATE
C###	CONDENSATE PRESSURE ###kPa
CS	CONDENSER WATER SUPPLY
CR	CONDENSER WATER RETURN
	DIRECTION OF WATER FLOW
HPS	HIGH PRESSURE STEAM
LPS	LOW PRESSURE STEAM
LPC	LOW PRESSURE CONDENSATE
PCSS	PROCESS COOLING SYSTEM SUPPLY
PCSR	PROCESS COOLING SYSTEM RETURN
PC	PUMPED CONDENSATE
S	STEAM
S###	STEAM PRESSURE ###kPa
RS	REFRIGERATION SUCTION
RL	REFRIGERATION LIQUID
RHG	REFRIGERATION HOT GAS

SYMBOLS

DESIGNATION	SERVICE
	2-WAY CONTROL VALVE
	3-WAY CONTROL VALVE
	ANCHOR POINT
AAV	AUTOMATIC AIR VENT
BWV	BACK WATER VALVE (FOR SEWAGE)
	BALL VALVE
FT	FLOAT AND THERMOSTATIC STEAM TRAP
	INVERTED BUCKET TYPE STEAM TRAP
	BUTTERFLY VALVE
	BUTTERFLY VALVE
CBV	CIRCUIT BALANCING VALVE
	CHECK VALVE
	CONCENTRIC FITTING
	ECCENTRIC FITTING
	ELECTRIC VALVE OR DAMPER ACTUATOR
	EXPANSION JOINT
	FLOAT LEVEL CONTROL VALVE
FD	FLOOR DRAIN
	F & T TYPE STEAM TRAP
	FLOAT LEVEL SWITCH
	GATE VALVE
	GLOBE VALVE
	LOCKSHIELD VALVE
	OS&Y VALVE
	PLUG VALVE
	PRESSURE REDUCING VALVE
PG	PRESSURE GAUGE WITH GAUGE COCK
	PIPE DN
	PIPE UP
	PIPE SLEEVED THROUGH BEAM
	RELIEF VALVE
RD / RWC	ROOF DRAIN OR PLUMBING FIXTURE ON LEVEL ABOVE
	SOLENOID VALVE
	STRAINER
	THERMOMETER
	UNION
VB	VACUUM BREAKER
	VALVE ACTUATOR (PNEUMATIC OR ELECTRIC)
	STEAM MOISTURE SEPARATOR

SYMBOLS

DESIGNATION	SERVICE
A	AIR SAMPLING SENSOR
	BALL DRIP
BFP	BACKFLOW PREVENTOR (REDUCED PRESSURE TYPE)
CO	CLEANOUT TURNED UP THROUGH FLOOR
CO	CLEANOUT ABOVE GRADE OR FLOOR
TX	CONTROL TRANSFORMER AND LOW V WIRE
	EQUIPMENT SWITCH
H	HUMIDISTAT OR HUMIDITY SENSOR
HB	HOSE BIBB
	HOSE END DRAIN VALVE
	EXPANSION JOINT
P	PRESSURE SWITCH
FE	PORTABLE FIRE EXTINGUISHER
	PUMP
	UNIT HEATER HORIZONTAL
	UNIT HEATER DOWNBLAST
	PIPE GUIDE
	PIPE ANCHOR
	RETURN OR EXHAUST DUCT UP
	RETURN OR EXHAUST DUCT DN
	SUPPLY DUCT UP
	SUPPLY DUCT DN
T	THERMOSTAT ON INSULATION
T	THERMOSTAT OR TEMPERATURE SENSOR
TC	TEST COCK
FS	WATER FLOW SWITCH
	WET VACUUM OUTLET
M	STEAM METER
1	

SYMBOLS

DESIGNATION	SERVICE
	ACOUSTICAL DUCT LINING
	APPARATUS HUNG FROM STRUCTURE ABOVE
BD	BACKDRAFT DAMPER
BD	BALANCING DAMPER
BT	BUBBLE TIGHT DUCT
CAV	CONSTANT VOLUME BOX
	DIFFUSER/REGISTER TYPE
	NECK SIZE
	ABFLOW
CAP	DUCT CAPPED CONNECTION
	DUCT SILENCER
D	DROP IN DUCT
E	EQUIPMENT TAG (REFER TO SCHEDULES)
	EQUIPMENT NUMBER
	FAN
	FAN POWERED VAV BOX C/W SILENCER
FD	FIRE DAMPER
	FLEXIBLE DUCT CONNECTION
	FLEXIBLE PIPE/DUCT
C H	HEATING OR COOLING COIL
	MOTORIZED OPPOSED BLADE CONTROL DAMPER
	BUBBLE TIGHT DAMPER
	OPEN ENDED DUCT WITH WIRE MESH SCREEN
	POINT TYPE
	CONTROLLED PARAMETER
	RADIATION OR WALL-FIN HEATER TYPE
	HEATER LENGTH
	HEATING CAPACITY
R	RISE IN DUCT
	RETURN OR EXHAUST AIR GRILLE OR REGISTER
	SUPPLY AIR LINEAR SLOT PLENUM AND DIFFUSER
	SUPPLY AIR DIFFUSERS
	TURNING VANES
VD	VOLUME DAMPER
	VAV BOX C/W SILENCER
	VAV BYPASS
	VAV BOX
	WALL PROPELLER FAN
	DUCT SPOOL PIECE

DEMOLITION LEGEND

DESIGNATION	SERVICE
	REMOVE EXISTING PIPE
	REMOVE EQUIPMENT
	REMOVE EXISTING DUCT
	REMOVE EXIST. GRILLE/DIFFUSER

GENERAL NOTES

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ASPM A0 (1189x841)

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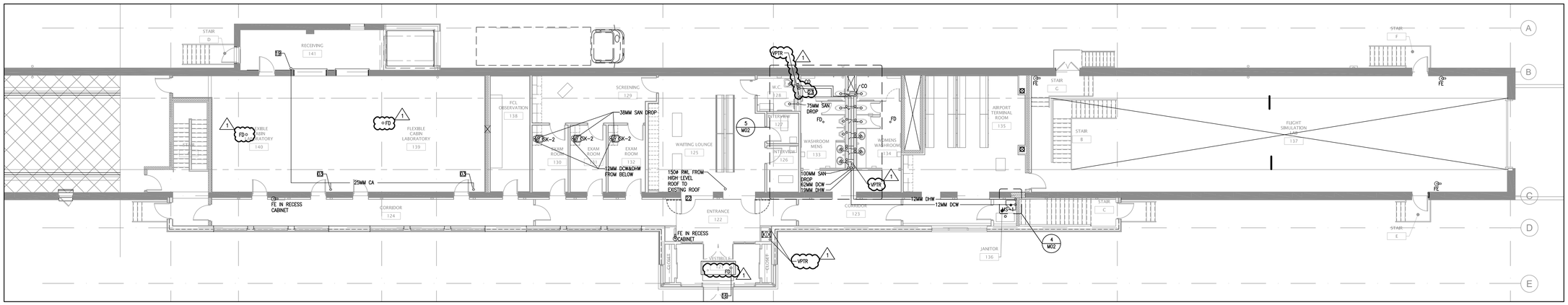
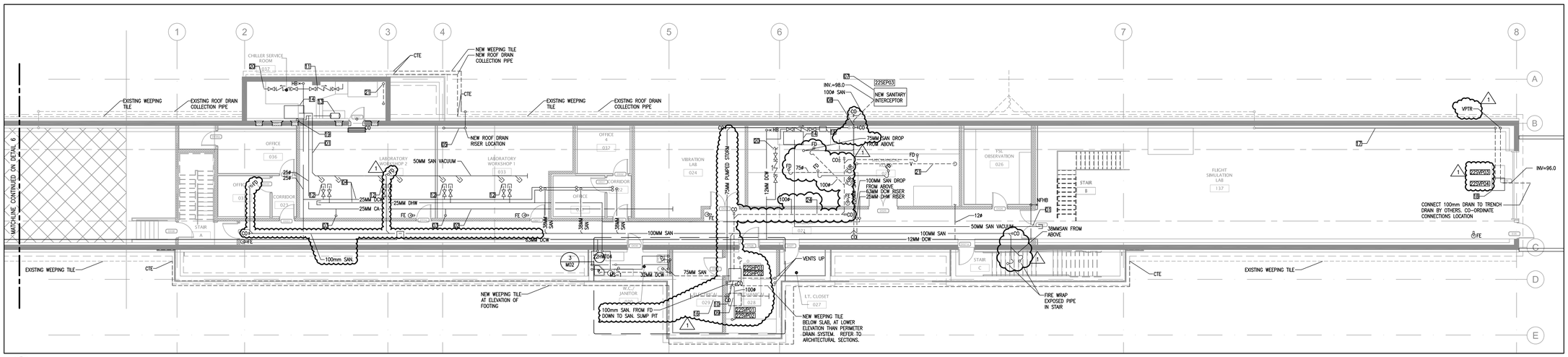


1 M02 UPPER LEVEL PLUMBING

SCALE = 1:100



2 M02 LOWER LEVEL PLUMBING

SCALE = 1:100

GENERAL NOTES:

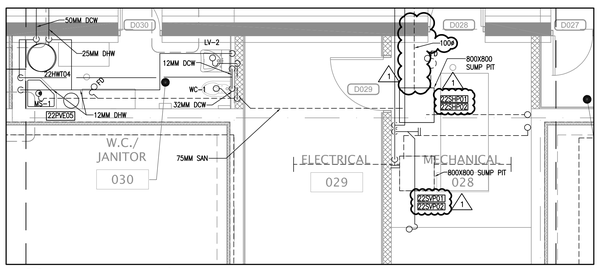
1. PLUMBING VENTING NOT COMPLETELY SHOWN. PROVIDE VENTING IN ACCORDANCE WITH PART 7 OF THE OBC.
2. PROVIDE SHUT OFF VALVES AT ALL FIXTURE SUPPLY CONNECTIONS.
3. INSULATE ALL SUPPLY DUCT, DHW, DHWR PIPING IN ACCORDANCE WITH SPECIFICATIONS.
4. COORDINATE SYSTEM SHUTDOWN FOR PLUMBING TIE-INS WITH OWNER.
5. RUNOUTS TO FIXTURES TO MATCH PIPE SIZES ON PLUMBING FIXTURE CONNECTION SCHEDULE.
6. ALL FLOOR DRAINS TO BE COMPLETE WITH TRAP SEAL PRIMERS.

DRAWING NOTES:

- D1 VACUUM SANITARY FROM AIRCRAFT LAVATORIES
- D2 COMPRESSED AIR MAIN IN RECESSED FLOOR OF FCL FOR MOVING FLOOR SYSTEM
- A1 12# COMPRESSED AIR DROP TO QUICK CONNECT ON WORKSHOP WALL WITH 150MM DIRT LEG WITH VALVE.
- C4 25# DCW AND DHW IN RECESSED FLOOR OF FCL FOR AIRCRAFT LAVATORY
- V2 OFFSET EXISTING ROOF DRAIN RISER IN CEILING SPACE OF UPPER LEVEL AND CONNECT TO NEW ROOF DRAIN RISER.
- X3 NOT USED.
- V7 NEW SANITARY INTERCEPTOR BELOW GRADE.
- X5 CORE THROUGH EXISTING 600MM THICK BUILDING FOUNDATION WALL. SEAL PENETRATIONS AROUND PIPE WATERTIGHT.
- V3 800X800X1030MM DEEP WEEPING TILE SUMP PIT C/W CHECKERPLATE COVER AND GASKET. VENT AND DISCHARGE PIPE TO OFFSET UNDERNEATH SLAB TO WALL.
- V4 800X800X925MM DEEP SANITARY SUMP PIT C/W CHECKERPLATE COVER AND GASKET. VENT AND DISCHARGE PIPING TO OFFSET UNDER SLAB TO WALL.
- E1 25# DCW MAKEUP TO PIPING SYSTEMS.
- F2 BALL VALVES AND THREADED HOSE ENDS W/ END CAP AND CHAIN FOR LABORATORY USE. EACH ROUGH-IN TO BE COMPLETE WITH TWO 50MM SANITARY VACUUM, A 19MM DCW AND 19MM DHW CAPPED CONNECTION.
- A3 COMPRESSED AIR RECEIVER, MOTORS, DRYER.
- F4 SANITARY VACUUM WASTE RECEIVER. RECEIVER PROVIDED BY NRC. CONTRACTOR TO INSTALL TANK AND VACUUM ACCESSORIES AND SERVICE CONNECTIONS INCLUDING DRAIN, WATER AND VACUUM WASTE PIPING. ALLOW SPACE FOR FUTURE SECOND RECEIVER.
- E5 ELECTRIC HUMIDIFIER.
- F6 BOOT CLEANER; REFER TO ARCHITECTURAL DRAWINGS FOR DETAILS.
- D7 PROVIDE HEAT TRACING OF ENTIRE SANITARY PIPE RUN. INSULATE PIPING.
- F8 800X800X1225 DEEP TRENCH DRAIN SUMP PIT C/W CHECKERPLATE COVER AND GASKET. DISCHARGE PIPING TO OFFSET IN SLAB TO WALL. VENT UP THROUGH ROOF.
- V9 25MM# COMPRESSED AIR RISER
- C9 25# DCW MAKEUP TO HYDRONIC SYSTEM
- E9 75# CONDENSATE RECEIVER VNET UP THROUGH ROOF.
- P2 CONNECT DRAIN FROM HIGH ROOF AND PROVIDE CONCRETE PAVER SPLASH ON LOW ROOF.
- C3 PROVIDE ACCESS HATCH FOR PLUMBING CLEANOUT INSIDE PIPING CHASE.
- C8 UNDERGROUND BURIED SANITARY PIPE TO CONNECT TO 800x800 SANITARY SUMP PIT.
- E5 SITE VERIFY EXACT LOCATION AND CONNECTION OF EX. DCW MAIN.

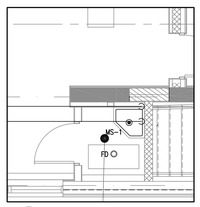
PLUMBING FIXTURE CONNECTION SCHEDULE

TAG	DCW	DHW	SAN	VENT
WC	25	—	75	38
LAV	12	12	32	32
SK	12	12	38	32
UR	19	—	38	32
MS	12	12	75	38



3 M02 LOWER LEVEL W/C

SCALE = 1:50



4 M02 UPPER LEVEL JANITOR'S CLOSET

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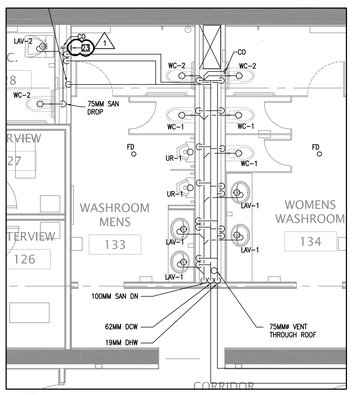

5 M02 UPPER LEVEL W/C

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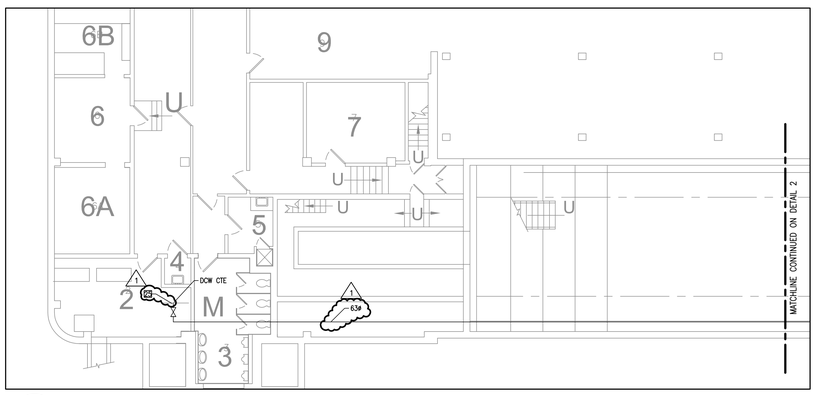

6 M02 DCW CONNECTION

SCALE = 1:100

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MONTREAL ROAD CAMPUS

drawing / dessin
PLUMBING LAYOUT

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3788-M02

ASPM A0 (1189x841)

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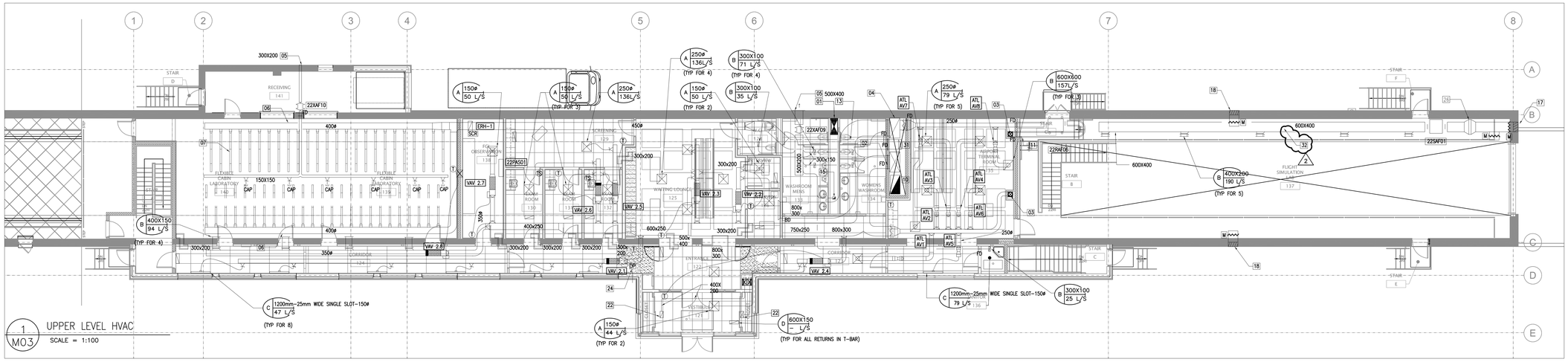
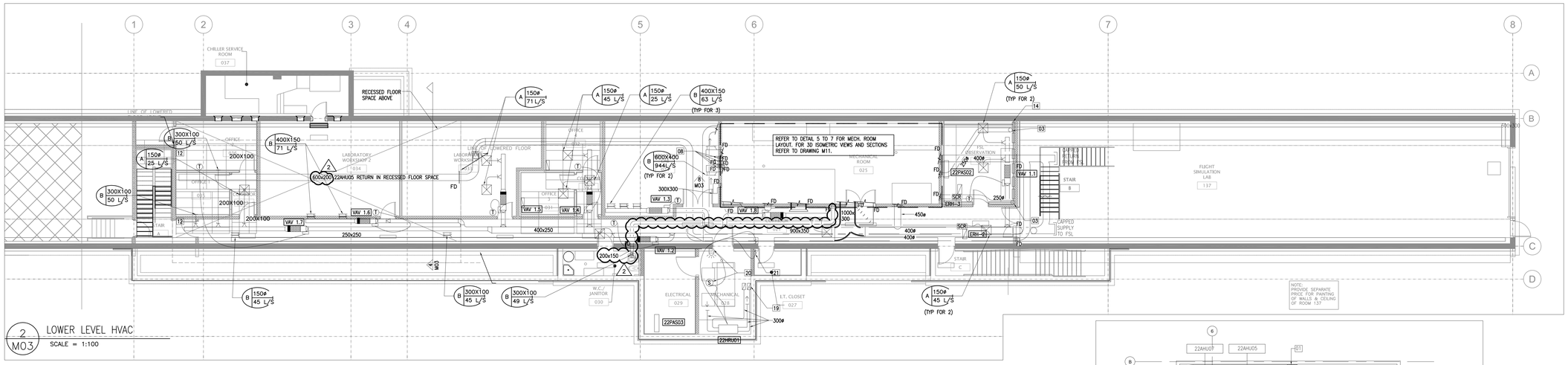


1 MO3 UPPER LEVEL HVAC
SCALE = 1:100



2 MO3 LOWER LEVEL HVAC
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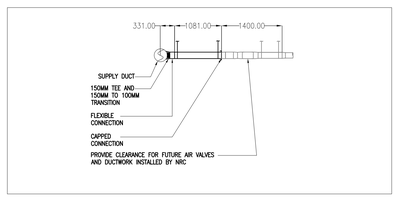

3 MO3 FLEXIBLE CABIN LAB AIR VALVE INSTALLATION
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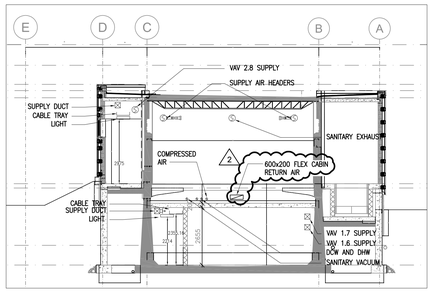

4 MO3 FLEXIBLE CABIN LAB SECTION
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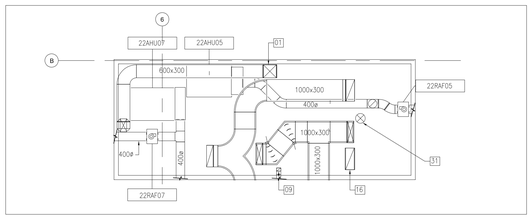

5 MO3 MECH. ROOM 025 LAYOUT (HIGHEST ELEVATION)
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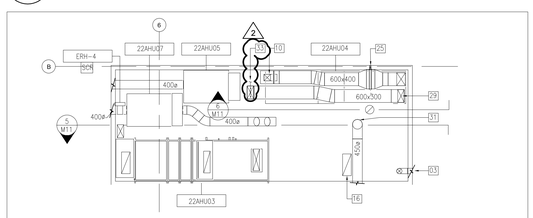

6 MO3 MECH. ROOM 025 LAYOUT (MIDDLE ELEVATION)
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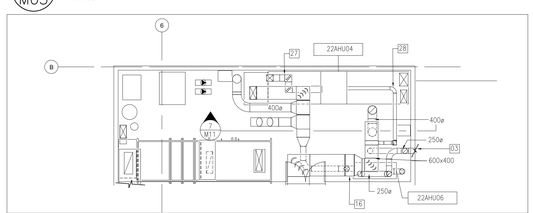

7 MO3 MECH. ROOM 025 LAYOUT (LOWEST ELEVATION)
SCALE = 1:100

MECHANICAL GENERAL NOTES:

01 DUCT RUNOUTS TO DIFFUSERS TO BE SAME SIZE AS DIFFUSER NECK SIZE
02 MAXIMUM LENGTH OF FLEXIBLE DUCTWORK TO BE 1M.
03 VAV INLET DUCTWORK SHALL ONE BIGGER THAN THE INLET SIZE OF BOX AS INDICATED ON SCHEDULE ON DWG M08.

MECHANICAL PLAN NOTES:

01 OUTDOOR AIR RISER TRANSITIONING TO 1000X400 THROUGH WASHROOM CHASE AND UP THROUGH ROOF C/W GOOSENECK AND BIRDSCREEN. C/W FIRE DAMPER AT FLOOR.
02 1000X400 BUILDING SUPPLY AIR RISER
03 AIRPORT TERMINAL LAB DUCT RISER COMPLETE WITH FIRE DAMPERS.
04 1000X400 BUILDING RETURN DUCT RISER
05 EXHAUST AIR LOUVRE AND 300MM DEEP PLENUM WITH INSULATED ISOLATION DAMPER.
06 400Ø DUCT HEADER WITH 100Ø CAPPED TEES AT 300MM CENTRES. EAST AND WEST AIR VALVES TO BE OFFSET.
07 AIR VALVES FOR FLEXIBLE CABIN SETUP. REFER TO DETAIL 3/MO3
08 100Ø SUPPLY RIGID DUCT SLEEVES AND FIRE DAMPERS FOR OWNER SUPPLIED BLOWERS. DUCT SLEEVES AT FLOOR LEVEL.
09 200x150 EXHAUST DUCT UP
10 EXHAUST DUCT THROUGH ROOF. PROVIDE GOOSENECK WITH BIRDSCREEN.
11 PROVIDE EXTERNAL THERMAL INSULATION.
12 DUCT INTO 300X100 FACE SIDEWALL GRILLE IN SIDE OF BULKHEAD.
13 750X250 SUPPLY AIR DUCT TO RUN BELOW 800x300 RETURN AIR DUCT AT CROSSOVER.
14 PROVIDE SIX RALSTON METAL N1-362407 600X900 BAS CONTROL BINS. COORDINATE WITH ELECTRICAL PANELS ON THIS WALL.
15 EXHAUST DUCT FROM LOWER LEVEL
16 1000X400 EXHAUST AIR DUCT RISER
17 500X400 AIR INTAKE LOUVRES WITH 300 DEEP PLENUMS C/W INSULATED ISOLATION DAMPERS.
18 500X400 EXHAUST AIR LOUVRE WITH 300 DEEP PLENUM C/W INSULATED ISOLATION DAMPER.
19 REFRIGERATION VENTILATION SUPPLY AND EXHAUST UP. PROVIDE FIRE DAMPERS IN SLAB.
20 PROVIDE WALL-MOUNTED REFRIGERANT VAPOUR DETECTOR AND RELAY MODULE TO SOUND AUDIBLE ALARM AND ENGAGE 22HRU01 TO HIGH SPEED AT REFRIGERANT CONCENTRATIONS ABOVE 100PPM
21 PROVIDE READILY ACCESSIBLE INDEPENDENT FAN SWITCHES INSIDE AND OUTSIDE REFRIGERATION EQUIPMENT ROOM CAPABLE OF STARTING BUT NOT STOPPING 22HRU01.
22 400x200 OUTDOOR AIR GOOSENECK WITH BIRDSCREEN AND INSULATED ISOLATION DAMPER HARD WIRE INTERLOCKED WITH HRV-1.
23 22HRU01 TO RUN CONTINUOUSLY AT 1/2 SPEED. REFRIGERANT SENSOR SIGNAL OR LOCAL SWITCH TO ENGAGE HRV TO HIGH SPEED.
24 BUILDING DIFFERENTIAL PRESSURE SENSOR
25 STEAM PREHEAT COIL FOR 22AHU04 IN DUCT ABOVE UNIT. REFER TO DUCT HEATING COIL SCHEDULE.
26 GLYCOL HEATING COIL FOR 22SAF01. REFER TO DUCT HEATING COIL SCHEDULE.
27 300x300 OUTDOOR AIR DUCT DOWN FROM 600x600 RISER AND CONNECT TO 22AHU04, REACTIVATE AIR INLET.
28 150x200 EXHAUST AIR DUCT FROM 22AHU04 REACTIVE AIR OUTLET TO CONNECT TO 600x400 EXHAUST AIR DUCT.
29 600x300 BYPASS DUCT FROM 22AHU04 SUPPLY PLENUM TO FRESH AIR INTAKE INLET.
30 600x300 SUPPLY DUCT FROM 22AHU04 TO 22AHU05, 06, 07, FRESH AIR INTAKE.
31 450ø SUPPLY AIR RISER UP AND TRANSITIONING TO 750x250 INSIDE MECHANICAL SHAFT.
32 DUCTWORK IN FLIGHT SIMULATION LAB TO BE INSULATED AS PER MECHANICAL SPECIFICATIONS
33 22HUM04 DUCT MOUNTED RAPID ABSORB HUMIDIFIER MANIFOLD

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- MAKE GOOD ALL SURFACES AFFECTED BY THIS WORK.
- COORDINATE ALL SHUTDOWNS WITH THE DEPARTMENTAL REPRESENTATIVE.
- PROVIDE ALL LABOUR AND MATERIAL REQUIRED TO FORM A COMPLETE, FUNCTIONAL SYSTEM AS DESCRIBED ON DRAWINGS.

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KEY PLAN

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project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

MONTREAL ROAD CAMPUS

drawing / dessin
HVAC LAYOUT

designed / conçu	date / date
KC	MAY '15
drawn / dessiné	scale / échelle
ALM	AS SHOWN
checked / vérifié	sheet / feuille
KC	of/de
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dwg.no. / dessin no.
3788-M03

ASPM A0 (1189x841)
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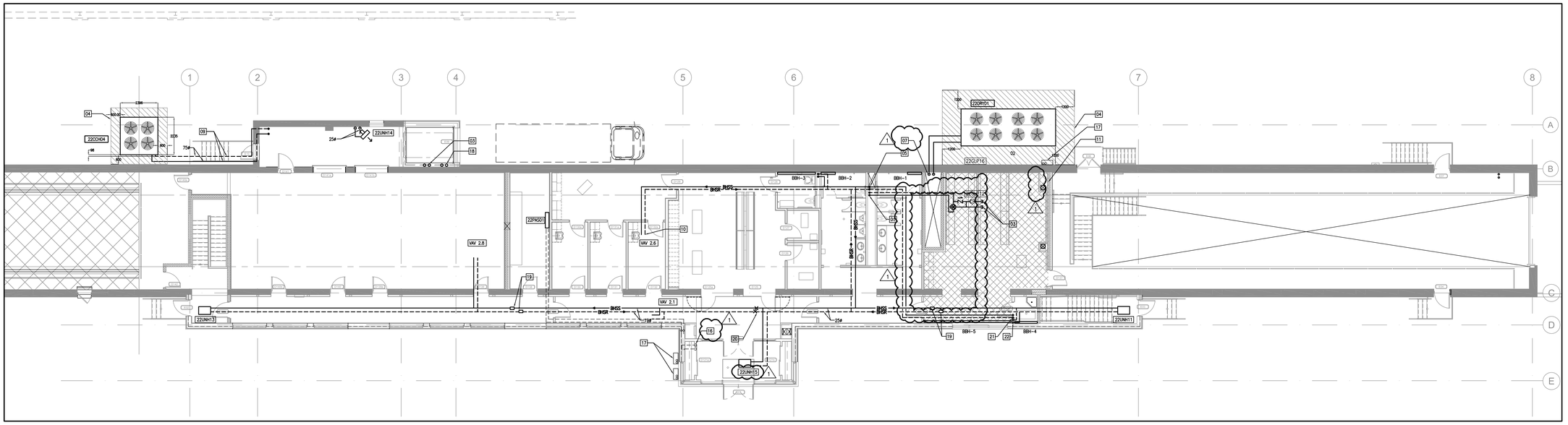
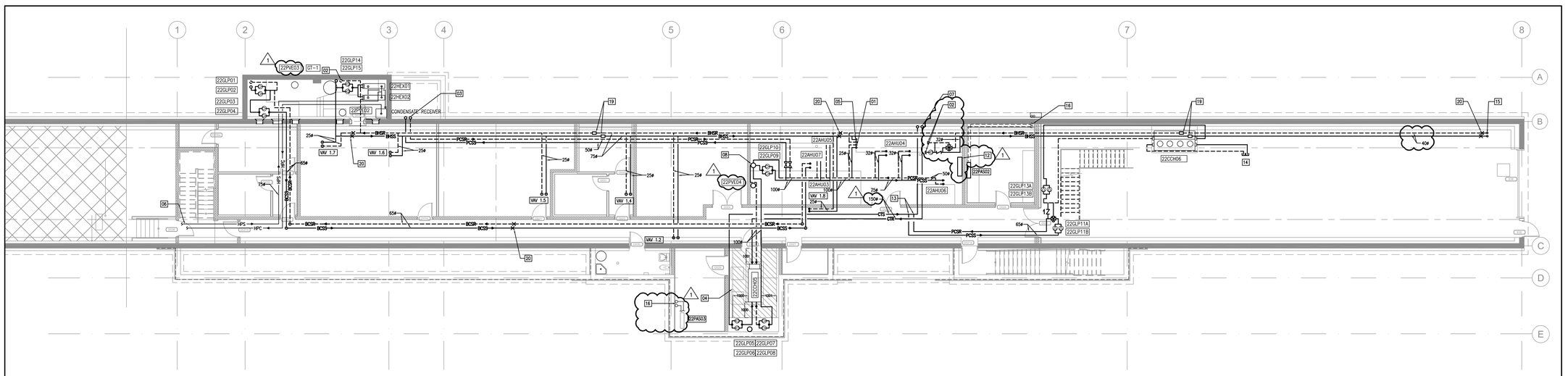


1 M04 UPPER LEVEL PIPING

SCALE = 1:100



2 M04 LOWER LEVEL PIPING

SCALE = 1:100

MECHANICAL GENERAL NOTES:

01 ALL FLOOR-MOUNTED EQUIPMENT TO BE ON 100MM HIGH HOUSEKEEPING PADS.
02 INSULATE ALL HOT AND COLD WATER AND GLYCOL PIPING.

MECHANICAL PLAN NOTES:

01 CHILLED GLYCOL SUPPLY AND RETURN UP IN WASHROOM PLUMBING CHASE TO SERVE UPPER FLOOR.
02 BHSS/R UP TO INFLOOR RADIANT HEATING MANIFOLD.
03 CHILLED GLYCOL SERVICE TO AIRPORT TERMINAL ROOM & FLEXIBLE CABIN LABORATORY.
04 EQUIPMENT SERVICE CLEARANCE.
05 GLYCOL SUPPLY AND RETURN UP TO UPPER LEVEL.
06 STEAM PIPING CONTINUED ON DRAWING M05.
07 150Ø CONDENSER WATER PIPING UP TO 22DRY01.
08 CHILLED GLYCOL SYSTEM LOW LOSS HEADER.
09 PIPING MOUNTED TO WALL 600MM ABOVE GRADE. PIPING TO BE STACKED AND ROUTED BETWEEN EXTERIOR STAIR AND WALL.
10 CONNECTION TO REHEAT COIL (TYPICAL)
11 AREA OF IN-FLOOR HEATING.
12 IN-FLOOR RADIANT HEATING MANIFOLD CABINET AT FLOOR LEVEL C/W PUMP PACKAGE
13 CLOSELY-SPACED TEES MAXIMUM 300MM APART.
14 PROVIDE 65Ø CAPPED TEES FOR FUTURE CHILLER CONNECTION.
15 BUILDING HEATING SUPPLY UP TO DUCT HEATING COIL ABOVE CATWALK.
16 REFRIGERANT PIPE UP.
17 CONDENSING UNIT ON WALL.
18 PROVIDE TWO 74MM SLEEVES THROUGH SLAB FOR FUTURE PIPING.
19 PROVIDE EXPANSION JOINT AND PIPE GUIDES IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. ANCHORS TO BE EQUIVALENT TO METAFLEX SMALL DIAMETER COMPENSATORS WITH 50MM COMPRESSION. FLANGED CONNECTIONS FOR 50MM# PIPE SIZE AND OVER. THREADED CONNECTIONS FOR 38MM# AND UNDER.
20 PROVIDE PIPE ANCHORS.
21 19MM# SERVICE TO BBH-5
22 19MM# SERVICE TO BBH-4

ASPM A0 (1189x841)

0 10 20mm 40 60 80 100 120 140 160 180 200mm

Natural Resources Canada / Ressources naturelles Canada
Architectural Services and Property Management Branch / Division des services architecturaux et gestion de l'immeuble

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project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY
MONTREAL ROAD CAMPUS

drawing / dessin
PIPING LAYOUT

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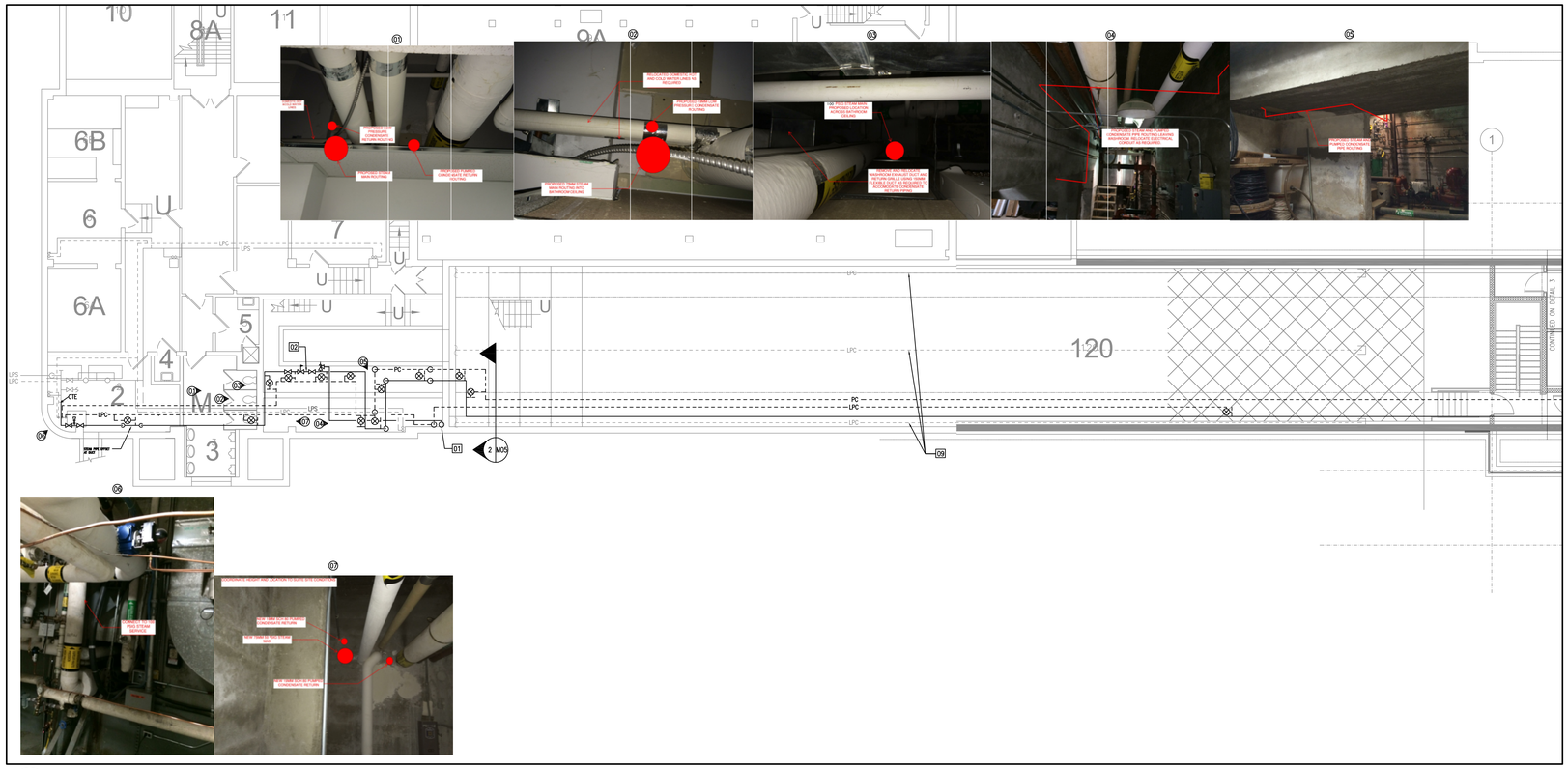
3788-M04



1 M05 BASEMENT AND FIRST FLOOR STEAM PIPING
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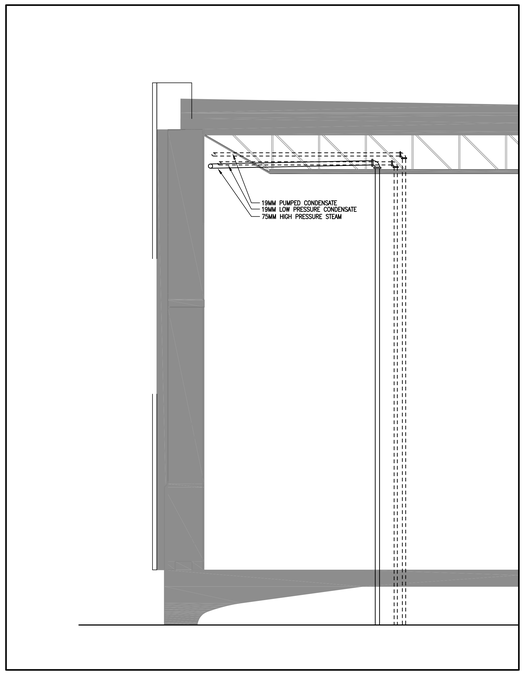
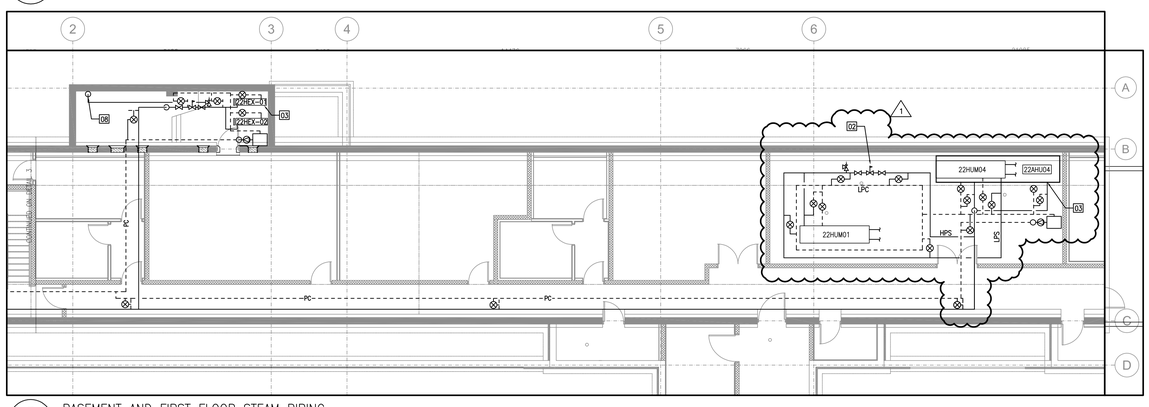


2 M05 STEAM & CONDENSATE RISER DETAIL
SCALE = 1:100



3 M05 BASEMENT AND FIRST FLOOR STEAM PIPING
SCALE = 1:100

MECHANICAL GENERAL NOTES:

01 PROVIDE STEAM TRAPS, AS INDICATED IN DETAIL 5 OF DRAWING M10, BEFORE ANY CHANGE IN ELEVATION AND BEND.

02 PROVIDE STEAM TRAPS AFTER ANY PIECE OF EQUIPMENT AS PER DETAIL 01 OF DRAWING M09.

03 REFER TO DETAIL 07 OF DRAWING M10 FOR STEAM AND CONDENSATE SCHEMATIC.

04 INSTALLATION OF EXPANSION JOINTS, PIPE ANCHORS AND PIPE GUIDES TO BE IN ACCORDANCE WITH EXPANSION JOINT MANUFACTURERS ASSOCIATIONS STANDARDS.

MECHANICAL PLAN NOTES:

01 ROUTE PRESSURE RELIEF VALVE PIPING ALONG EXTERIOR TO CORNER OF BASEMENT AS INDICATED, BRING STRAIGHT UP THROUGH TO ROOF FROM CORNER. COORDINATE WITH ARCHITECTURAL AND STRUCTURAL FOR ROOF PENETRATION. ONCE COMPLETE REPAIR ROOF TO AS BUILD CONDITION. REFER TO ARCHITECTURAL FOR PIPE SHIELDING IN OCCUPIED SPACE.

02 PRESSURE REDUCING VALVE STATION, REFER TO TO DETAILS 06 & 07 OF DRAWING M10 FOR PIPING SCHEMATIC. ENSURE THAT PRV STATION DOES NOT INTERFERE WITH REQUIRED, 1M, CLEARANCES OF NEARBY ELECTRICAL EQUIPMENT.

03 REFER TO DETAIL 08 OF DRAWING M10 FOR STEAM AND CONDENSATE PIPING SCHEMATIC FOR HEAT EXCHANGERS AND AIR SEPARATOR UNIT AND HUMIDIFIERS.

04 DOWNWARD SLOPE IN DIRECTION OF FLOW TO THE EXTENT POSSIBLE (NOT > 50MM/3048MM RUN)

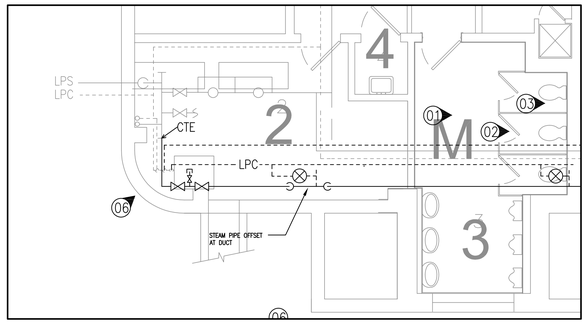
05 COORDINATE INSTALLATION OF HIGH PRESSURE STEAM, LOW PRESSURE CONDENSATE AND PUMPED CONDENSATE WITH SITE CONDITIONS PRIOR TO THE START OF ANY WORK.

06 TYPICAL PIPE GUIDES MUST BE FASTENED TO UNDERSIDE OF SLAB AND NOT THE JOISTS. PROVIDE EXTENSION FOR PIPE GUIDES TO ANCHOR TO SLAB IN AREAS WHERE IT IS REQUIRED. INSTALLATION OF GUIDES AND EXTENSION SHALL BE IN ACCORDANCE WITH EXPANSION JOINT MANUFACTURERS ASSOCIATION.

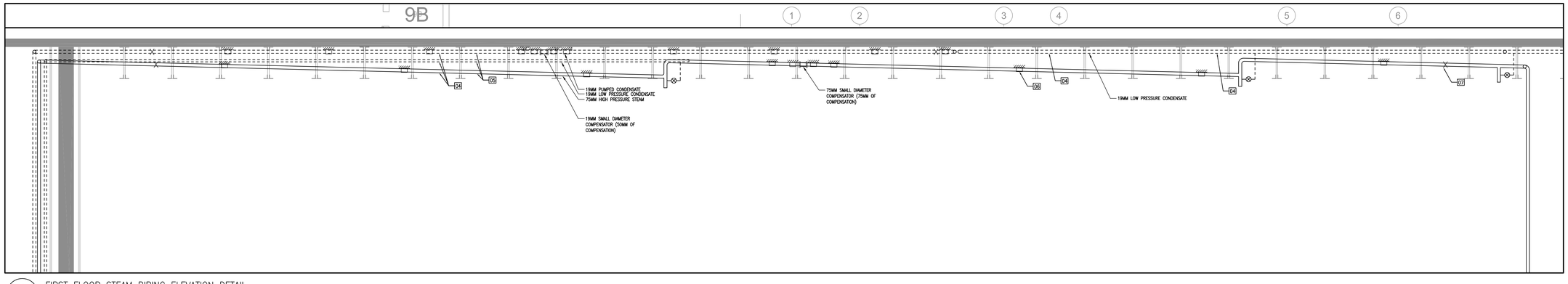
07 TYPICAL PIPE ANCHORS MUST BE FASTENED TO UNDERSIDE OF SLAB AND NOT THE JOISTS. PROVIDE EXTENSION FOR PIPE GUIDES TO ANCHOR TO SLAB IN AREAS WHERE IT IS REQUIRED. INSTALLATION OF GUIDES AND EXTENSION SHALL BE IN ACCORDANCE WITH EXPANSION JOINT MANUFACTURERS ASSOCIATION.

08 ROUTE PRESSURE RELIEF PIPING UP THROUGH LOADING DOCK AND OUT THROUGH ROOF. COORDINATE WITH ARCHITECTURAL AND STRUCTURAL FOR ROOF PENETRATION. ONCE COMPLETE REPAIR ROOF TO AS-BUILD CONDITION.

09 REINSULATE EXISTING PIPING.



5 M05 ENLARGED MECHANICAL ROOM STEAM PLAN
SCALE = 1:50



4 M05 FIRST FLOOR STEAM PIPING ELEVATION DETAIL
SCALE = 1:100

Natural Research Council Canada
Applications Services and Property Management Branch

Conseil national de recherches Canada
Direction des services aux applications et gestion de l'immeuble

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0	29 05 2015	ISSUED FOR TENDER	

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project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

drawing / dessin
BASEMENT AND FIRST FLOOR STEAM PIPING

designed / conçu	M. PILIC	date	MAY '15
drawn / dessiné	M. PILIC	scale / échelle	1 : 100
checked / vérifié	KC	sheet / feuille	of/de
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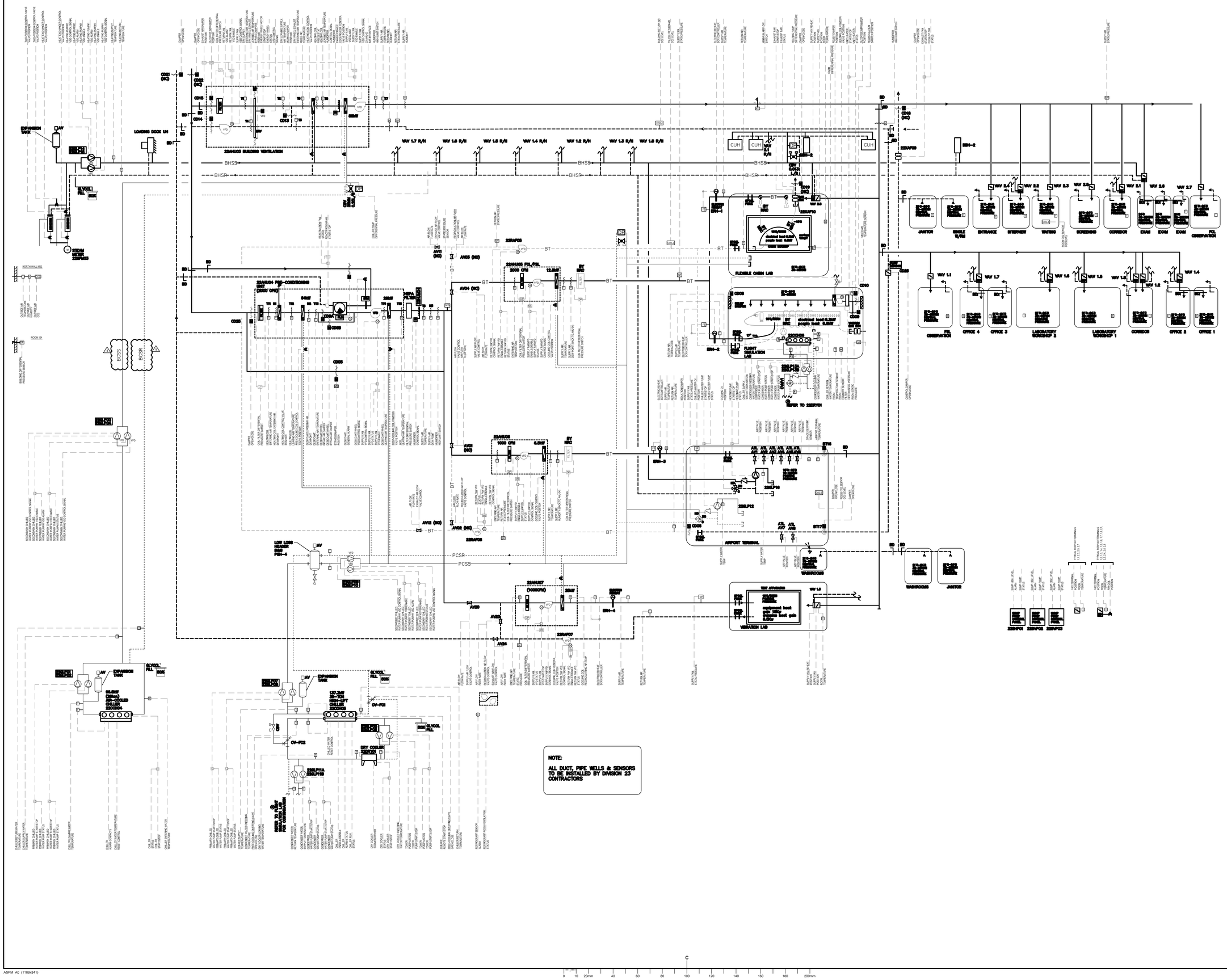
3788-M05



Conseil national de recherches Canada
Administration centrale et Gestion immobilière

Conseil national de recherches Canada
Bâtiment des services généraux et gestion de l'immeuble

NRC · CNRC

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MONTREAL ROAD CAMPUS

drawing / dessin
MECHANICAL SCHEMATIC

designed / conçu	date / date
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3788-M07

ASPM A0 (1189x841)

C

0 10 20mm 40 60 80 100 120 140 160 180 200mm

PUMP SCHEDULE

No.	Service	Model	L/s	GPM	kPa	FT WC	BHP	MOTOR HP	Min. Effy	VFD	EMERG. POWER	V/PH/HZ - Speed	Comments
22GLP01	BUILDING CHILLER PRIMARY LOOP PUMPS DUTY	B&G SERIES 80-SC 1.5X1.5X9.5	5	80	180	60	2.37	3		N		575/3/60 - 1750	2
22GLP02	BUILDING CHILLER PRIMARY LOOP PUMPS STANDBY	B&G SERIES 80-SC 1.5X1.5X9.5	5	80	180	60	2.37	3		N		575/3/60 - 1750	2
22GLP03	BUILDING CHILLED WATER SECONDARY DISTRIBUTION DUTY	B&G SERIES e-90 1.25AAB	3.78	60	165	55	1.27	2		Y		575/3/60 - 1750	2
22GLP04	BUILDING CHILLED WATER SECONDARY DISTRIBUTION STANDBY	B&G SERIES e-90 1.25AAB	3.78	60	165	55	1.27	2		Y		575/3/60 - 1750	2
22GLP05	LABS CONDENSER WATER PUMPS DUTY	B&G 2.5BB SERIES e-1510	20	324	165	55	6.4	7.5	71%	Y		575/3/60 - 1800	2
22GLP06	LABS CONDENSER WATER PUMPS STANDBY	B&G 2.5BB SERIES e-1510	20	324	165	55	6.4	7.5	71%	Y		575/3/60 - 1800	2
22GLP07	LABS CHILLER PRIMARY LOOP PUMP DUTY	B&G 2BD SERIES e-1510	10	155	120	40	2.19	3	71%	Y		575/3/60 - 1800	2
22GLP08	LABS CHILLER PRIMARY LOOP PUMP STANDBY	B&G 2BD SERIES e-1510	10	155	120	40	2.19	3	71%	Y		575/3/60 - 1800	2
22GLP09	LABS SECONDARY CHILLED WATER DISTRIBUTION DUTY	B&G 2AD-es SERIES e-1510	9.14	145	120	40	1.86	2		Y		575/3/60 - 1750	2
22GLP10	LABS SECONDARY CHILLED WATER DISTRIBUTION STANDBY	B&G 2AD-es SERIES e-1510	9.14	145	120	40	1.86	2		Y		575/3/60 - 1750	2
22GLP11A	FUSELAGE CONDENSER WATER PUMP	B&G 1.5AB SERIES e-90	2.5	40	150	50	0.89	1.5	58%	Y		575/3/60 - 1800	2
22GLP11B	FUSELAGE CONDENSER WATER PUMP	B&G 1.5AB SERIES e-90	2.5	40	150	50	0.89	1.5	58%	Y		575/3/60 - 1800	2
22GLP12	AIRPORT TERMINAL ROOM COOLING	[illegible]	[illegible]	10	[illegible]	[illegible]	[illegible]	0.4		N		120V/1/60 - 3250	2
22GLP13A	FUSELAGE PRIMARY CONDENSER PUMP	B&G 1.5AB SERIES e-90	2.5	40	150	50	0.89	1.5	58%	Y		575/3/60 - 1800	2
22GLP13B	FUSELAGE PRIMARY CONDENSER PUMP	B&G 1.5AB SERIES e-90	2.5	40	150	50	0.89	1.5	58%	Y		575/3/60 - 1800	2
22GLP14	BUILDING GLYCOL DISTRIBUTION DUTY	B&G 2AAC SERIES e-90	7.9	125	164	55	2.41	3		Y		575/3/60 - 1750	2
22GLP15	BUILDING GLYCOL DISTRIBUTION STANDBY	B&G 2AAC SERIES e-90	7.9	125	164	55	2.41	3		Y		575/3/60 - 1750	2
22GLP16	AIRPORT TERMINAL ROOM HEATING	B&G PL-55	0.63	10	105	35	0.21	0.4		N		120V/1/60 - 3250	2
22SHP01	SANITARY SUMP PUMP DUTY	HYDROMATIC SHEF 50	3.15	50	60	20		0.5		N		120V/1/60 - 3250	6
22SHP02	SANITARY SUMP PUMP STANDBY	HYDROMATIC SHEF 50	3.15	50	60	20		0.5		N		120V/1/60 - 3250	6
22SVP01	WEEPING TILE SUMP PUMP DUTY	HYDROMATIC SHEF 50	3.15	50	60	20		0.5		N		120V/1/60 - 3250	6
22SVP02	WEEPING TILE SUMP PUMP STANDBY	HYDROMATIC SHEF 50	3.15	50	60	20		0.5		N		120V/1/60 - 3250	6
22SVP03	TRENCH DRAIN SUMP PUMP DUTY	HYDROMATIC SHEF 50	3.15	50	60	20		0.5		N		120V/1/60 - 3250	6
22SVP04	TRENCH DRAIN SUMP PUMP STANDBY	HYDROMATIC SHEF 50	3.15	50	60	20		0.5		N		120V/1/60 - 3250	6

Notes:
1 ALL BRONZE CONSTRUCTION
2 COMPLETE WITH FLOWTREX VALVE AND SUCTION GUIDE
3 EXTRA HIGH EFFICIENCY MOTOR
4 INTERNAL FLOAT SWITCH
5 EMERGENCY POWER
6 COMPLETE SUMP PIT CONTROLLER PACKAGE WITH FLOATS
7 PART OF DOMESTIC WATER BOOSTER PACKAGE C/W CONTROLLER
8 PART OF COMPLETE PUMP PACKAGE C/W CONTROLLER, STRAINER, RELIEF VALVE AS PER (TSSA / NFPA) REQUIREMENTS

AIR VALVES

TAG / FLOOR	TYPE	SERVICE / ZONE	ROOM#	MAKE	MODEL	SIZE (INLET) mm	(IN.)	MAX L/S	MAX (CFM)	MIN L/S	MIN (CFM)	OFF L/S	OFF (CFM)	NOTES:
CD01	VENTURI	AHU06 SUPPLY		PHOENIX	LOW PRESSURE SHUT-OFF	125	5	472	1,000	0	-		0	
CD02	VENTURI	AHU06 RETURN		PHOENIX	LOW PRESSURE SHUT-OFF	175	7	472	1,000	0	-		0	
CD03	VENTURI	AHU05RETURN		PHOENIX	LOW PRESSURE SHUT-OFF	150	6	944	2,000	0	-		0	
CD04	VENTURI	AHU05 SUPPLY		PHOENIX	LOW PRESSURE SHUT-OFF	125	5	944	2,000	0	-		0	
CD11	VENTURI	AHU05 EXHAUST		PHOENIX	LOW PRESSURE SHUT-OFF	150	6	944	2,000	0	-		0	
CD12	VENTURI	AHU06 EXHAUST		PHOENIX	LOW PRESSURE SHUT-OFF	150	6	472	1,000	0	-		0	
CD20	VENTURI	AHU07 SUPPLY		PHOENIX	LOW PRESSURE SHUT-OFF	125	5	944	2,000	0	-		0	
CD23	VENTURI	AHU07 RETURN		PHOENIX	LOW PRESSURE SHUT-OFF	125	5	944	2,000	0	-			
CD24	VENTURI	AHU07 EXHAUST		PHOENIX	LOW PRESSURE SHUT-OFF	125	5	944	2,000	0	-			
ATLAV1	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	79	167	24	50		0	
ATLAV2	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	79	167	24	50		0	
ATLAV3	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	79	167	24	50		0	
ATLAV4	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	79	167	24	50		0	
ATLAV5	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	79	167	24	50		0	
ATLAV6	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	79	167	24	50		0	
ATLAV7	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	157	333	71	150		0	
ATLAV8	VENTURI	AIRPORT TERMINAL LOUNGE		PRICE	VVA	250	10	157	333	71	150		0	

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

AIR HANDLING UNITS SCHEDULE

GENERAL INFO / FAN SECTION

TAG	SYSTEM	LOCATION	MANUF.	TYPE	SUPPLY BHP	SUPPLY MOTOR HP	EXHAUST BHP	EXHAUST MOTOR HP	ELECT. V/P/C	FLOW L/S	FLOW CFM	E.S.P. Pa	E.S.P. IN WC
22AHU03	GENERAL BUILDING CONDITIONING	BASEMENT MECH ROOM	AAON	PACKAGED CHILLED GLYCOL/HOT GLYCOL	7.47	10.0	3.9	5.0	575/3/60	3,070	6,500	500	2
22AHU04	LABS PRE-CONDITIONING	BASEMENT MECH ROOM	MUNTERS	STEAM DESICCANT CHILLED WATER PRE AND POST COOL, STEAM HEAT	3.9	5.0			575/3/60	940	2,000	500	2
22AHU05	FLEXIBLE CABIN / FUSELAGE LAB	BASEMENT MECH ROOM	AAON	HORIZONTAL AHU		8			575/3/60	940	2,000	875	3.5
22AHU06	AIRPORT TERMINAL LAB	BASEMENT MECH ROOM	AAON	HORIZONTAL AHU	1.76	2.3			575/3/60	470	1,000	875	3.5
22AHU07	VIBRATION LAB	BASEMENT MECH ROOM	AAON	HORIZONTAL AHU	1.76	8			575/3/60	940	2000	875	3.5

HEATING COIL SECTION

TAG	COIL DUTY	SENSIBLE LOAD MBH	SENSIBLE LOAD KW	Ent Air Temp db Deg. F.	Leaving Air Temp db Deg. F.	Fluid Type	Ent Fluid Temp Deg. F.	Ent Fluid Temp Deg. C.	Lv Fluid Temp Deg. F.	Lv Fluid Temp Deg. C.	FLOW GPM	FLOW L/S	PRESSURED ROP KPA
22AHU03	PRE-HEAT COIL	251	73.50	20	55	GLYCOL	180.0	82.0	160.0	71.1	25.10	1.584	11.350
22AHU04	PRE-HEAT COIL	133.92	39.21	-12	50	STEAM	175.0	79.4	160.0	71.1	17.86	1.127	
22AHU05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
22AHU06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
22AHU07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

COOLING COIL #1

TAG	COIL DUTY	SENSIBLE LOAD MBH	SENSIBLE LOAD KW	LATENT LOAD MBH	LATENT LOAD KW	COIL Ent Air Temp wb/db Deg. F.	COIL Leaving Air Temp wb/db Deg. F.	Fluid Type	Ent Fluid Temp Deg. F.	Ent Fluid Temp Deg. C.	Lv Fluid Temp Deg. F.	Lv Fluid Temp Deg. C.	FLOW GPM	FLOW L/S
22AHU03	COOLING COIL	181.47	53.17	80.44	23.57	80/67	54.5/53.9	GLYCOL	46.0	7.8	56.0	13.3	52.10	3.287
22AHU04	PRE-COOLING COIL	218099				95	45	GLYCOL	35.0	1.7	45.0	7.2	43.10	2.719
22AHU05	COOLING COIL	126.6223	37.1	21	6	75/62	55/54	GLYCOL	35.0	1.7	45.0	7.2	30	1.89
22AHU06	COOLING COIL	11.9455	3.5	10.239	3	75/62	55/54	GLYCOL	35.0	1.7	45.0	7.2	4.6	0.29
22AHU07	COOLING COIL	85	25	0	0	75/62	55/54	GLYCOL	35.0	1.7	45.0	7.2	18	1.13

DESICCANT SECTION

TAG	MOISTURE REMOVAL LB/HR	MOISTURE REMOVAL KG/HR	SA HUMID %RH	REACTIVATION ENERGY MBH	REACTIVATION ENERGY KW	REACTIVATION AIRFLOW CFM	REACTIVATION AIRFLOW L/S	HP	ENTERING AIR TEMP Deg. F.	ENTERING AIR TEMP Deg. C.	LEAVING AIR TEMP Deg. F.	LEAVING AIR TEMP Deg. C.
22AHU03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU04			5	120,288.000	35.200	601.000	284.000	3.000	45.000		89.000	
22AHU05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

COOLING COIL #2

TAG	COIL DUTY	SENSIBLE LOAD MBH	SENSIBLE LOAD KW	LATENT LOAD MBH	LATENT LOAD KW	COIL Ent Air Temp wb/db Deg. F.	COIL Leaving Air Temp wb/db Deg. F.	Fluid Type	Ent Fluid Temp Deg. F.	Ent Fluid Temp Deg. C.	Lv Fluid Temp Deg. F.	Lv Fluid Temp Deg. C.	FLOW GPM	FLOW L/S
22AHU03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU04	POST-COOLING COIL	97442	28.55			94	65/40	GLYCOL	46.0	7.8	56.0	13.3	19.00	1.199
22AHU05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ENERGY RECOVERY SECTION

TAG	AIRFLOW CFM	AIRFLOW L/S	SUMMER RETURN AIR DB/WB(F)	WINTER RETURN AIR DB/WB(F)	SUMMER OA DB/WB(F)	WINTER OA DB/WB(F)	TOTAL EFFECTIVENESS
22AHU03	3200	1510	75/63	72/55	87/71	-17	72%
22AHU04	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU05	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU06	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22AHU07	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note:
1 to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

VAV BOX / BOOSTER COILS

TAG / FLOOR	TYPE	SERVICE / ZONE	ROOM#	MAKE	MODEL	STYLE	SIZE (INLET) mm	(IN.)	MAX L/S	MAX (CFM)	MIN L/S	MIN (CFM)	OFF L/S	OFF (CFM)	CAPACITY TYPE	CAPACITY MBTU	EAT °C	EAT (°F)	EWT °C	EWT (°F)	LWT °C	LWT (°F)	FLOW L/S	FLOW (GPM)	WPD KPa	WPD (FT)	NOTES:
VAV 1.1	VAV	FSL OBSERVATION	26	PRICE	SDV		125	5	100	212	50	106		0													
VAV 1.2	VAV	CORRIDOR	21	PRICE	SDV		175	7	230	487	69	146		0		60	13	55	82	180	71	160	0.4	6.7			
VAV 1.3	VAV	VIBRATION LAB	24	PRICE	SDV		150	6	188	398	56	119		0		24	13	55	82	180	71	160	0.2	2.7			
VAV 1.4	VAV	OFFICES	22,31,32	PRICE	SDV		125	5	115	244	35	74		0		7.1	13	55	82	180	71	160	0	0.79			
VAV 1.5	VAV	WORKSHOP	33	PRICE	SDV		150	6	142	301	106	225		0		18	13	55	82	180	71	160	0.1	2			
VAV 1.6	VAV	WORKSHOP	34	PRICE	SDV		150	6	142	301	106	225		0		18	13	55	82	180	71	160	0.1	2			
VAV 1.7	VAV	OFFICES	23,35,36	PRICE	SDV		125	5	115	244	35	74		0		7.1	13	55	82	180	71	160	0	0.79			
VAV 1.8	VAV	CORRIDOR	21	PRICE	SDV		125	5	90	191	27	57				25	13	55	82	180	71	160	0.2	2.8			
VAV 2.1	VAV	CORRIDOR	124	PRICE	SDV		225	9	376	797	113	240		0		51	13	55	82	180	71	160	0.4	5.7			
VAV 2.2	VAV	INTERVIEW	127	PRICE	SDV		150	6	120	254	36	76		0													
VAV 2.3	VAV	WAITING	125	PRICE	SDV		300	12	544	1,153	408	865		0													
VAV 2.4	VAV	ENTRANCE	121,122	PRICE	SDV		125	5	88	186	26	56		0													
VAV 2.5	VAV	SCREENING	129	PRICE	SDV		150	6	136	288	41	86		0													
VAV 2.6	VAV	EXAM	130,131,132	PRICE	SDV		150	6	150	318	52	111		0		6.9	13	55	82	180	71	160	0.04	0.69			
VAV 2.7	VAV	FCL OBSERVATION	138	PRICE	SDV		125	5	50	200	47	100		0													
VAV 2.8	VAV	FLEXIBLE CABIN LAB	139	PRICE	SDV		225	9	376	797	113	239		0		42	13	55	82	180	71	160	0.3	4.7			

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

SPLIT SYSTEM AC SCHEDULE

TAG	SERVICE	MAKE	EER	EVAPORATOR DIM. (W X L X H) mm	mm	mm	CONDENSER DIM. (W X L X H) mm	mm	mm	TOTAL CAPACITY (KW)	ELECTRICAL MCA	POWER	V/PH	MEDIUM	WEIGHT KG	LBS	NOTE:
22PAS01	OBSERVATION RM	DAIKIN	12	1000	225	300				4.4	15	1.29	208/1	R410a		93	INDOOR UNIT POWERED FROM CONDENSING UNIT. LOW AMBIENT COOLING
22PAS02	OBSERVATION RM	DAIKIN	12	1000	225	300				4.4	15	1.29	208/1	R410a		93	INDOOR UNIT POWERED FROM CONDENSING UNIT. LOW AMBIENT COOLING
22PAS03	ELECTRICAL RM	MITSUBISHI					950	330	1350	7.00	28	2.45	208/1	R410a	120	265.00	INDOOR UNIT POWERED FROM CONDENSING UNIT. LOW AMBIENT COOLING

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

HEAT RECOVERY VENTILATOR SCHEDULE

TAG	SYSTEM	LOCATION	MANUF.	TYPE	MOTOR	ELECT. V/P/C	TAG	FLOW L/S	FLOW CFM	E.S.P. Pa	E.S.P. IN WC	TAG	FLOW L/S	FLOW CFM	E.S.P. Pa	E.S.P. IN WC	WEIGHT KG	WEIGHT LB.	DIMENSIONS L	W	H	REMARKS
22HRU01	REFRIGERANT RM VENTN	BSMT JANITOR RM	VENMAR	HRV700i	2 X 1/6HP	120/1/60	SUPPLY	330	700	50	0.2	EXHAUST	330	700	50	0.2	95	210	660	1372	1168	POLYPROPYLENE CORE

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

CHILLER SCHEDULE

TAG	MAKE	TYPE	LOCATION	MODEL	APPLICATION	CAPACITY KW	CAPACITY TONS	POWER INPUT KW	MCA	EMERGENCY POWER	EVAPORATOR EWT Deg. F	LWT Deg. F	FLOW GPM	PRESS DROP KpA	PRESS DROP Ft WC	WATER CONDENSER (50% GLYCOL) EWT Deg. F	LWT Deg. F	FLOW L/S	FLOW GPM	PRESS DROP FT NWC	REFRIGERANT	IPLV COP	PHYSICAL DATA HEIGHT Inches	WIDTH Inches	LENGTH Inches	WEIGHT kg	WEIGHT Lb.s	dBA
22CCH04	DAIKIN	Packaged air-cooled chiller	Outdoors on Grade	AGZ030E	BUILDING COOLING	96.6	27.5	32.7	63.9	NO	54	44	78	51	17	N/A	N/A	N/A	N/A	N/A	R410a	15.1	100	88	94	1346	2960	88
22CCH05	AERMEC	Screw - Water Cooled	East Mech Rm	NXW0900Y8	LABS COOLING	189.7	54	64.15	117	NO	44	34	155	44	15	103	110	12.4	284.2	20	R410a	19.8	74.2	31.5	95	1265	2789	82
22CCH06	REFPLUS	Screw - Water Cooled	FSL	WCS-250-5L4-8	FUSELAGE COOLING	35.1	10		38.4	NO	-21	-30	40	50	16.7	103	110	2.52	40	21	R404A		100	50	100	460	1009	85

1. Refplus chiller is made up of two modules stacked with an acoustic enclosure. Each chiller module will need a separate power supply 600V, 38.4 MCA and 60 MOP.
Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

BASEBOARD HEATER SCHEDULE

TAG	LOCATION	MAKE	MODEL	STYLE	LENGTH (MM) ENCLOSURE	ACTIVE	EAT °C	EAT (°F)	AVGWT °C	AVGWT (°F)	FLOW L/S	FLOW (GPM)	CAPACITY KW	NOTES
22BBH01	WOMEN'S WASHROOM 1	ROSEMEX	RVS 44C3	D	900	800	21	70	77	170	0.03339	0.53	1.5KW/M	PROVIDE END CAP
22BBH02	MEN'S WASHROOM 133	ROSEMEX	RVS 44C3	D	900	800	21	70	77	170	0.03339	0.53	1.5KW/M	PROVIDE END CAP
22BBH03	SINGLE WASHROOM 128	ROSEMEX	RVS 44C3	H	2400	1000	21	70	77	170	0.02268	0.36	1KW/M	APPROXIMATE WALL-TO-WALL LENGTH OF ENCLOSURE LISTED. SITE VERIFY BEFORE ORDERING
22BBH04	JANITOR 136	ROSEMEX	RVS 44C3	H	1440	900	21	70	77	170	0.02016	0.32	1KW/M	APPROXIMATE WALL-TO-WALL LENGTH OF ENCLOSURE LISTED. SITE VERIFY BEFORE ORDERING
22BBH05	AIRPORT TERMINAL 135	ROSEMEX	RVS 44C3	H	5666	2X1500	21	70	77	170	0.06741	1.07	1KW/M	APPROXIMATE WALL-TO-WALL LENGTH OF ENCLOSURE LISTED. SITE VERIFY BEFORE ORDERING

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

HEATER SCHEDULE

TAG	SERVICE	MAKE	MODEL	STYLE	VOLTAGE	SIZE (W X H X D) mm	(IN.)	AIR FLOW L/S	AIR FLOW (CFM)	FAN SPEED	MOTOR POWER KW	(HP)	EAT °C	EAT (°F)	EWT °C	EWT (°F)	LWT °C	LWT (°F)	FLOW L/S	FLOW (GPM)	WPD KPa	WPD (FT)	CAPACITY KW	CAPACITY (MBH)
22UNH11	WEST STAIRWELL	ROSEMEX	F300-A	RW-2	115	1000X750X20	40X30X8		200					70		170		150		2.24				22.4
22UNH15	EAST STAIRWELL	ROSEMEX	F300-A	RW-2	115	1000X750X20	40X30X8		200					70		170		150		2.24				22.4
22UNH13	NORTH ENT. VESTIBULE	ROSEMEX	F300-A	RW-2	115	1000X750X20	40X30X8		200					70		170		150		2.24				22.4
22UNH14	PENTHOUSE MECH	ROSEMEX	HORIZONTAL	H18	115	1000X750X20	40X30X8		460					70		170		155		2.4				18

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

EXPANSION TANKS

TAG	SYSTEM	TANK VOLUME (GAL)	ACCEPT VOLUME (GAL)	DIMENSIONS HEIGHT (IN)	DIAMETER (IN)	SYSTEM VOLUME (GAL)	MEDIUM	INITIAL TEMP (F)	MAX DESIGN TEMP (F)	INITIAL PRESSURE (PSI)	MAX DESIGN PRESURE (PSI)	DESIGN BASIS
22PVE02	BUILDING HEATING SYSTEM	11	5	28	14	62.5	50% ETH GLY	80	180	35	65	TACO CBX-42
22PVE03	BUILDING COOLING SYSTEM	4	2.5	15	14	126.3	50% ETH GLY	40	75	35	65	TACO CBX-15
22PVE04	PROCESS COOLING SYSTEM	4	2.5	15	14	133.5	50% ETH GLY	35	75	35	65	TACO CBX-15
22PVE05	DOMESTIC HOT WATER	8	5	25	14	25	POTABLE WATER	40	120	12	65	TACO PAX-30

HEAT EXCHANGER SCHEDULE

TAG	SERVICE	MAKE	MODEL	STYLE	CAPACITY (KW)	SIZE (W X H X D) mm	(IN.)	SHELL SIDE PD KPA	PD FT	MEDIUM	PRESS KPA	PRESS PSI	FLOW G/H	FLOW LB/HR	TUBE SIDE MEDIUM	EWT °C	EWT (°F)	LWT °C	LWT (°F)	FLOW L/S	FLOW (GPM)	WPD KPa	WPD (FT)	NOTES
22HEX01	BUILDING HOT WATER			SHELL AND TUBE	180		4.9 X 12.2 X 8.8		1.2	STEAM		50		694	GLYCOL		190		165		49		10	
22HEX02	LABS GLYCOL			SHELL AND TUBE	160				1.2	STEAM		50		564	GLYCOL		180		155		50			

Note: to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

GRILLES AND DIFFUSER SCHEDULE

TAG	TYPE	MATERIAL	BALANC. DAMPER	FINISH	MAKE	MODEL	REMARKS
A	SQUARE DIFFUSER	ALUMINUM	YES	TO MATCH SURFACE	EH PRICE	SCD	600 X 600mm UNLESS INDICATED OTHERWISE
B	GRILLE	ALUMINUM	YES	TO MATCH SURFACE	EH PRICE	620	
C	LINEAR DIFFUSER	ALUMINUM	YES	TO MATCH SURFACE	EH PRICE	ASP	1200MM LONG/25MM WIDE SINGLE SLOT/150ø COMPLETE WITH PLENUM
D	GRILLE	ALUMINUM	YES	TO MATCH SURFACE	EH PRICE	630	

to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation and Volume 2 - Part 2 RFP PWGSC Federal Office Bld Standards

TANK SCHEDULE

No.	SERVICE	LOCATION	MAKE	MODEL	STORAGE Litre	TYPE	ELEMENTS	VOLTAGE	HEIGHT mm	DIAMETER mm	ORIENT	NOTES
22HWT04	DOMESTIC HOT WATER	JANITOR ROOM	AO SMITH	DRE-80	300	ELECTRIC	3x3000W	600V/3PH	1530	648	VERTICAL	

Note:

DRY COOLER SCHEDULE

REF. NO.	MAKE	TYPE	MODEL	LOCATION	CAPACITY KW	CAPACITY TONS	FAN HP	MCA	POWER V/PH/HZ	EMERGENCY POWER	50% EG EWT Deg. F	LWT Deg. F	FLOW GPM	PRESS DROP Ft WC	PHYSICAL DATA HEIGHT Inches	WIDTH Inches	LENGTH Inches	WEIGHT Lb.s	SOUND LEVEL dBA
22DRY01	REFPLUS	FLUID COOLER	FVD264FL-8-F116	GRADE	268.0	84.7	0.95	24.5	600/3/60	NO	110	103	324	13.6	56	93	351.5	7,000	

to be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation

FANS SCHEDULE

TAG	SYSTEM	LOCATION	MANUF.	MODEL	TYPE	BHP	MOTOR HP	ELECTRICAL V/P/C	VFD	FLOW L/S	FLOW CFM	E.S.P. Pa	E.S.P. IN WC	SONES
22XAF09	BUILDING SANITARY EXHAUST	UPPER LEVEL W/RM CEILING	GREENHECK	SQ-120	INLINE CABINET DIRECT DRIVE	0.14	0.5	120/1/60	NO	401	850	125	0.5	5.9
22XAF10	FLEX CABIN SAN EXHAUST	FCL CEILING	GREENHECK	SQ-80	INLINE CABINET DIRECT DRIVE	0.06	0.25	120/1/60	NO	94	200	125	0.5	7.6
22RAF06	AIRPORT TERMINAL RETURN	LOWER LEVEL	GREENHECK	BSQ-130HP	INLINE CABINET BELT DRIVE	1	1	575/3/60	YES	472	1,000	560	2.25	16.8
22RAF05	FCL/FSL RETURN	LOWER LEVEL	GREENHECK	BSQ-140	INLINE CABINET BELT DRIVE	1.7	2	575/3/60	YES	944	2000	585	2.35	25
22SAF01	FSL VENTILATION/HEATING	FSL	GREENHECK	BSQ-140	INLINE CABINET BELT DRIVE	0.43	0.5	120/1/60	NO	944	2000	125	0.5	13
22RAF07	VIBRATION LAB RETURN	LOWER LEVEL	GREENHECK	BSQ-140	INLINE CABINET BELT DRIVE	1.7	2	575/3/60	YES	944	2000	585	2.35	25

DUCT HEATING COIL SCHEDULE

TAG	SYSTEM	LOCATION	TYPE	COIL DUTY	AIRFLOW cfm	AIRFLOW L/s	SENSIBLE LOAD btu/hr	SENSIBLE LOAD KW	Power V/PH/HZ	Ent Air Temp DEG C	Ent Air Temp DEG F	Leaving Air Temp DEG C	Leaving Air Temp DEG F	PRESS DROP KPa	PRESS DROP in WC	NOTES
ERH-1	FLEX CABIN	UPPER LEVEL	ELECTRIC	HEATING	2000	944	21600	6.33	600/3/60	35	95	41	105	24.9	0.1	SCR CONTROLLER, AIRFLOW PROVING SWITCH, HIGH LIMIT STAT
ERH-2	FUSELAGE	LOWER LEVEL	ELECTRIC	HEATING	2000	944	21600	6.33	600/3/60	35	95	41	105	24.9	0.1	SCR CONTROLLER, AIRFLOW PROVING SWITCH, HIGH LIMIT STAT
ERH-3	AIRPORT TERMINAL	LOWER LEVEL	ELECTRIC	HEATING	1000	472	10800	3.16	600/3/60	35	95	41	105	24.9	0.1	SCR CONTROLLER, AIRFLOW PROVING SWITCH, HIGH LIMIT STAT
ERH-4	VIBRATION LAB	MAIN MECH RM	ELECTRIC	HEATING	2000	944	21600	6.33	600/3/60	35	95	41	105	24.9	0.1	SCR CONTROLLER, AIRFLOW PROVING SWITCH, HIGH LIMIT STAT
	22SAF01	FSL	GLYCOL	HEATING	2000	944	110160	32.28	N/A	21	70	49	121	57.27	0.23	180F - 160F GLYCOL EWT/LWT
	22AHU04	MAIN MECH RM	STEAM	PREHEAT	2000	944	144720	42.40	N/A	-27	-17	10	50			50 PSI STEAM

Note: to be provided complete all required accessories and components to constitute a complete and working installation

HUMIDIFIER SCHEDULE

HUM	CFM	SERVES	ENTERING AIR TEMP / RH	LEAVING AIR TEMP/RH	REQUIRED KG/HR	TYPE	PROCESS STEAM INLET PRESSURE PSI	CLEAN STEAM OUTLET PRESSURE	MANUFACTURER	MODEL	NOTES
22HUM01	3,200	AHU-03	0 C / 0%	22 C / 35%	40.0	STEAM TO STEAM	15	ATMOSPHERIC	DRISTEEM	STS-25	1,2,3
22HUM04	2,000	AHU-04	40 C / 10%	40 C / 30%	55.0	STEAM TO STEAM	15	ATMOSPHERIC	DRISTEEM	STS-50	1,2,4

Note:
1 c/w: controller, modulating valve (suitable for DDC control), s/s distributor(s), high limit switch, air proving switch, & mounting hardware.
2 To be provided complete with all required accessories and components to constitute a complete and working installation in accordance with manufacturer's recommendation
3 To be provided c/w 2" duct-mounted type rapid-sorb steam dispersion manifold in accordance with manufacturer's recommendation.
4 To connect to steam dispersion manifold as provided by AHU manufacturer. Refer to AHU specs for details.

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ARCHITECTS ENGINEERS PLANNERS
NORR Limited
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KEY PLAN

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Date Printed 30 OCT 2014 Date imprimée

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A Detail no. / No. du détail
B Location drawing no. / sur dessin no.
C Drawing no. / dessin no.

project / projet: NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY
MONTREAL ROAD CAMPUS

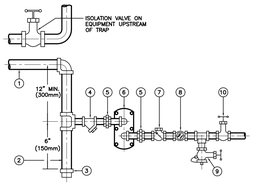
drawing / dessin: MECHANICAL SCHEDULES

designed / conçu: KC — date / date: OCT '14
drawn / dessiné: ALM — scale / échelle: AS SHOWN
checked / vérifié: KC — sheet / feuille: of/de
approved / approuvé — W.O.no. — D.T.no.

dwg.no. / dessin no.: 3788-M08

ASPM A0 (1189x841)

0 10 20mm 40 60 80 100 120 140 160 180 200mm



01 M09 EQUIPMENT TRAPPING
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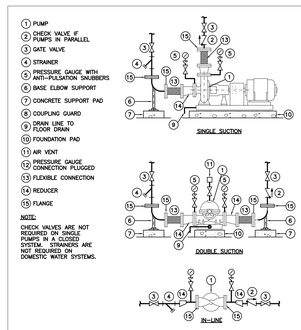

02 M09 PUMPS
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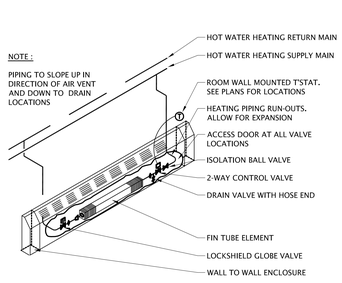
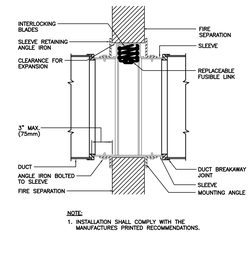


03 M09 BASEBOARD CONVECTOR PIPING SCHEMATIC
N.T.S.



04 M09 FIRE DAMPER INSTALLATION
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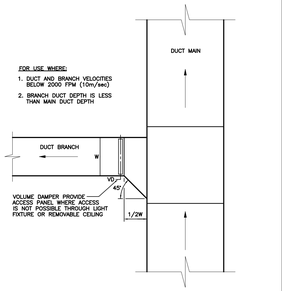

05 M09 DUCT BRANCH CONNECTION FROM DUCT MAIN
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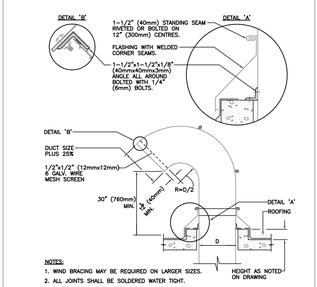

06 M09 GOOSENECK DETAIL
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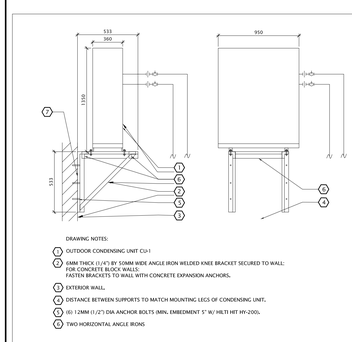

07 M09 TURNING VANES IN SQUARE ELBOWS
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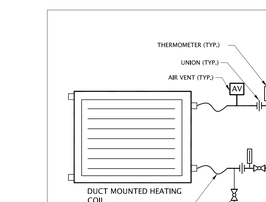
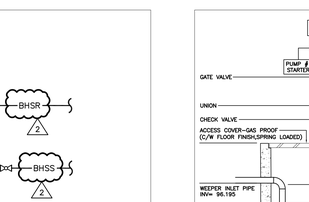


CFM	A (MIN.)	B (MIN.)	INTERNAL ACOUSTICAL LINING
100	250	250	25mm TH
200	400	250	25mm TH
300	500	300	25mm TH
400	500	300	25mm TH
500	500	400	25mm TH

"Z" CONFIGURATION SHOWN. DIMENSIONS SIMILAR FOR "C" CONFIGURATION.
MAX AIR VELOCITY THROUGH SILENCER 2.5 m/S

08 M09 CROSS TALK SILENCER
N.T.S.



09 M09 TYPICAL PLUMBING VENT STACK
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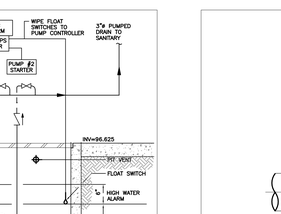
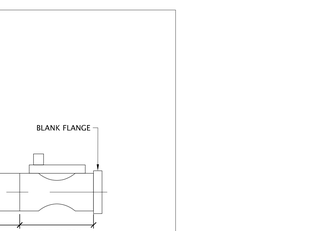


CONNECTIONS TO SHELL AND TUBE HEAT EXCHANGER INCLUDES CONVERTORS, CHILLERS, CONDENSERS, OR OTHER DEVICES WITH REMOVABLE HEADS.

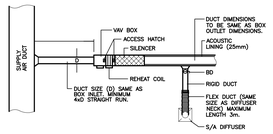
10 M09 HEAT EXCHANGER CONNECTIONS
N.T.S.



NOTE: FOR PIPE SIZE SEE DRAWINGS.

11 M09 CHEMICAL TREATMENT FOR CLOSED WATER SYSTEMS
N.T.S.

12 M09 GLYCOL FEED SYSTEM
N.T.S.



13 M09 TYPICAL V.A.V. INSTALLATION DETAIL
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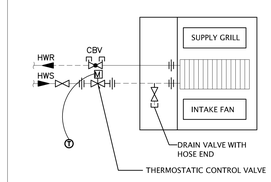
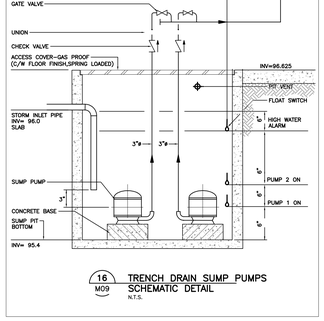


15 M09 CABINET UNIT HEATER PIPING SCHEMATIC
N.T.S.



16 M09 TRENCH DRAIN SUMP PUMPS SCHEMATIC DETAIL
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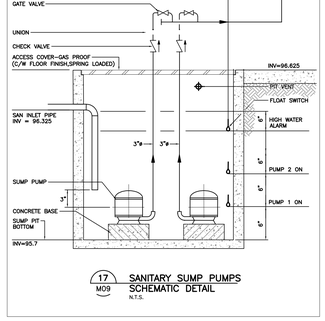
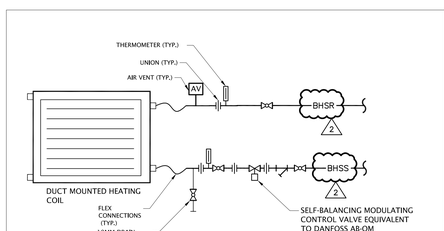


17 M09 SANITARY SUMP PUMPS SCHEMATIC DETAIL
N.T.S.

18 M09 CONDENSING UNIT MOUNTING
N.T.S



19 M09 TERMINAL UNIT RE-HEAT COIL PIPING DETAIL
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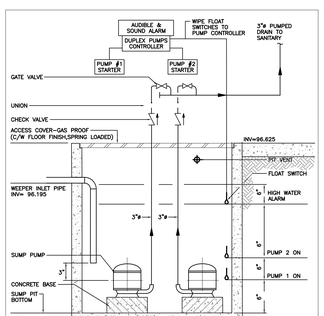

20 M09 WEEPER DRAIN SUMP PUMPS SCHEMATIC DETAIL
N.T.S.

21 M09 AIR VALVE BLANK FLANGE CONNECTION STRAIGHT RUN REQUIREMENT
N.T.S.

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MONTREAL ROAD CAMPUS

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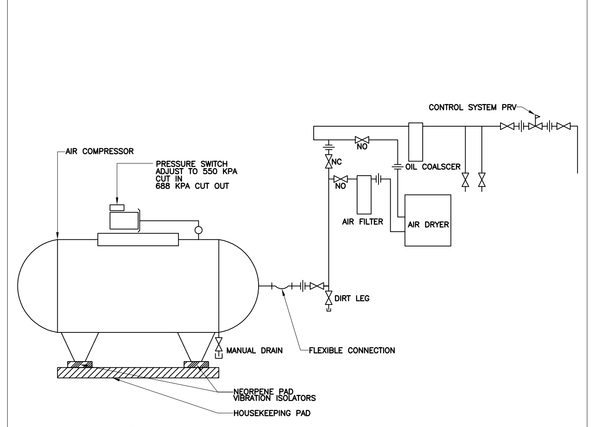
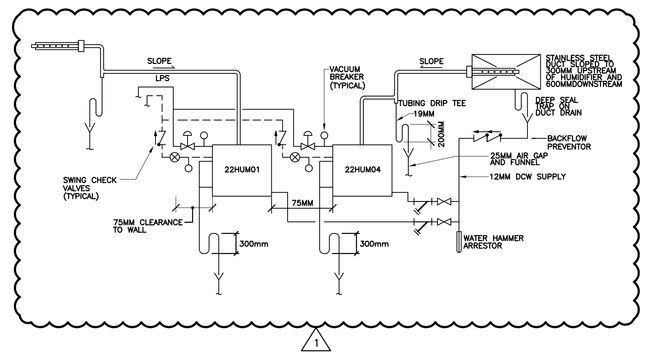
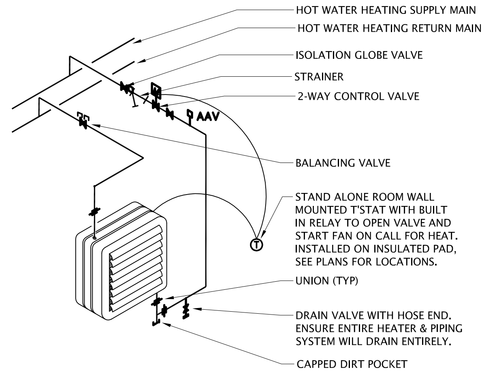


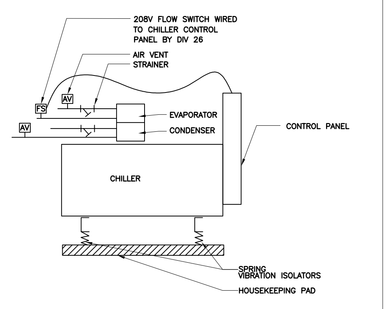
01 M09 COMPRESSED AIR INSTALLATION
N.T.S



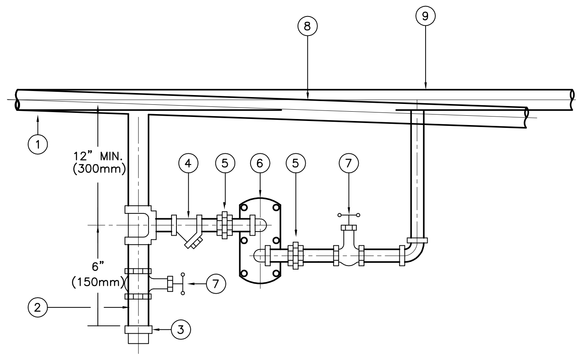
02 M10 HUMIDIFIER INSTALLATION
N.T.S



03 M10 UNIT HEATER PIPING SCHEMATIC
N.T.S

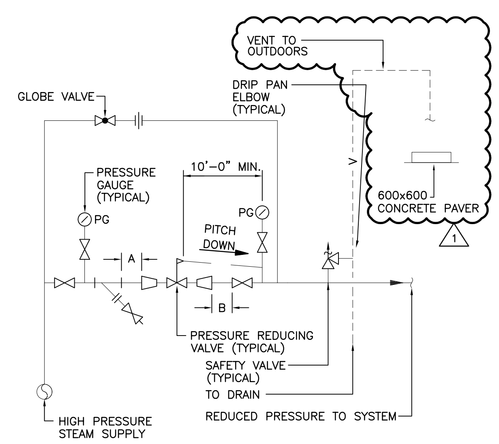


04 M10 CHILLER INSTALLATION
N.T.S



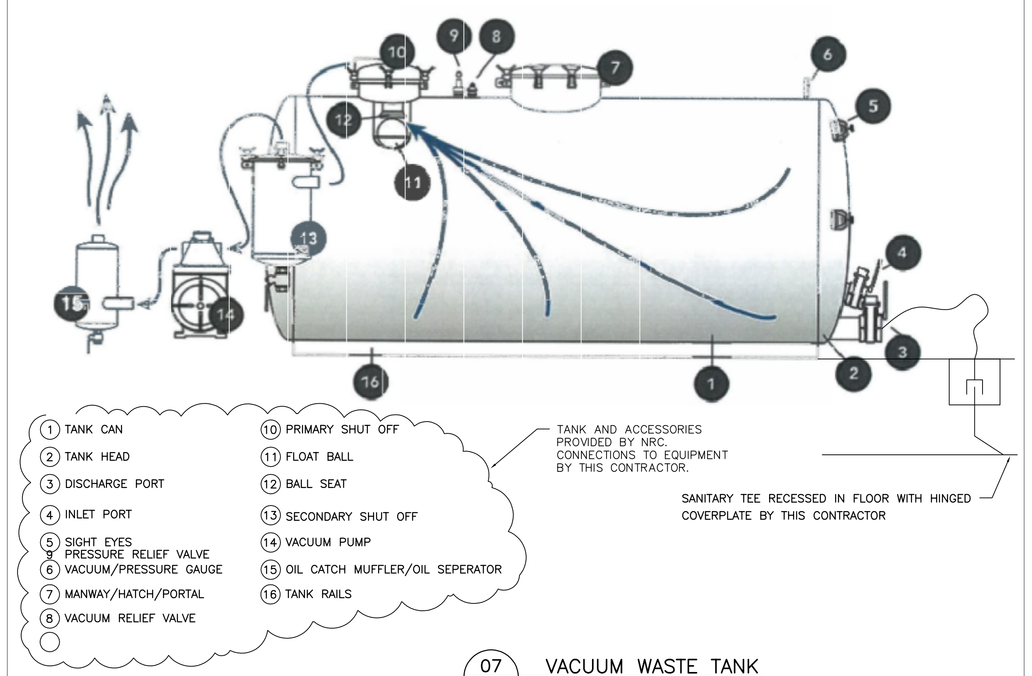
1. RETURN FROM EQUIPMENT. FULL SIZE OF OUTLET CONNECTION.
2. DIRT LEG.
3. REMOVABLE CAP.
4. STRAINER. DO NOT INSTALL ON FRESH AND MIXED AIR COIL OR AFTER A CONTROL VALVE.
5. UNION.
6. TRAP.
7. GATE VALVE.
8. 64MM STEAM MAIN. SLOPE OF STEAM MAIN TO BE 12MM FALL EVERY 3048MM.
9. 38MM CONDENSATE RETURN.

05 M10 STEAM AND CONDENSATE PIPING DIAGRAM OF STEAM TRAP
N.T.S.

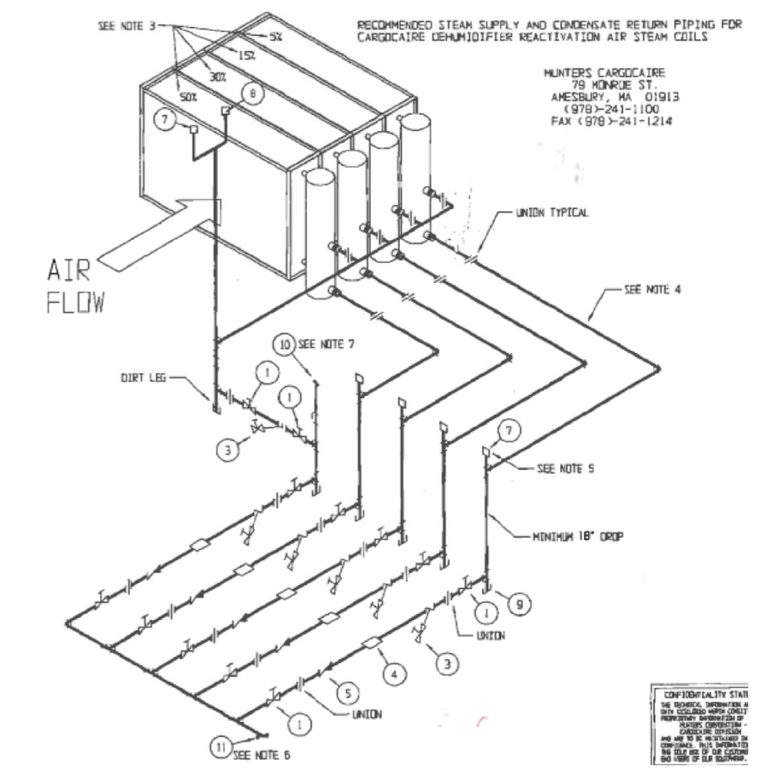


NOTES:
1. LENGTH OF STRAIGHT PIPE SECTION 'A' AND 'B' PER MANUFACTURE REQUIREMENT.
2. RELIEF VALVES ONE OR MORE AS REQUIRED.
3. VENTS THAT TERMINATE ON ROOF TO BE 600MM OFF FINISHED ROOF AND TERMINATE DOWN TURN ELBOW OVER 600x600 CONCRETE PAVER UNDER DISCHARGE.

06 M10 STEAM PIPING DIAGRAM OF PRESSURE REDUCING VALVE STATION
N.T.S.



07 M10 VACUUM WASTE TANK
N.T.S.



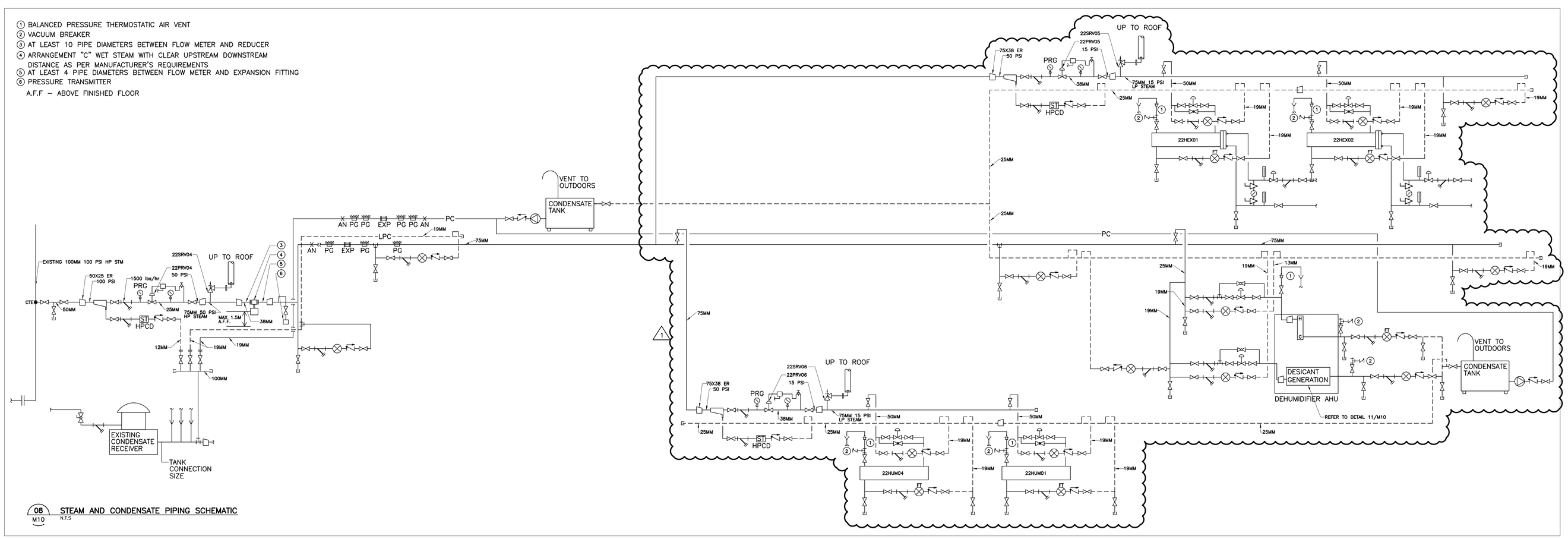
NOTES:
1. QUANTITY OF STEAM COILS REQUIRED IS DETERMINED BY STEAM PRESSURE AVAILABLE, AND REACTIVATION ENERGY REQUIRED.
2. THESE RECOMMENDATIONS ARE FOR GUIDANCE ONLY. IT IS RECOMMENDED THAT THE CUSTOMER CONSULT A STEAM PIPING CONSULTANT FOR SPECIAL REQUIREMENTS.
3. CONDENSATE PIPING AND TRAPS TO BE SIZED PER TRAP MANUFACTURERS SPECIFICATION. COILS TO BE INDIVIDUALLY TRAPPED. THE CONDENSATE LOAD OF EACH COIL IS A PERCENTAGE OF THE TOTAL CONDENSATE LOAD. THE APPROXIMATE PERCENTAGE OF CONDENSATE LOAD FOR EACH COIL IS SHOWN ON SHEET 1. SIZE CONDENSATE TRAPS ACCORDINGLY.
4. CONDENSATE LINES TO BE SAME SIZE AS CONDENSATE CONNECTION ON COIL. REDUCE LINE SIZE AT TRAP USING AN ECCENTRIC REDUCER.
5. AIR VENTS AND VACUUM BREAKERS TO BE HIGHER THAN THE STEAM SUPPLY CONNECTION.
6. CONDENSATE IS TO DRAIN TO A GRAVITY SYSTEM. NO BACK PRESSURE ALLOWED. THERMODYNAMIC TRAPS ARE RECOMMENDED.
7. DO NOT INSTALL MODULATING STEAM VALVE ON COILS. ENERGY MODULATION IS ACHIEVED BY MODULATING AIRFLOW ACROSS COILS. (REFER TO SEQUENCE OF OPERATION). INSTALLATION OF A MODULATING VALVE MAY CAUSE DAMAGE TO STEAM COILS AND MAY VOID WARRANTY.
8. IF SUPPLY VALVE IS USED, IT SHOULD BE SLOW ACTING AND SHOULD BE CLOSED ONLY DURING SYSTEM SHUTDOWN AND WIDE OPEN AT ALL OTHER TIMES.
9. COILS MUST BE INSTALLED LEVEL TO ASSURE PROPER CONDENSATE DRAINAGE.
10. DRAWING SHOWN REPRESENTS HORIZONTAL TUBES FOR VERTICAL TUBE COILS. PIPING REMAINS THE SAME; SUPPLY HEADERS ARE ON TOP OF THE COIL AND CONDENSATE HEATERS ARE ON THE BOTTOM OF THE COIL.
11. SCHEDULE 80 PIPING RECOMMENDED.

1. GATE VALVE
2. WYE STRAINER
3. BLOW DOWN VALVE
4. STEAM TRAP–SEE NOTE 3
5. CHECK VALVE
6.
7. VACUUM BREAKER
8. AIR VENT
9. DIRT LEG
10. STEAM SUPPLY CONNECTION
11. CONDENSATE RETURN CONNECTION

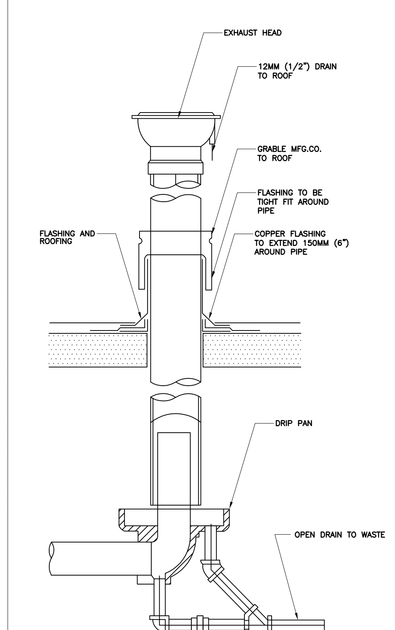
11 M10 STEAM PIPING SUPPLY FOR DEHUMIDIFIER

1. BALANCED PRESSURE THERMOSTATIC AIR VENT
2. VACUUM BREAKER
3. AT LEAST 10 PIPE DIAMETERS BETWEEN FLOW METER AND REDUCER
4. ARRANGEMENT "C" WET STEAM WITH CLEAR UPSTREAM DOWNSTREAM DISTANCE AS PER MANUFACTURER'S REQUIREMENTS
5. AT LEAST 4 PIPE DIAMETERS BETWEEN FLOW METER AND EXPANSION FITTING
6. PRESSURE TRANSMITTER

A.F.F – ABOVE FINISHED FLOOR



08 M10 STEAM AND CONDENSATE PIPING SCHEMATIC
N.T.S



09 M10 DRIP PAN AND EXHAUST FOR PRESSURE RELIEF VALVE

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MONTREAL ROAD CAMPUS

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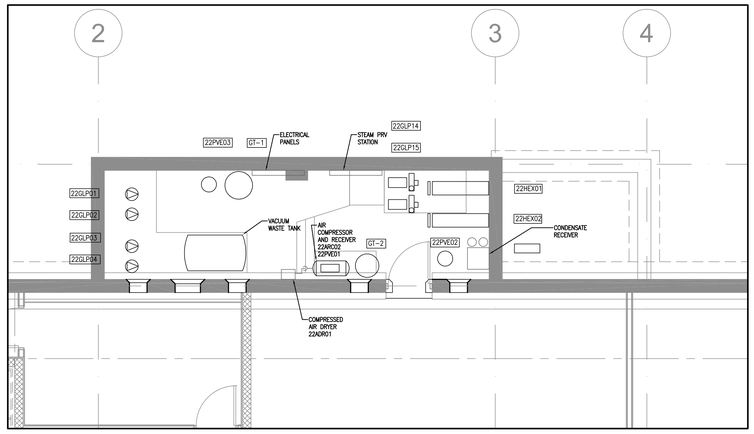
approved / approuvé	W.O.no. / D.T.no.

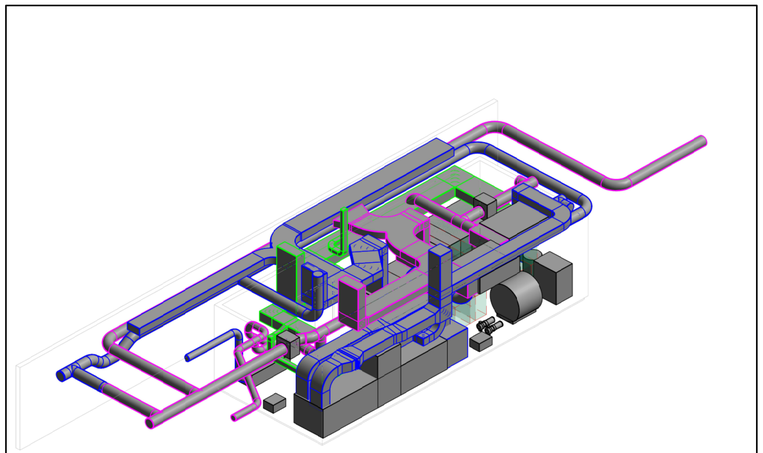
dwg.no. / dessin no.
3788-M10

ASPM A0 (1189x841)



1 / M11 MECHANICAL ROOM 037 ENLARGED PLAN

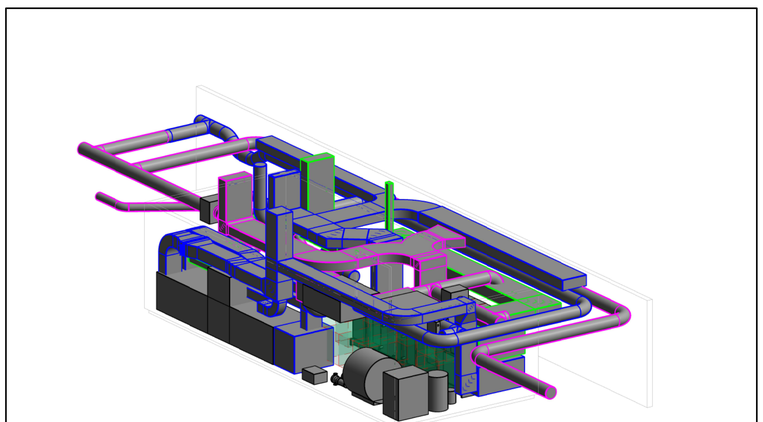
SCALE = 1:50



NOTE: ISOMETRIC VIEWS ARE FOR REPRESENTATION PURPOSES.
DRAWINGS ARE NOT TO BE SCALED NOR ASSUMED COMPLETE.

3 / M11 MECHANICAL ROOM 025 – ISOMETRIC VIEW 1

SCALE = NTS



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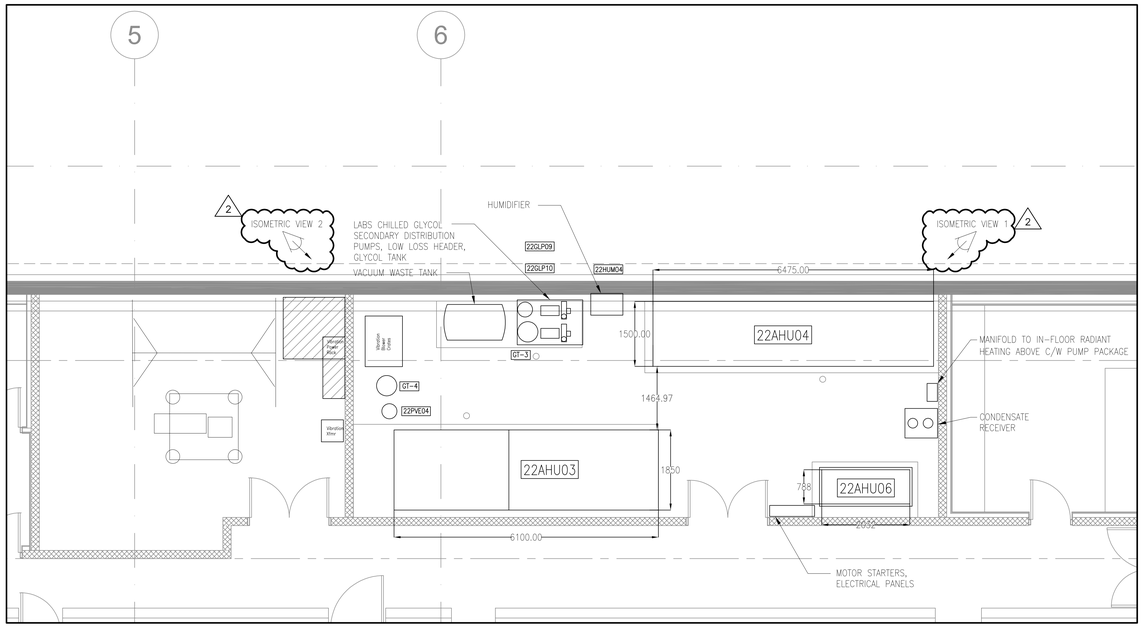
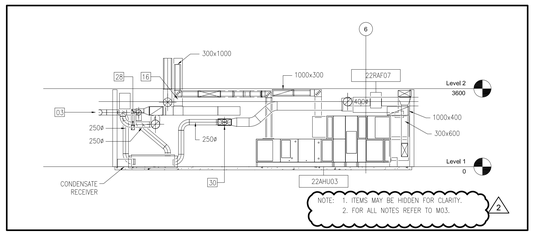
4 / M11 MECHANICAL ROOM 025 – ISOMETRIC VIEW 2

SCALE = NTS.



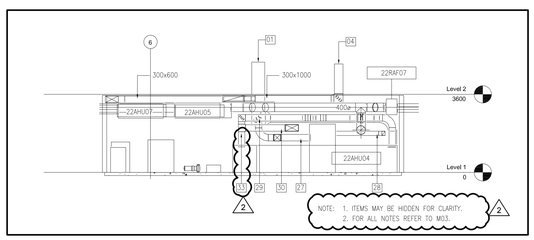
2 / M11 MAIN MECHANICAL ROOM 025 AND VIBRATION LAB EQUIPMENT LAYOUT

SCALE = 1:50



5 / M11 MECH. ROOM 025 SECTION 1

SCALE = 1:100



6 / M11 MECH. ROOM 025 SECTION 2

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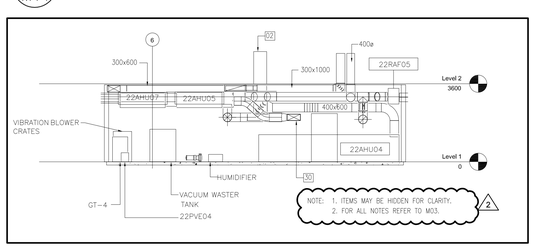

7 / M11 MECH. ROOM 025 SECTION 3

SCALE = 1:100

C

0 10 20mm 40 60 80 100 120 140 160 180 200mm

ASPM A0 (1189x841)

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Conseil national de recherches Canada
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KEY PLAN

No.	Date	Revision	By/Par.
2	10 07 2015	ISSUED FOR ADDENDUM 03	
1	30 06 2015	ISSUED FOR ADDENDUM 02	
0	29 05 2015	ISSUED FOR TENDER	AM

Date Printed 10 APR 2015 Date imprimée

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- Vérifier toutes les dimensions et l'état des lieux et en assumer la responsabilité

A Detail no. No. du détail
B Location drawing no. sur dessin no.
C Drawing no. dessin no.

project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

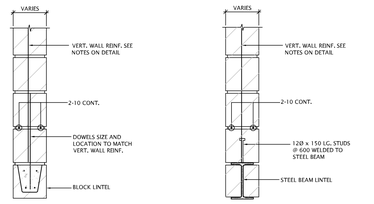
MONTREAL ROAD CAMPUS

drawing / dessin
ENLARGED MECHANICAL ROOM PLANS

designed / conçu	KC	date / date	MAY '15
drawn / dessiné	ALM	scale / échelle	AS SHOWN
checked / vérifié	KC	sheet / feuille	of/de
approved / approuvé		W.O.no.	D.T.no.

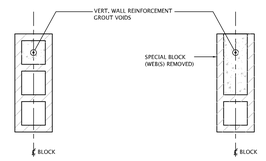
dwg.no. / dessin no.
3788-M11

EARTHQUAKE REINFORCEMENT FOR MASONRY WALLS — TDM-8



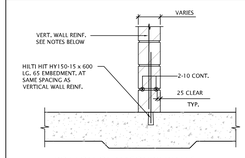
TYPICAL DETAIL AT BLOCK LINTEL SHOWING PLACEMENT OF VERTICAL REINFORCEMENT

DETAIL AT STEEL BEAM LINTEL SHOWING PLACEMENT OF VERTICAL REINFORCEMENT



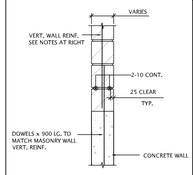
PLAN DETAILS OF BLOCKS SHOWING PLACEMENT OF VERTICAL REINFORCEMENT

EARTHQUAKE ANCHORAGE FOR MASONRY WALLS (BOTTOM) — TDM-7



BOTTOM OF MASONRY WALLS ON REINF. CONCRETE SLABS

BOTTOM OF MASONRY WALLS ON CONCRETE FOOTINGS



BOTTOM OF MASONRY WALLS ON REINF. CONCRETE WALLS

SEISMIC MASONRY REINFORCEMENT

NOTES:

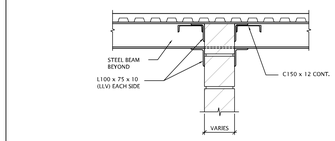
PROVIDE VERTICAL AND HORIZONTAL REINFORCEMENT IN HOLLOW CLAY TILE AND CONCRETE UNIT MASONRY BLOCK WALLS WITH UNSUPPORTED HEIGHT 3000 OR OVER:

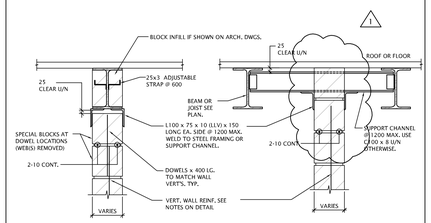
- BAR REINF.: DEFORM BARS OF 400 MPa YIELD STRENGTH.
- VERT. REINF.: VERTICAL BARS
- HORIZ. REINF.: TRUSS TYPE MASONRY REINFORCEMENT.
- SPACING OF REINFORCEMENT

WALL THICKNESS	VERT. BARS	HORIZ. REINF.
100	10 @ 800	3.65 mm @ 400
150	10 @ 800	4.75 mm @ 200
200	10 @ 600	4.75 mm @ 200
250	10 @ 400	4.75 mm @ 200
300	15 @ 400	4.75 mm @ 200

- LAP VERT. REINF. 450 MIN. AND HORIZ. REINF. 150 MIN. AT SPLICES.
- FILL REINFORCED CORES WITH 20 MPa CONCRETE.
- PROVIDE 2-10 BARS ALL AROUND OPENINGS. EXTEND BARS 600 BEYOND EDGES OF OPENINGS.
- PROVIDE 2-10 CONT. BARS AT TOP AND BOTTOM OF WALLS AND PARTITIONS AS DETAILED AND EACH SIDE OF CONTROL JOINTS.

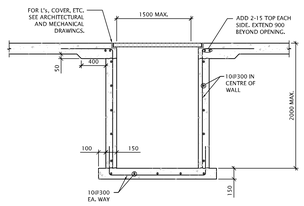
EARTHQUAKE ANCHORAGE FOR MASONRY WALLS (TOP) — TDM-6

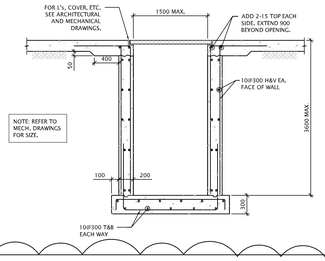




TYPICAL EARTHQUAKE ANCHORAGE AT TOP OF MASONRY WALLS WHERE STRUCTURAL STEEL OCCURS

SUMP PIT DETAILS — TDF-11





REINFORCEMENT FOR MASONRY PARTITIONS — TDM-4

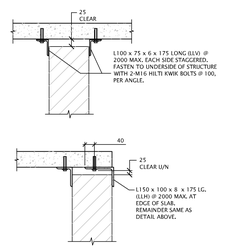
HOLLOW BLOCK THICKNESS	HORIZ. REINF., VERT. SPACING	VERTICAL REINFORCING
90	LADDER REINFORCING (As=21 mm²) @ 400 mm	1-10 @ 1200 mm IN CENTRE OF WALL
140	LADDER REINFORCING (As=21 mm²) @ 400 mm	1-10 @ 1200 mm IN CENTRE OF WALL
190	LADDER REINFORCING (As=21 mm²) @ 400 mm	1-15 @ 1200 mm IN CENTRE OF WALL

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING SERIES 501.
2. HOLLOW LIGHT WEIGHT BLOCK.
3. GROUT CELLS CONTAINING BARS.
4. REFER TO SPECIFICATIONS AND DETAILS FOR SUPPORT AT TOP OF PARTITIONS.

1

LATERAL SUPPORT AT TOP OF MASONRY WALLS — TDM-2



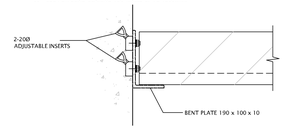
UNDERSIDE OF CONCRETE FRAMING

CONCRETE BLOCK LINTEL — TDM-1

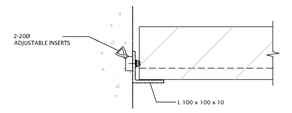
CLEAR SPAN	LINTEL UNIT	90 WALL	140 WALL	190 WALL	240 WALL	290 WALL
190 DEEP LINTEL						
UP TO 1200	190	1-10 B	1-10 B	2-10 B	2-10 B	3-10 B
1200 TO 1800	190	1-15 B	2-10 B	2-15 B	2-15 B	3-15 B
1800 TO 2400	190	1-15 T&B	2-15 T&B	2-15 T&B	2-15 T&B	3-15 T&B
390 DEEP LINTEL						
2400 TO 3000	390	1-15 B	1-15 B	2-15 B	2-15 B	3-15 B

NOTES:

1. USE ONLY FOR NON-LOAD BEARING MASONRY WALLS AND LINTEL SPANS UP TO 1200mm IN LOAD-BEARING WALLS.
2. USE LINTELS ON THIS TYPICAL DETAIL ONLY IF THE HEIGHT OF THE MASONRY ABOVE THE OPENING IS EQUAL TO OR GREATER THAN HALF THE CLEAR SPAN OF THE OPENING AND IF THERE ARE NO CONCENTRATED LOAD DIRECTLY ABOVE THE LINTEL.
3. CONCRETE FILL FOR LINTELS TO HAVE MINIMUM 20 MPa COMPRESSIVE STRENGTH AT 28 DAYS.
4. WHERE LINTELS ABUT CONCRETE COLUMNS OR CONCRETE WALLS, PROVIDE SEAT ANGLE AS SHOWN BELOW. WHERE LINTELS ABUT STEEL COLUMNS, WELD SEAT ANGLE TO THE COLUMN.
5. USE FOR LOAD BEARING 190 WALLS UP TO 1200mm.

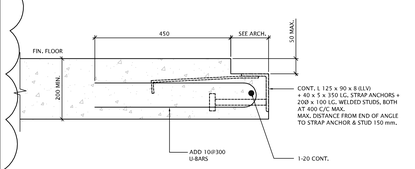


SEAT DETAIL FOR LINTELS GRATER THAN 150 WIDE

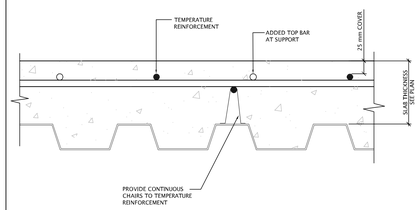


SEAT ANGLE DETAIL FOR LINTELS UP TO 150 WIDE

ANCHORAGE FOR STEEL STAIR — TDS-18



CONCRETE SLAB ON STEEL DECK — TDS-10



NOTES:

1. PROVIDE 10 REINFORCEMENT FOR SLAB THICKNESS UP TO 100 mm. PROVIDE 15 REINFORCEMENT FOR SLAB THICKNESS OVER 100 mm.
2. TOP CONTINUOUS BARS @ 300 WITH MINIMUM 450 LAP AT MIDSPAN AS REQUIRED AND TOP BARS @ WITH LENGTH OF 1/3 OF CENTRE TO CENTRE DISTANCE BETWEEN SUPPORTS, PLACE ON CENTRELINE OF SUPPORT AND ALTERNATE WITH CONTINUOUS TOP BARS.
3. AT DISCONTINUOUS END OF SLABS, AT OPENINGS, AT EXPANSION JOINTS, ETC., ADD 800 LONG ┌ TOP BARS @ 300.
4. TOP TEMPERATURE BARS @ 400 (MINIMUM 450 LAP).
5. AT OPENINGS, PROVIDE 800 LONG┌ TOP BARS @ 400 PERPENDICULAR TO THE SPAN.
6. OVER SUPPORTS PARALLEL TO THE SPAN OF THE DECK, ADD 1800 LONG TOP BARS @ 400 CENTRED AT SUPPORTS.
7. LIVE LOADS FOR STEEL DECK FORM TO BE WEIGHT OF WET CONCRETE PLUS 1.0 kPa CONSTRUCTION ALLOWANCE.
8. CONSTRUCTION JOINTS TO BE LOCATED ON CENTRELINE OF SUPPORTS.

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1	10 07 2015	ISSUED FOR ADDENDUM #03	
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Date Printed 15 MAY 2015 — Date imprimée

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project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

MONTREAL ROAD CAMPUS

drawing / dessin
TYPICAL DETAILS 3

designed / conçu	G. ALEXANDER	date / date	MAY 2015
drawn / dessiné	V. JANUSZKO	scale / échelle	NTS
checked / vérifié	H. SAFFARINI	sheet / of/de / feuille	4 of/de 8
approved / approuvé		W.O.no.	D.T.no.

dwg.no. / dessin no.
3788-S03

ASPM A0 (1189x841)

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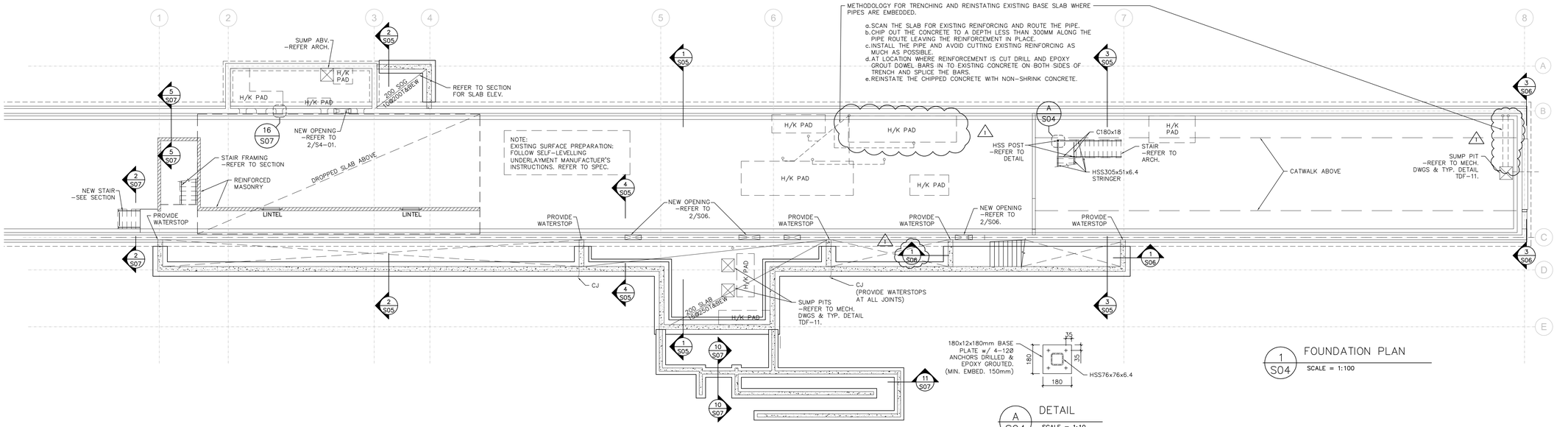

1 S04 FOUNDATION PLAN
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A S04 DETAIL
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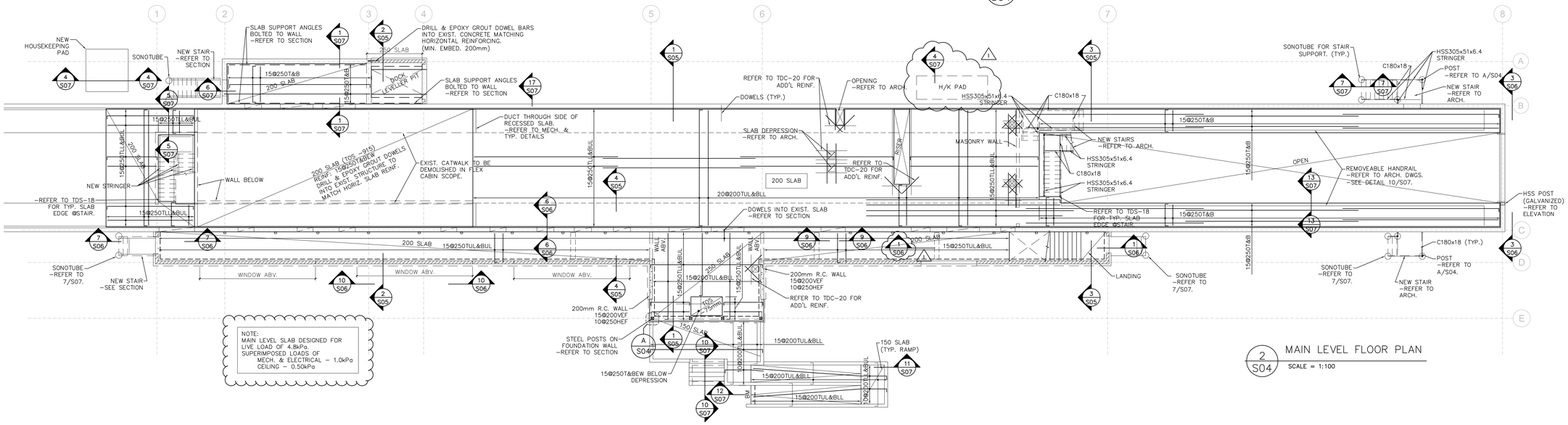

2 S04 MAIN LEVEL FLOOR PLAN
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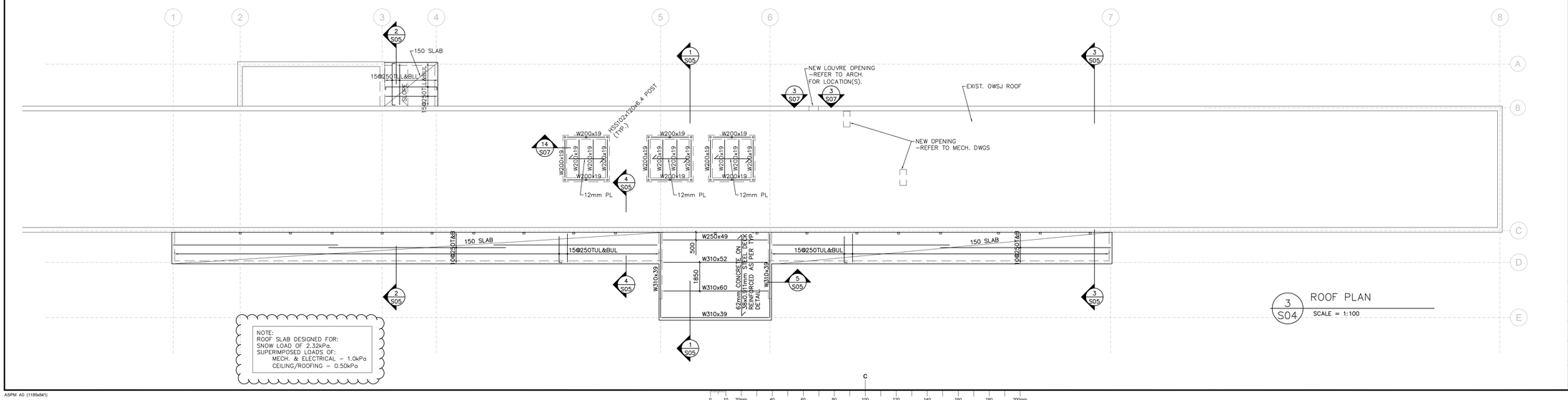

3 S04 ROOF PLAN
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project / projet
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MONTREAL ROAD CAMPUS

drawing / dessin
ROOF PLAN
MAIN LEVEL PLAN
LOWER LEVEL PLAN

designed / conçu	C. ALEXANDER	date / date	MAY 2015
drawn / dessiné	V. JANUSZKO	scale / échelle	1:100
checked / vérifié	H. SAFFARINI	sheet / feuille	5 of/de 8
approved / approuvé		W.O.no.	D.T.no.

dwg.no. / dessin no.
3788-S04

ASPM A0 (1189x841)

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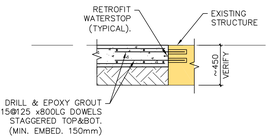

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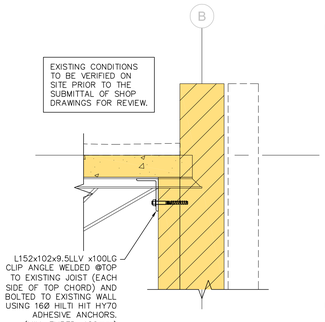

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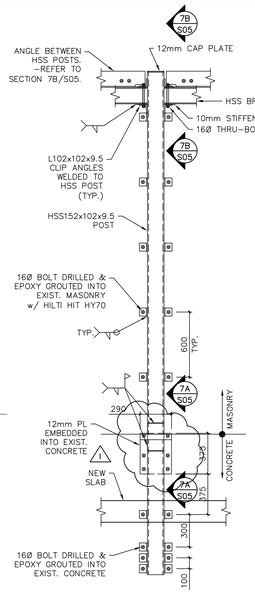
BETWEEN GRIDS 1 AND 7



7 S05 ELEVATION
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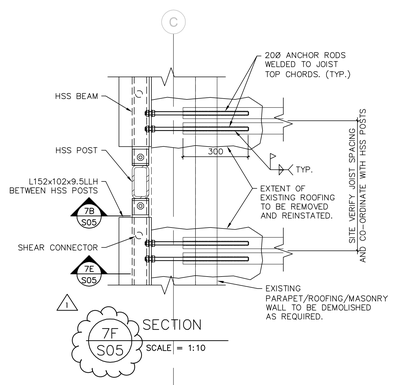

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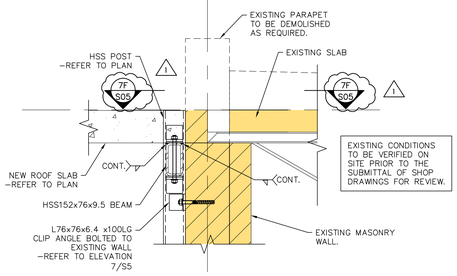

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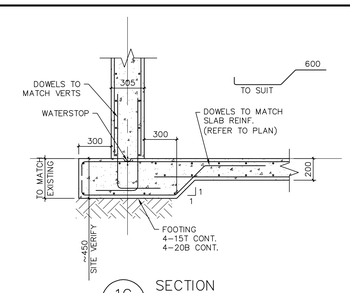

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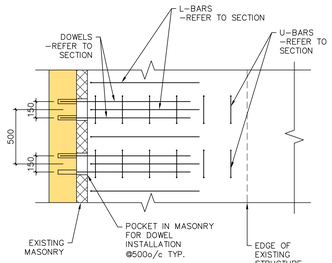

6 S05 TYP. DETAIL AT NEW SLAB/ EXIST. WALL BOTH SIDES
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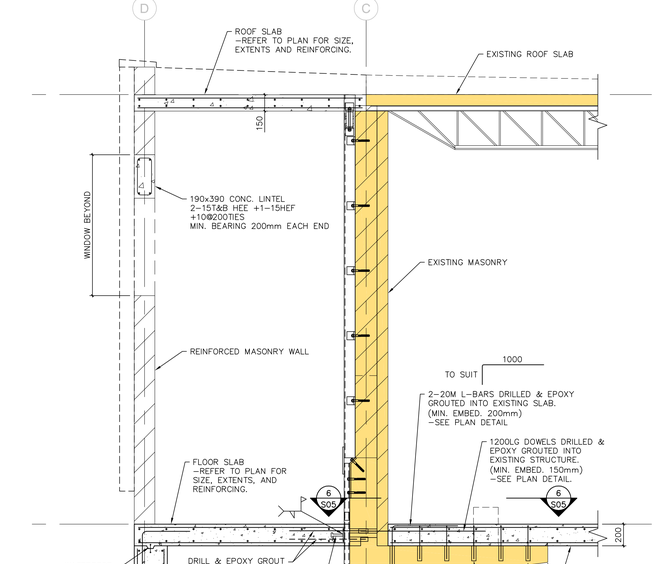

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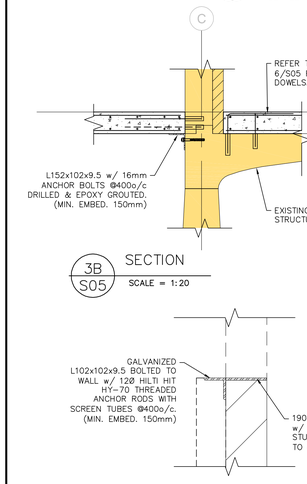

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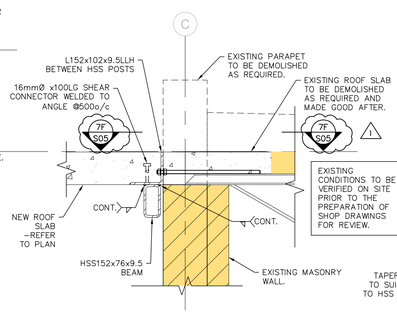

7E S05 SECTION
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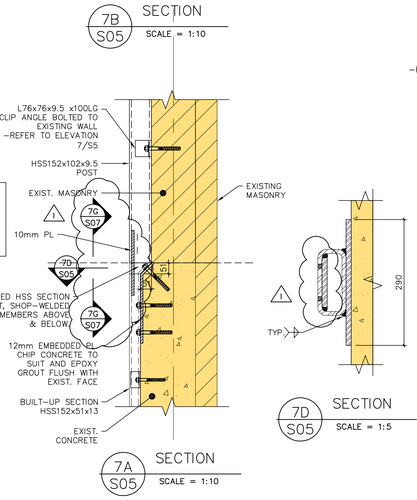
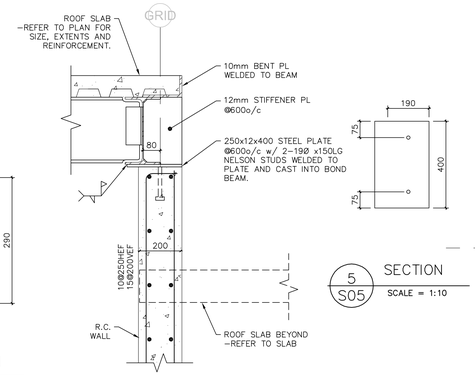


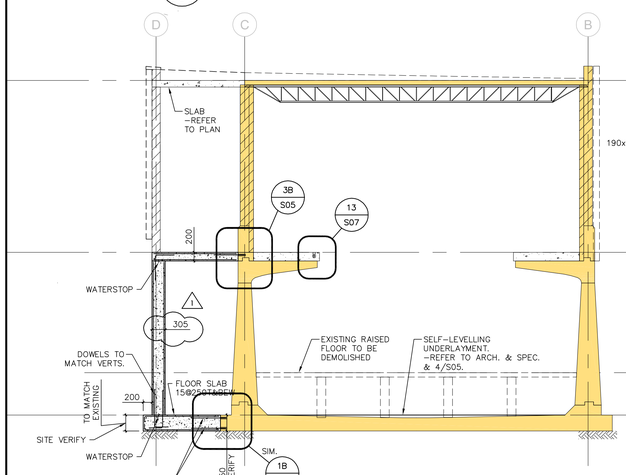
7D S05 SECTION
SCALE = 1:5

7A S05 SECTION
SCALE = 1:10



5 S05 SECTION
SCALE = 1:10

7C S05 SECTION
SCALE = 1:10



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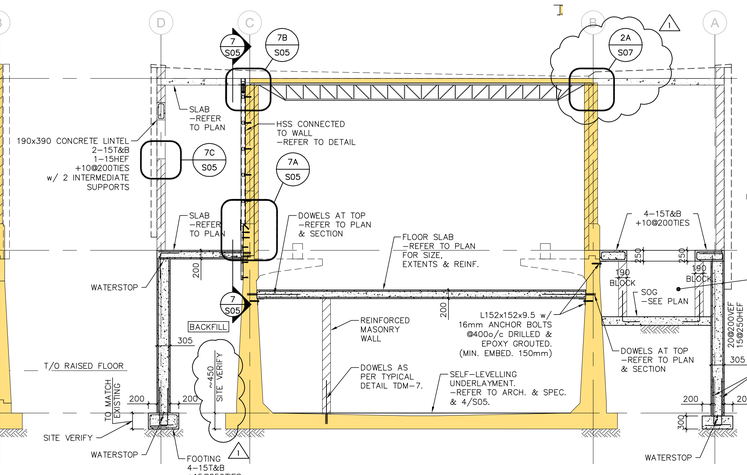
SCALE = 1:50



2 S05 SECTION
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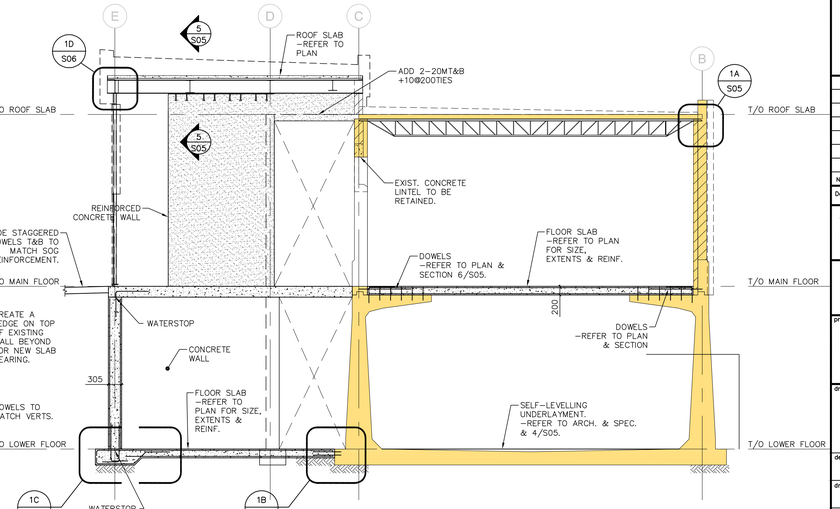

1 S05 SECTION
SCALE = 1:50

0 10 20mm 40 60 80 100 120 140 160 180 200mm

ASPM A0 (1189x841)

National Research Council Canada
Administrative Services and Property Management Branch

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KEY PLAN

No.	Date	Revision	By/ Par.
1	10 07 2015	ISSUED FOR ADDENDUM #03	
0	29 05 2015	ISSUED FOR TENDER	

Date Printed 15 MAY 2015 Date imprimée

- Verify all dimensions and site conditions and be responsible for same
- Vérifier toutes les dimensions et l'état des lieux et en assumer la responsabilité

A Detail no. No. du détail
B Location drawing no. sur dessin no.
C Drawing no. dessin no.

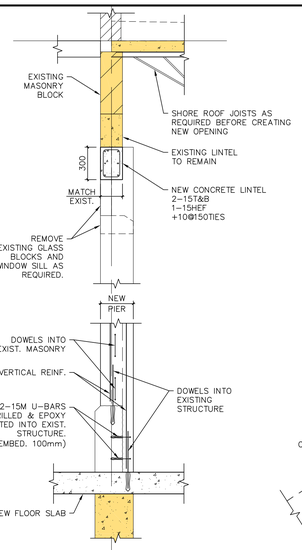
project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

MONTREAL ROAD CAMPUS

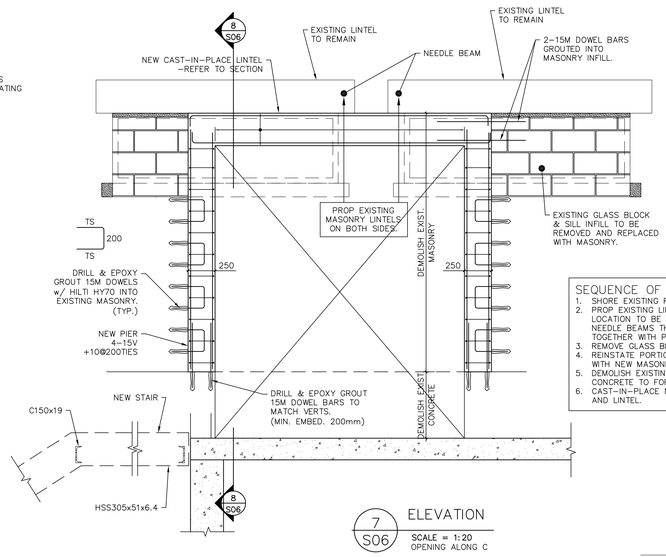
drawing / dessin
SECTIONS & DETAILS 1

designed / conçu: G. ALEXANDER
date: MAY 2015
drawn / dessiné: V. JANUSZKO
scale / échelle: AS NOTED
checked / vérifié: H. SAFFARINI
sheet / feuille: 6 of/de 8
approved / approuvé
W.O.no.
D.T.no.

dwg.no. / dessin no.: 3788-S05



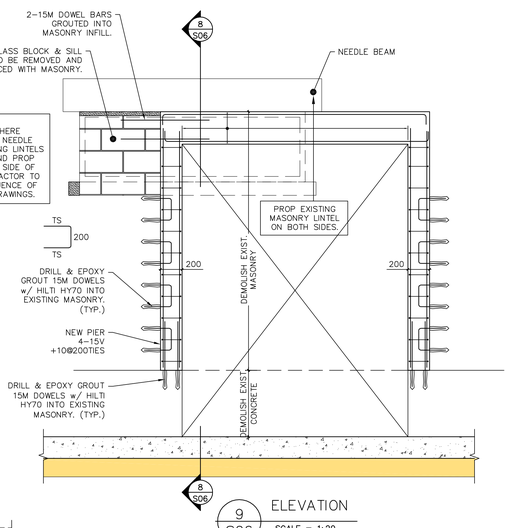
8 S06 SECTION
SCALE = 1:20



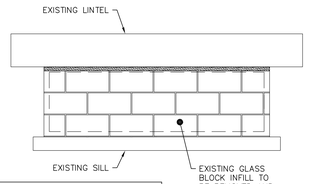
7 S06 ELEVATION
SCALE = 1:20
OPENING ALONG C

NOTE:
FOR ALL EXISTING LINTELS WHERE PROPPING IS REQUIRED, USE NEEDLE BEAMS THROUGH THE EXISTING LINTELS AT THE LINTEL SUPPORTS AND PROP THE NEEDLE BEAM ON EACH SIDE OF THE EXISTING LINTEL. CONTRACTOR TO SUBMIT PROPOSAL FOR SEQUENCE OF CONSTRUCTION AND SHOP DRAWINGS.

SEQUENCE OF CONSTRUCTION:
1. SHORE EXISTING ROOF JOISTS.
2. PROP EXISTING LINTELS AT BEARING LOCATION TO BE DEMOLISHED USING NEEDLE BEAMS THROUGH LINTEL TOGETHER WITH PROPS ON EITHER SIDE.
3. REMOVE GLASS BLOCKS.
4. REINSTATE PORTION OF GLASS BLOCK WITH NEW MASONRY.
5. DEMOLISH EXISTING MASONRY AND CONCRETE TO FORM NEW OPENING.
6. CAST-IN-PLACE NEW CONCRETE JAMBS AND LINTEL.

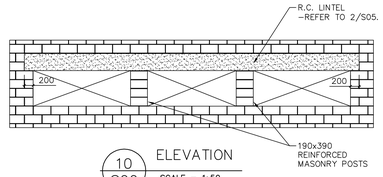


9 S06 ELEVATION
SCALE = 1:20

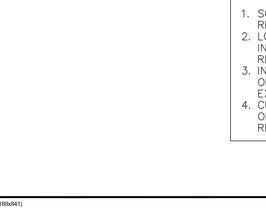


NOTE:
REMOVE EXISTING GLASS BLOCKS AND WINDOW SILL IF REQUIRED AND CLOSE THE OPENING WITH MASONRY. REMOVE ADJACENT MASONRY AS REQUIRED TO FORM KEYS.

4 S06 TYP. WINDOW CLOSURE DETAIL
SCALE = 1:20

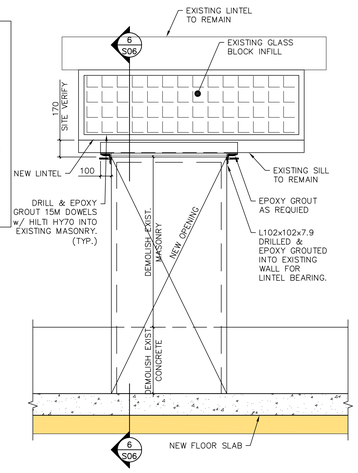


10 S06 ELEVATION
SCALE = 1:50

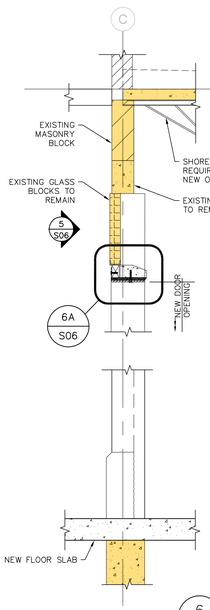


6A S06 SECTION
SCALE = 1:10

SEQUENCE OF CONSTRUCTION (5/S06)
1. CAREFULLY REMOVE THE EXISTING PARGING TO EXPOSE THE GLASS BLOCK SUPPORTS.
2. CREATE GROOVE BETWEEN THE BRICK SUPPORT AND MASONRY TO FACILITATE INSTALLATION OF NEW ANGLE AND INSTALL THE NEW HORIZONTAL ANGLE.
3. CUT THE CENTER THIRD PART OF NEW OPENING FOR THE WIDTH OF NEW LINTEL PLATE.
4. INSTALL THE NEW LINTEL PLATE NORMAL TO THE NEW WALL OPENING AND PROP THE LINTEL PLATE ALIGNING THE CENTER OF OPENING AND CENTER OF LINTEL PLATE WITH THE PROP.
5. CUT THE MASONRY ON BOTH SIDES OF PROP TO FORM THE FULL NEW OPENING.
6. INSTALL ANGLES AT NEW LINTEL BEARING LOCATIONS.
7. INSTALL NEW LINTEL PLATE IN ITS FINAL POSITION BY ROTATING AND WELDING LINTEL PLATE TO THE INSTALLED BEARING ANGLES.
8. GROUT OR REINSTATE THE CUT/DAMAGED MASONRY BLOCKS

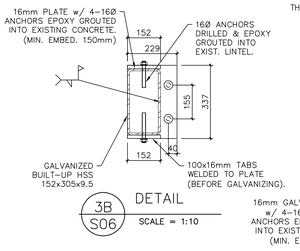


5 S06 TYP. EXIST. OPENING INFILL ABOVE NEW DOOR
SCALE = 1:20

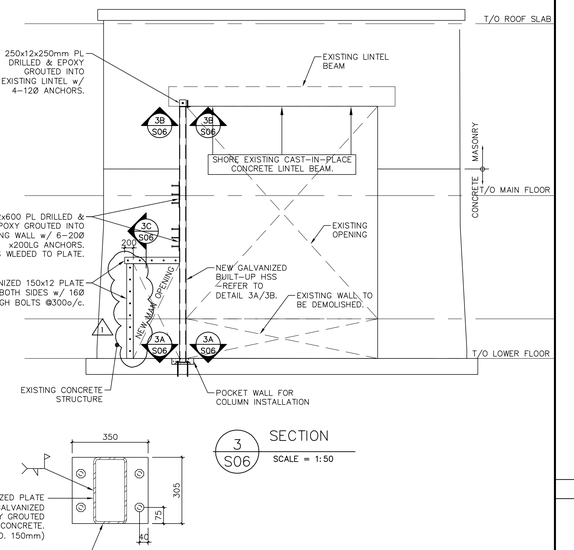


6 S06 SECTION
SCALE = 1:20

SEQUENCE OF CONSTRUCTION (3/S06)
1. CAREFULLY REMOVE EXISTING ROLLING SHUTTER.
2. CUT THE CATWALK SLAB FROM THE WALL AT LOCATION OF NEW STEEL COLUMN.
3. SHORE THE EXISTING OPENING'S LINTEL BEAM.
4. CAREFULLY REMOVE THE VERTICAL STRIP OF CONCRETE/MASONRY TO WIDEN THE EXISTING OPENING ENOUGH FOR NEW COLUMN INSTALLATION.
5. INSTALL PLATES WITH WELDED ANCHORS ON THE CUT FACE OF CONCRETE WALL AS SHOWN.
6. INSTALL THE NEW HSS COLUMN TIGHT AGAINST THE INSTALLED PLATES TO SUPPORT THE LINTEL BEAM.
7. WELD STEEL HSS COLUMN TO THE INSTALLED PLATES.
8. INSTALL NEW REINFORCING PLATES ON BOTH SIDES OF WALL ABOVE THE MAN OPENING.
9. WELD ONE END OF THE PLATE TO THE NEW HSS COLUMN.
10. CUT THE NEW MAN OPENING IN THE EXISTING CONCRETE WALL.
11. WELD THE BOTTOM PLATE TO THE BOTTOM OF THE REINFORCING PLATES.



3B S06 DETAIL
SCALE = 1:10



3 S06 SECTION
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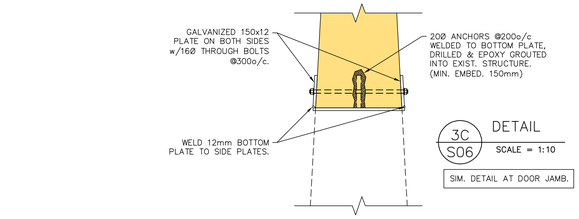
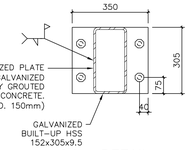
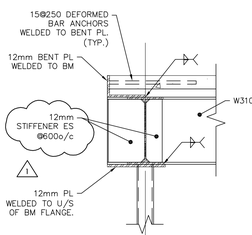


3C S06 DETAIL
SCALE = 1:10

SIM. DETAIL AT DOOR JAMB.



3A S06 DETAIL
SCALE = 1:10



1D S06 SECTION
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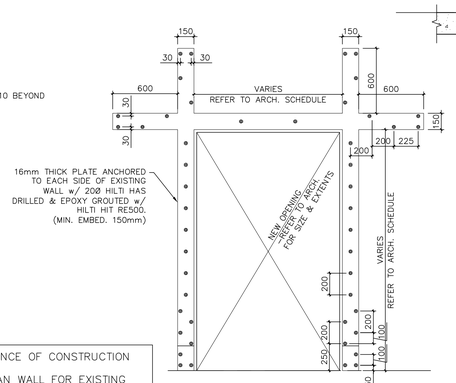
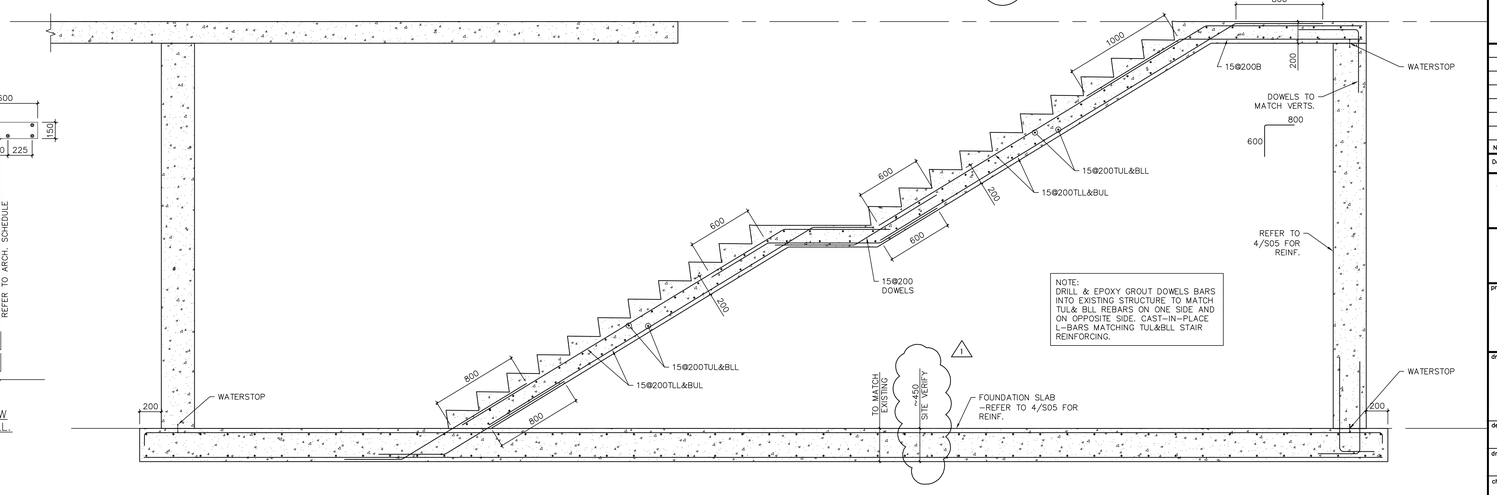


TYPICAL REINFORCING DETAIL AT NEW OPENIGN IN EXISTING CONCRETE WALL.

SEQUENCE OF CONSTRUCTION
1. SCAN WALL FOR EXISTING REINFORCING BARS.
2. LOCATE ANCHORS TO AVOID INTERFERING WITH REINFORCING BARS.
3. INSTALL REINFORCING PLATES ON BOTH SIDES OF THE EXISTING WALL.
4. CUT THE REQUIRED WALL OPENING CLEAR OF THE REINFORCING PLATE.

2 S06 SECTION
SCALE = 1:20



1 S06 SECTION
SCALE = 1:20

C

0 10 20mm 40 60 80 100 120 140 160 180 200mm

ASPM A0 (1189x841)

National Research Council Canada | Conseil national de recherches Canada
Administrative Services and Property Management Branch | Division des services administratifs et gestion de l'immobilier

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1	10 07 2015	ISSUED FOR ADDENDUM #03	
0	29 05 2015	ISSUED FOR TENDER	

Date Printed 15 MAY 2015 — Date imprimée

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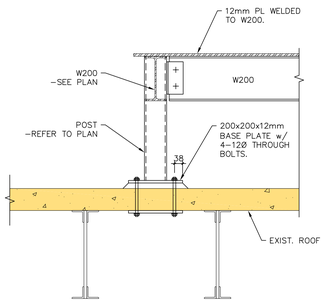
A Detail no. No. du détail
B Location drawing no. sur dessin no.
C Drawing no. dessin no.

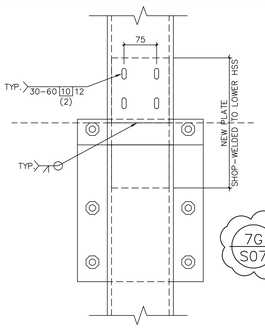
project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY
MONTREAL ROAD CAMPUS

drawing / dessin
SECTIONS & DETAILS 2

designed / conçu	date / date
G. ALEXANDER	MAY 2015
drawn / dessiné	scale / échelle
V. JANUSZKO	AS NOTED
checked / vérifié	sheet / feuille
H. SAFFARINI	7 of/de 8
approved / approuvé	W.O.no. / D.T.no.

dwg.no. / dessin no.
3788-S06





1 / 7G / S07 ELEVATION
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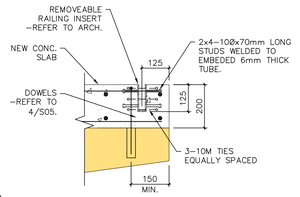
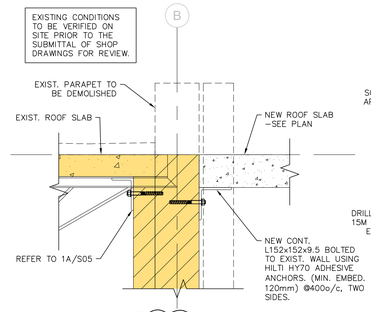


13 / S07 SECTION
SCALE = 1:10



2A / S07 SECTION
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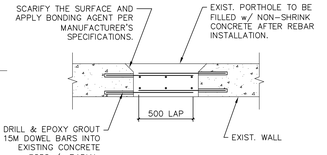
BETWEEN GRIDS 1 AND 7



16 / S07 PORTHOLE INFILL
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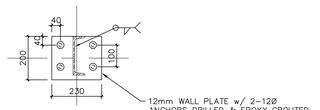
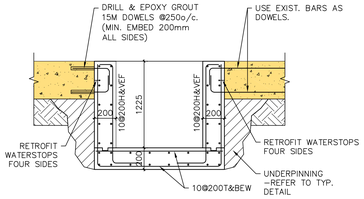


A / S07 WALL PL DETAIL
SCALE = 1:10



15 / S07 SUMP PIT SECTION
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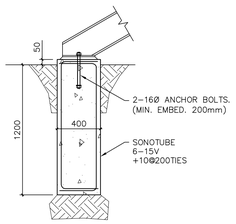

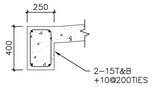

12 / S07 SECTION
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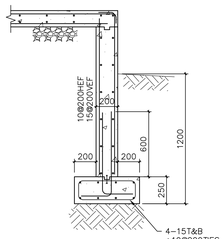

11 / S07 SECTION
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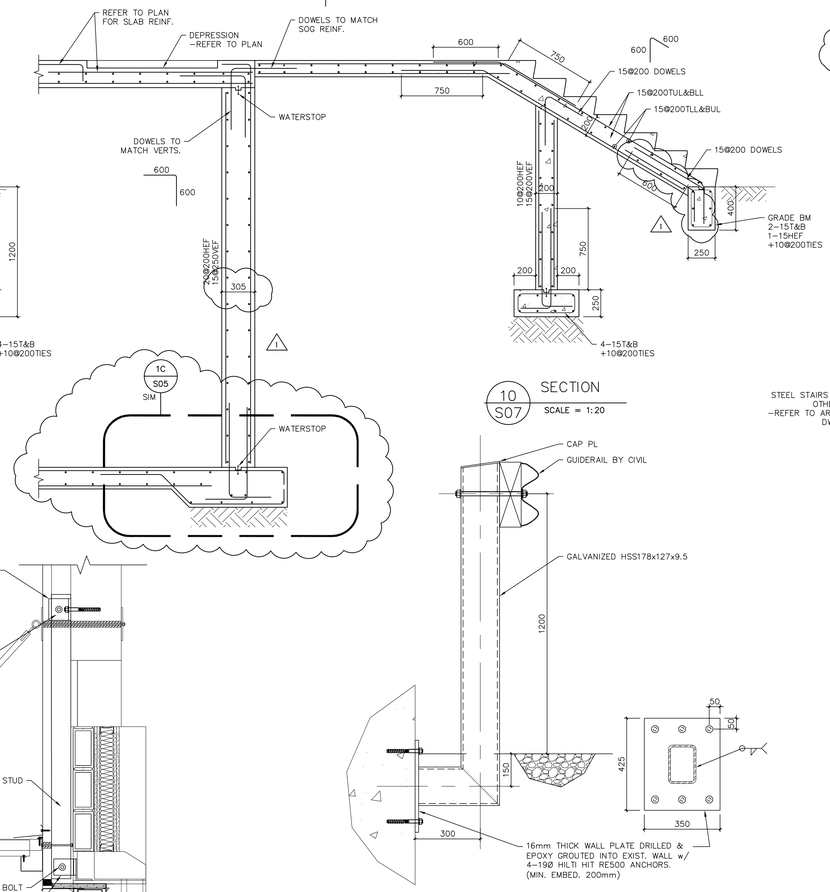
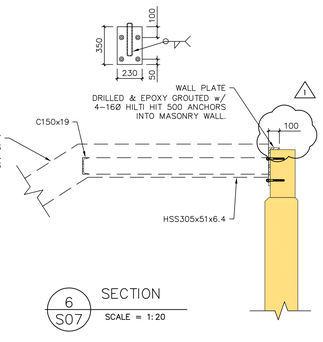


10 / S07 SECTION
SCALE = 1:20

17 / S07 GUIDERAIL DETAIL
SCALE = 1:10



6 / S07 SECTION
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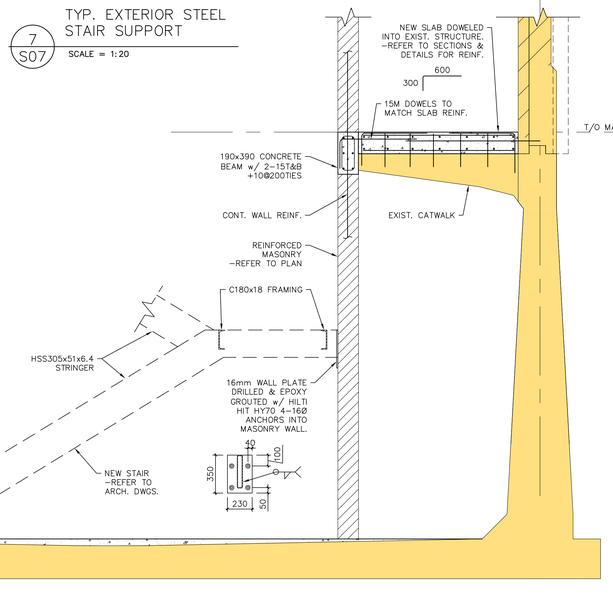

5 / S07 SECTION
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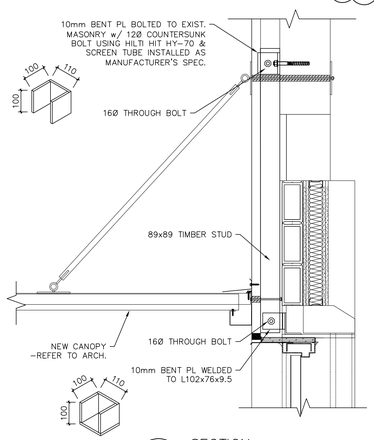

9 / S07 SECTION
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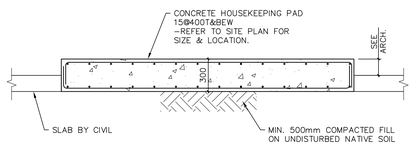

4 / S07 HOUSEKEEPING PAD SECTION
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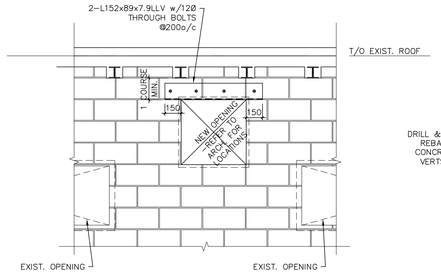
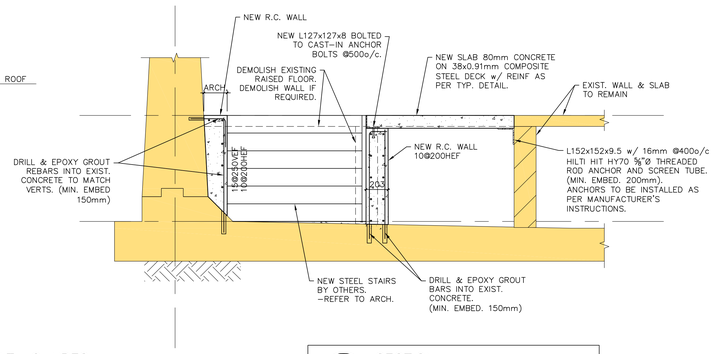


SEQUENCE OF CONSTRUCTION

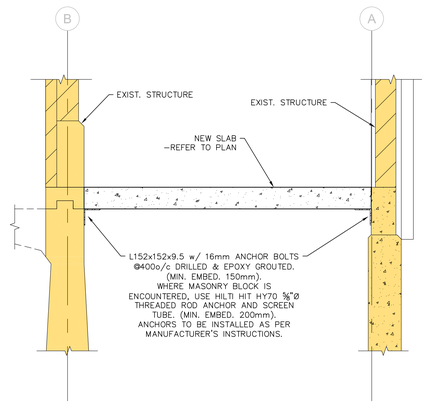
1. CREATE GROOVE BETWEEN CONCRETE BLOCKS AT LOCATION OF NEW LOUVRE OPENING ON BOTH SIDES OF WALL.
2. INSERT L152x89x7.9LLV. ON EITHER SIDE OF WALL INTO THE GROOVE.
3. INSTALL THROUGH BOLTS @200o/c
4. CUT OPENING IN MASONRY WITHOUT DISTURBING NEW LINTEL.

3 / S07 ELEVATION AT LOUVRES
SCALE = 1:20



2 / S07 SECTION
SCALE = 1:20

SITE VERIFY LOCATION OF EXISTING WALL AND REPLACE WALL AND SLAB ONLY IF NECESSARY.



1 / S07 SECTION
SCALE = 1:20

National Research Council Canada
Administrative Services and Property Management Branch
Conseil national de recherches Canada
Division des services administratifs et gestion de l'immobilier
NRC · CNRC

- CONTRACTORS TO CHECK AND VERIFY ALL DIMENSIONS ON SITE PRIOR TO DEMOLITION OR CONSTRUCTION AND REPORT ANY ERRORS OR OMISSIONS TO DEPARTMENTAL REPRESENTATIVE.
- CONTRACTORS MUST VISIT THE SITE & FULLY FAMILIARIZE THEMSELVES WITH THE SCOPE OF THE WORK.
- PREVENT THE SPREAD OF DUST & DEBRIS BEYOND THE WORK AREA AND CLEAN ALL SURFACES AT COMPLETION.
- MAKE GOOD ALL SURFACES AFFECTED BY THIS WORK.
- COORDINATE ALL SHUTDOWNS WITH THE DEPARTMENTAL REPRESENTATIVE.
- PROVIDE ALL LABOUR AND MATERIAL REQUIRED TO FORM A COMPLETE, FUNCTIONAL SYSTEM AS DESCRIBED ON DRAWINGS.

NORR
ARCHITECTS ENGINEERS PLANNERS
NORR Limited
An Ingenium Group Company

KEY PLAN

No.	Date	Revision	By/Par.
1	10 07 2015	ISSUED FOR ADDENDUM #03	
0	29 05 2015	ISSUED FOR TENDER	

Date Printed 15 MAY 2015 — Date imprimée

- Verify all dimensions and site conditions and be responsible for same
- Vérifier toutes les dimensions et l'etat des lieux et en assumer la responsabilité

A Detail no. No. du détail
B Location drawing no. sur dessin no.
C Drawing no. dessin no.

project / projet
NRC CABIN COMFORT + ENVIRONMENTAL RESEARCH FACILITY

MONTREAL ROAD CAMPUS

drawing / dessin
SECTIONS & DETAILS 3

designed / conçu	date	date
G. ALEXANDER	MAY 2015	
drawn / dessiné	scale / échelle	
V. JANUSZKO	AS NOTED	
checked / vérifié	sheet / feuille	
H. SAFFARINI	8 of/de 8	
approved / approuvé	W.O.no.	D.T.no.

dwg.no. / dessin no.
3788-S07

ASPM A0 (1189x841)

0 10 20mm 40 60 80 100 120 140 160 180 200mm

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION

DIVISION 03 – CONCRETE

AS-1	Tactile Walking Surface	Manufacturer: Kinesik or equal and approved Product: Access Tile Colour: Contrasting TBC	Stairs
AS-2	Anti-Slip Inserts	Manufacturer: Balco or equal and approved Product: Stair Nosing Type: H225 Size: 57mm D x 6 mm H Color: Extruded Aluminum with colour contrasted slip resistant strips Fixing: Continuous ball anchor	Stairs

DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

PLAM1	Plastic Laminate	Manufacturer: Arborite Product: P-352 CA Color: Sahara Eclipse Finish: Matte finish	Countertops
PLAM2	Plastic Laminate	Manufacturer: Arborite Product: W-461-EV Color: Sulawesi Dunes Finish: Matte finish	Millwork
PLAM3	Plastic Laminate	Manufacturer: Arborite Product: W-456-EV Color: Silvered Crossfire Pear Finish: Matte finish	Closet doors laminate

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
PLAM4	Plastic Laminate	Manufacturer: Wilsonart Product: 7945K-18 Color: Xanadu Finish: Matte finish	Airport lounge millwork
WD-1	Solid Wood	Material: Maple Thickness :19mm Finish: Stained	Window sill
HW1	Hardware pull	Product: Richelieu Name: Contemporary Antibacterial Stainless Steel Pull - 348 Product no: BP3487105170AB Length: 185mm Material: Stainless Steel	Lower and upper cabinets/drawers

DIVISION 07 – THERMAL & MOISTURE PROTECTION

INS-1	Insulation	Polyiso Insulation (~~avg~~ **min**150mm thk)	Insulation- Roof (min R-30)
INS-2	Insulation	Mineral Fibre Insulation (Roxul Cavity rock or similar) See drawings for thickness	Insulation- Exterior Walls (min R-value/inch = 4.0)
INS-3	Insulation	Mineral Fibre Insulation (Roxul AFB or similar) See drawings for thickness	Insulation- Interior Walls
INS-4	Insulation	75mm Rigid extruded polystyrene foam insulation 50mm Rigid extruded polystyrene foam insulation	Insulation – below slab on grade for distance of 600mm from perimeter foundation walls (min R-15) Insulation – below grade at perimeter foundation walls (min R-10) Refer to drawings for coverage

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
R-1	SBS Modified Roofing	Cap Sheet on Base Sheet on Tapered insulation to roof drains 2nd Layer Insulation INS-1 1st Layer Insulation INS-1 Vapour Barrier 13mm sheathing Reinforced concrete deck or steel deck with concrete infill (refer to structural)	
PNL-1	Steel cladding Wall Panel	Manufacturer: Vicwest or equal and approved Product: Prefinished Metal sheet siding CL 5022-SR or similar to match existing Color: White to match existing Fasteners: Exposed	Exterior Wall Finish
PNL-2	Steel cladding Wall Panel	Manufacturer: Vicwest or equal and approved Product: Prefinished AD300 Vertical Color: White to match existing Size: 300mm x 40mm Fasteners: Hidden	Exterior Wall Finish

DIVISION 08 – OPENINGS

G.W.G	Interior Fire Rated –Wired Glass	Rating: 45min.	Doors in Rated Walls – See A02
GL-1	Sidelights	Glass: Clean Tempered glass Color: Clear Size: ~~12 mm glass~~ **Min 6mm glass/ as engineered to meet OBC/NBC**	Sidelights, interior screens & glazed doors, and vestibule screen & doors.
GL-2	Door panels	Glass: Clean Laminate glass Color: Clear Size: 6 mm glass	Door panels (non-fire rated)

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
GL-3	Millwork glazing	Glass: Frosted & textured Laminate glass Effect: Rain Color: Clear Size: 6 mm glass	Airport lounge millwork
MIR	Mirror	Custom size mirrors	Washrooms
WI-1	Curtain wall system	Manufacturer: Model 1600UT by Kawneer or approved equal Glass Clean Laminate glass **Door E01: Standard entrance door 190 by Kawneer or equivalent** Color: Clear Anodised Size: 6 mm glass with 12mm airspace Low emissivity coating: Solarban 60 by PPG on surface no2 Pilkington Energy Advantage on surface no 4 Spandrel Panel: Opaque matt finished coloured aluminium panel (Reynobond 6mm or 6mm) with insulated back frame. Colour: Mid Grey -TBC	Main entrance glazing
WI-1a	**Curtain wall system**	**Manufacturer:** **Model Trifab 450 by Kawneer or approved equivalent** **Glass: GL-1** **Colour: Clear Anodised** **Door 121: Standard entrance door 350 by Kawneer or equivalent**	**Between Vestibule 121 and Entrance 122**

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
WI-2	High performance window	Manufacturer: Model Isoport by Kawneer or approved equal Glass: As WI-1 Colour: As WI-1 Integral flashing: Reynobond 6mm panel or similar. Colour: to match WI-1 spandrel panel	All other windows

DIVISION 09 – FINISHES

TRM-1	Trim	Manufacture: Johnsonite finishing accessories tool Product: CTA-XX-H 1/4" to 1/8" material	Trim between VCT and Carpet tiles
TRM-2	Trim	Manufacture: Johnsonite finishing accessories tool Product: RRD-XX-C 1/8" material to floor Color: TBD	Trim between Concrete and VCT
TRM-3	Trim	Manufacture: Johnsonite finishing accessories tool Product: SSR-XX-D 1/8" material to 0.080" flooring Color: TBD	Trim between VCT and homogenous vinyl tile
TRM-4	Trim	Manufacture: Johnsonite finishing accessories tool Product: EG-XX-J 3/16" material Color: 44 – dark brown	For carpet edge (to wall) profile in the lower level office rooms.
WB1	Rubber Base	Manufacturer: Johnsonite Style Name: Rubber base Style: Reveal Color: 107 - neutrality Size: 3mm x 100mm	Throughout

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
WB2	Paint Existing wall base	Product: Sherwin Williams Code: SW6991 Color: Black Magic Sheen: Eggshell	Lower floor offices on existing wall
CONC	Sealed Concrete	On-site Untreated/ unpainted & sealed	Mechanical [029], Electrical [028], IT [027], Janitor's room [030], Staircase C (lower level), Receiving area, Flexible cabin lab, Flight Simulation Lab Stair A (main level)
SLCT	Self Levelling Concrete Topping/Floor Underlayment	Untreated	Mechanical [025],Flight simulation lab – lower level [137], Staircase A, Vibration lab [024], FSL observation [026], Laboratory workshops 1 and 2 [033 & 034], Lower level corridor.
VCT1	Vinyl Composite Tile	Manufacturer: Johnsonite Style Name: Azrock Collection Color: V-224 Stonework Size: 304mm x 304mm Installation: Random	Corridor [124], FCL observation Corridor [022] & [023]
VCT2	Vinyl Composite Tile – premium	Manufacturer: Johnsonite Style Name: Azrock Textile Color: V-281 Warm Wool Size: 304mm x 610mm Installation: Brick	Universal washroom [128]
VIN1	Homogenous Vinyl Tiles	Manufacturer: Johnsonite Style Name: iQ Optima Color: 821 Frothy Latte CB Size: 304mm x 304mm tiles Installation: TBD Seam color: TBD	Vestibule, entrance & main floor corridors, washrooms, exam rooms.

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
CPT1	Carpet Tiles (Main levels)	Manufacturer: Tandus Style: Change II 03747 Color: Venus in Furs 10807 Size: 610mm x 610mm Installation: random	Waiting Lounge, Screening, Interview rooms, And Airport Terminal room
CPT2	Carpet Tiles (Offices)	Manufacturer: Tandus Style: Street Life 03973 Color: Brown Derby 36112 Size: 610mm x 610mm Installation: Horizontal ashlar	Lower level offices only
PT1	Paint General	Product: Sherwin Williams Code: SW7003 Color: Toque White Sheen: Eggshell	General wall finish
PT2	Paint Accent	Product: Sherwin Williams Code: SW7502 Color: Dry Dock LRV Sheen: Semi-gloss	Accent paint
PT3	Paint Door	Product: Sherwin Williams Code: SW7031 Color: Mega Greige Sheen: Semi-gloss	Door paint
PT4	Paint Frame	Product: Sherwin Williams Code: SW7545 Color: Pier LRV Sheen: high-gloss	Door frame paint

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
PT5	Painted exposed steel deck/beams/ mech equip	Product: Sherwin Williams Code: SW7003 Color: Toque White Sheen: Eggshell	General exposed ceiling paint
PT6	Painted exposed steel deck/beams/ mech equip	Product: Sherwin Williams Code: SW7020 Color: Black Fox Sheen: Eggshell	Painted black in waiting lounge and airport terminal
C-1	Acoustical Ceiling Tile	Manufacturer: Armstrong or equal and approved Product: Cortega Lay-in 769 Color: White Edge Detail: Square Lay in Size: 610mm x 1220mm x 15.8mm Grid: Prelude ML 15/16” Exposed Tee NRC: 0.55	General ceiling tiles
C-2	Suspended Gypsum Drywall		
C-3	Suspended acoustical ceiling (accent)	Manufacturer: Rockfon or equal and approved Product: Rockfon island 8100 Color: White Edge Detail: DMT Size: 1160mm x 1160mm x 40mm	Waiting lounge and airport terminal

DIVISION 10 – SPECIALTIES

PTN1	Washroom Partitions	Manufacturer: Bobrick or equal and approved Product: High Pressure Laminate Classic Series 1541 Mounting: floor anchored Finish: Arborite P-271 CA Colour: Fresh Mist	Toilet Compartments

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
PTN2	Urinal Partitions	Manufacturer: Bobrick or equal and approved Product: High Pressure Laminate Classic Series 1545 Mounting: Wall hung Finish: Arborite P-271 CA Colour: Fresh Mist	Urinals
WG1	Wall Guard	Manufacturer: Richelieu or equal and approved Product: Nelplas Wall protection System – 470 series Code: 470 Accessory: 470E end cap Size: 4” high Finish: Aluminum	Around high traffic areas: corridors, washroom, and entrance.
FG	Foot grille	Manufacturer: CSgroup Product: PEDIGRID-SA G8 Deep frame with drain and Pan.	Main entrance vestibule

END OF SECTION

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION

DIVISION 03 – CONCRETE

AS-1	Tactile Walking Surface	Manufacturer: Kinesik or equal and approved Product: Access Tile Colour: Contrasting TBC	Stairs
AS-2	Anti-Slip Inserts	Manufacturer: Balco or equal and approved Product: Stair Nosing Type: H225 Size: 57mm D x 6 mm H Color: Extruded Aluminum with colour contrasted slip resistant strips Fixing: Continuous ball anchor	Stairs

DIVISION 06 – WOOD, PLASTICS AND COMPOSITES

PLAM1	Plastic Laminate	Manufacturer: Arborite Product: P-352 CA Color: Sahara Eclipse Finish: Matte finish	Countertops
PLAM2	Plastic Laminate	Manufacturer: Arborite Product: W-461-EV Color: Sulawesi Dunes Finish: Matte finish	Millwork
PLAM3	Plastic Laminate	Manufacturer: Arborite Product: W-456-EV Color: Silvered Crossfire Pear Finish: Matte finish	Closet doors laminate

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
PLAM4	Plastic Laminate	Manufacturer: Wilsonart Product: 7945K-18 Color: Xanadu Finish: Matte finish	Airport lounge millwork
WD-1	Solid Wood	Material: Maple Thickness :19mm Finish: Stained	Window sill
HW1	Hardware pull	Product: Richelieu Name: Contemporary Antibacterial Stainless Steel Pull - 348 Product no: BP3487105170AB Length: 185mm Material: Stainless Steel	Lower and upper cabinets/drawers

DIVISION 07 – THERMAL & MOISTURE PROTECTION

INS-1	Insulation	Polyiso Insulation (~~avg~~ **min**150mm thk)	Insulation- Roof (min R-30)
INS-2	Insulation	Mineral Fibre Insulation (Roxul Cavity rock or similar) See drawings for thickness	Insulation- Exterior Walls (min R-value/inch = 4.0)
INS-3	Insulation	Mineral Fibre Insulation (Roxul AFB or similar) See drawings for thickness	Insulation- Interior Walls
INS-4	Insulation	75mm Rigid extruded polystyrene foam insulation 50mm Rigid extruded polystyrene foam insulation	Insulation – below slab on grade for distance of 600mm from perimeter foundation walls (min R-15) Insulation – below grade at perimeter foundation walls (min R-10) Refer to drawings for coverage

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
R-1	SBS Modified Roofing	Cap Sheet on Base Sheet on Tapered insulation to roof drains 2nd Layer Insulation INS-1 1st Layer Insulation INS-1 Vapour Barrier 13mm sheathing Reinforced concrete deck or steel deck with concrete infill (refer to structural)	
PNL-1	Steel cladding Wall Panel	Manufacturer: Vicwest or equal and approved Product: Prefinished Metal sheet siding CL 5022-SR or similar to match existing Color: White to match existing Fasteners: Exposed	Exterior Wall Finish
PNL-2	Steel cladding Wall Panel	Manufacturer: Vicwest or equal and approved Product: Prefinished AD300 Vertical Color: White to match existing Size: 300mm x 40mm Fasteners: Hidden	Exterior Wall Finish

DIVISION 08 – OPENINGS

G.W.G	Interior Fire Rated –Wired Glass	Rating: 45min.	Doors in Rated Walls – See A02
GL-1	Sidelights	Glass: Clean Tempered glass Color: Clear Size: ~~12 mm glass~~ **Min 6mm glass/ as engineered to meet OBC/NBC**	Sidelights, interior screens & glazed doors, and vestibule screen & doors.
GL-2	Door panels	Glass: Clean Laminate glass Color: Clear Size: 6 mm glass	Door panels (non-fire rated)

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
GL-3	Millwork glazing	Glass: Frosted & textured Laminate glass Effect: Rain Color: Clear Size: 6 mm glass	Airport lounge millwork
MIR	Mirror	Custom size mirrors	Washrooms
WI-1	Curtain wall system	Manufacturer: Model 1600UT by Kawneer or approved equal Glass Clean Laminate glass **Door E01: Standard entrance door 190 by Kawneer or equivalent** Color: Clear Anodised Size: 6 mm glass with 12mm airspace Low emissivity coating: Solarban 60 by PPG on surface no2 Pilkington Energy Advantage on surface no 4 Spandrel Panel: Opaque matt finished coloured aluminium panel (Reynobond 6mm or 6mm) with insulated back frame. Colour: Mid Grey -TBC	Main entrance glazing
WI-1a	**Curtain wall system**	**Manufacturer:** **Model Trifab 450 by Kawneer or approved equivalent** **Glass: GL-1** **Colour: Clear Anodised** **Door 121: Standard entrance door 350 by Kawneer or equivalent**	**Between Vestibule 121 and Entrance 122**

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
WI-2	High performance window	Manufacturer: Model Isoport by Kawneer or approved equal Glass: As WI-1 Colour: As WI-1 Integral flashing: Reynobond 6mm panel or similar. Colour: to match WI-1 spandrel panel	All other windows

DIVISION 09 – FINISHES

TRM-1	Trim	Manufacture: Johnsonite finishing accessories tool Product: CTA-XX-H 1/4" to 1/8" material	Trim between VCT and Carpet tiles
TRM-2	Trim	Manufacture: Johnsonite finishing accessories tool Product: RRD-XX-C 1/8" material to floor Color: TBD	Trim between Concrete and VCT
TRM-3	Trim	Manufacture: Johnsonite finishing accessories tool Product: SSR-XX-D 1/8" material to 0.080" flooring Color: TBD	Trim between VCT and homogenous vinyl tile
TRM-4	Trim	Manufacture: Johnsonite finishing accessories tool Product: EG-XX-J 3/16" material Color: 44 – dark brown	For carpet edge (to wall) profile in the lower level office rooms.
WB1	Rubber Base	Manufacturer: Johnsonite Style Name: Rubber base Style: Reveal Color: 107 - neutrality Size: 3mm x 100mm	Throughout

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
WB2	Paint Existing wall base	Product: Sherwin Williams Code: SW6991 Color: Black Magic Sheen: Eggshell	Lower floor offices on existing wall
CONC	Sealed Concrete	On-site Untreated/ unpainted & sealed	Mechanical [029], Electrical [028], IT [027], Janitor's room [030], Staircase C (lower level), Receiving area, Flexible cabin lab, Flight Simulation Lab Stair A (main level)
SLCT	Self Levelling Concrete Topping/Floor Underlayment	Untreated	Mechanical [025],Flight simulation lab – lower level [137], Staircase A, Vibration lab [024], FSL observation [026], Laboratory workshops 1 and 2 [033 & 034], Lower level corridor.
VCT1	Vinyl Composite Tile	Manufacturer: Johnsonite Style Name: Azrock Collection Color: V-224 Stonework Size: 304mm x 304mm Installation: Random	Corridor [124], FCL observation Corridor [022] & [023]
VCT2	Vinyl Composite Tile – premium	Manufacturer: Johnsonite Style Name: Azrock Textile Color: V-281 Warm Wool Size: 304mm x 610mm Installation: Brick	Universal washroom [128]
VIN1	Homogenous Vinyl Tiles	Manufacturer: Johnsonite Style Name: iQ Optima Color: 821 Frothy Latte CB Size: 304mm x 304mm tiles Installation: TBD Seam color: TBD	Vestibule, entrance & main floor corridors, washrooms, exam rooms.

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
CPT1	Carpet Tiles (Main levels)	Manufacturer: Tandus Style: Change II 03747 Color: Venus in Furs 10807 Size: 610mm x 610mm Installation: random	Waiting Lounge, Screening, Interview rooms, And Airport Terminal room
CPT2	Carpet Tiles (Offices)	Manufacturer: Tandus Style: Street Life 03973 Color: Brown Derby 36112 Size: 610mm x 610mm Installation: Horizontal ashlar	Lower level offices only
PT1	Paint General	Product: Sherwin Williams Code: SW7003 Color: Toque White Sheen: Eggshell	General wall finish
PT2	Paint Accent	Product: Sherwin Williams Code: SW7502 Color: Dry Dock LRV Sheen: Semi-gloss	Accent paint
PT3	Paint Door	Product: Sherwin Williams Code: SW7031 Color: Mega Greige Sheen: Semi-gloss	Door paint
PT4	Paint Frame	Product: Sherwin Williams Code: SW7545 Color: Pier LRV Sheen: high-gloss	Door frame paint

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
PT5	Painted exposed steel deck/beams/ mech equip	Product: Sherwin Williams Code: SW7003 Color: Toque White Sheen: Eggshell	General exposed ceiling paint
PT6	Painted exposed steel deck/beams/ mech equip	Product: Sherwin Williams Code: SW7020 Color: Black Fox Sheen: Eggshell	Painted black in waiting lounge and airport terminal
C-1	Acoustical Ceiling Tile	Manufacturer: Armstrong or equal and approved Product: Cortega Lay-in 769 Color: White Edge Detail: Square Lay in Size: 610mm x 1220mm x 15.8mm Grid: Prelude ML 15/16” Exposed Tee NRC: 0.55	General ceiling tiles
C-2	Suspended Gypsum Drywall		
C-3	Suspended acoustical ceiling (accent)	Manufacturer: Rockfon or equal and approved Product: Rockfon island 8100 Color: White Edge Detail: DMT Size: 1160mm x 1160mm x 40mm	Waiting lounge and airport terminal

DIVISION 10 – SPECIALTIES

PTN1	Washroom Partitions	Manufacturer: Bobrick or equal and approved Product: High Pressure Laminate Classic Series 1541 Mounting: floor anchored Finish: Arborite P-271 CA Colour: Fresh Mist	Toilet Compartments

NOTE: The application / location for the materials indicated is not limited to the list below and is to be used in conjunction with and may be supplemented by, the Specifications, Schedules and Drawings. Refer to Specifications, Schedules and Drawings for full extent of material application and additional material types.

CODE	ITEM	DESCRIPTION	APPLICATION / LOCATION
PTN2	Urinal Partitions	Manufacturer: Bobrick or equal and approved Product: High Pressure Laminate Classic Series 1545 Mounting: Wall hung Finish: Arborite P-271 CA Colour: Fresh Mist	Urinals
WG1	Wall Guard	Manufacturer: Richelieu or equal and approved Product: Nelplas Wall protection System – 470 series Code: 470 Accessory: 470E end cap Size: 4” high Finish: Aluminum	Around high traffic areas: corridors, washroom, and entrance.
FG	Foot grille	Manufacturer: CSgroup Product: PEDIGRID-SA G8 Deep frame with drain and Pan.	Main entrance vestibule

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Submit to NRC Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to NRC Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify NRC Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work is co-ordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by NRC Departmental Representative's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by NRC Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit shop drawings bearing stamp and signature of qualified professional engineer registered or licensed in Province of Ontario, Canada.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 14 days for NRC Departmental Representative's review of each submission.

.5 Adjustments made on shop drawings by NRC Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to NRC Departmental Representative prior to proceeding with Work.

.6 Make changes in shop drawings as NRC Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify NRC Departmental Representative in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter, in duplicate, containing:

.1 Date.
.2 Project title and number.
.3 Contractor's name and address.
.4 Identification and quantity of each shop drawing, product data and sample.
.5 Other pertinent data.

.8 Submissions include:

.1 Date and revision dates.
.2 Project title and number.
.3 Name and address of:
.1 Subcontractor.
.2 Supplier.
.3 Manufacturer.
.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
.5 Details of appropriate portions of Work as applicable:
.1 Fabrication.
.2 Layout, showing dimensions, including identified field dimensions, and clearances.
.3 Setting or erection details.
.4 Capacities.
.5 Performance characteristics.
.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.9 After NRC Departmental Representative's review, distribute copies.

.10 Submit 6 prints of shop drawings for each requirement requested in specification Sections and as NRC Departmental Representative may reasonably request.

.11 Submit 6 print copies of product data sheets or brochures for requirements requested in specification Sections and as requested by NRC Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit 6 copies of test reports for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

.13 Submit 6 copies of certificates for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of project contract complete with project name.

.14 Submit 6 copies of manufacturers instructions for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.15 Submit 6 print copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.16 Submit ~~6 copies of Operation and~~**bilingual copies of** Maintenance **Manual**~~Data~~ for requirements requested in specification Sections and as requested by NRC Departmental Representative. **Refer to Section 01 10 00 – General Instructions for more information.**

.17 Delete information not applicable to project.

.18 Supplement standard information to provide details applicable to project.

.19 If upon review by NRC Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, transparency copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.20 The review of shop drawings by NRC Departmental Representative is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that NRC Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

.1 Submit for review samples in triplicate as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to NRC Departmental Representative's business address site office.

.3 Notify NRC Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by NRC Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to NRC Departmental Representative prior to proceeding with Work.

.6 Make changes in samples which NRC Departmental Representative may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

.1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic and hard copy of colour digital photography in jpg format, standard resolution monthly with progress statement and as directed by NRC Departmental Representative.

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4 locations.

.1 Viewpoints and their location as determined by NRC Departmental Representative.

.4 Frequency of photographic documentation: weekly as directed by NRC Departmental Representative.

1.6 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Compensation Board status.

.2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

Not Used.

Part 3 Execution

Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Submit to NRC Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to NRC Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify NRC Departmental Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work is co-ordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by NRC Departmental Representative's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by NRC Departmental Representative review.

.10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.2 Submit shop drawings bearing stamp and signature of qualified professional engineer registered or licensed in Province of Ontario, Canada.

.3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.4 Allow 14 days for NRC Departmental Representative's review of each submission.

.5 Adjustments made on shop drawings by NRC Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to NRC Departmental Representative prior to proceeding with Work.

.6 Make changes in shop drawings as NRC Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify NRC Departmental Representative in writing of revisions other than those requested.

.7 Accompany submissions with transmittal letter, in duplicate, containing:

.1 Date.
.2 Project title and number.
.3 Contractor's name and address.
.4 Identification and quantity of each shop drawing, product data and sample.
.5 Other pertinent data.

.8 Submissions include:

.1 Date and revision dates.
.2 Project title and number.
.3 Name and address of:
.1 Subcontractor.
.2 Supplier.
.3 Manufacturer.
.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
.5 Details of appropriate portions of Work as applicable:
.1 Fabrication.
.2 Layout, showing dimensions, including identified field dimensions, and clearances.
.3 Setting or erection details.
.4 Capacities.
.5 Performance characteristics.
.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.9 After NRC Departmental Representative's review, distribute copies.

.10 Submit 6 prints of shop drawings for each requirement requested in specification Sections and as NRC Departmental Representative may reasonably request.

.11 Submit 6 print copies of product data sheets or brochures for requirements requested in specification Sections and as requested by NRC Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.

.12 Submit 6 copies of test reports for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

.13 Submit 6 copies of certificates for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

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.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.15 Submit 6 print copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by NRC Departmental Representative.

.1 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.16 Submit ~~6 copies of Operation and~~**bilingual copies of** Maintenance **Manual**~~Data~~ for requirements requested in specification Sections and as requested by NRC Departmental Representative. **Refer to Section 01 10 00 – General Instructions for more information.**

.17 Delete information not applicable to project.

.18 Supplement standard information to provide details applicable to project.

.19 If upon review by NRC Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, transparency copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.20 The review of shop drawings by NRC Departmental Representative is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that NRC Departmental Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

.1 Submit for review samples in triplicate as requested in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to NRC Departmental Representative's business address site office.

.3 Notify NRC Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by NRC Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to NRC Departmental Representative prior to proceeding with Work.

.6 Make changes in samples which NRC Departmental Representative may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

.1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic and hard copy of colour digital photography in jpg format, standard resolution monthly with progress statement and as directed by NRC Departmental Representative.

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4 locations.

.1 Viewpoints and their location as determined by NRC Departmental Representative.

.4 Frequency of photographic documentation: weekly as directed by NRC Departmental Representative.

1.6 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Compensation Board status.

.2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

Not Used.

Part 3 Execution

Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canada Labour Code, Part 2, and Canada Occupational Safety and Health Regulations 2002.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.3 Province of Ontario

.1 Occupational Health and Safety Act, R.S.O. 1990, as amended.

.4 PWGSC/RPB NRC Departmental Policy DP 073 - Occupational Health and Safety - Construction.

1.2 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit site-specific Health and Safety Plan: Within 14 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:

.1 Results of site specific safety hazard assessment.

.2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.

.3 Submit one copy of Contractor's authorized representative's work site health and safety inspection reports to NRC Departmental Representative and authority having jurisdiction, weekly.

.4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.

.5 Submit copies of incident and accident reports.

.6 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

.7 NRC Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 14 days after receipt of plan. Revise plan as appropriate and resubmit plan to NRC Departmental Representative within 5 days after receipt of comments from NRC Departmental Representative.

.8 NRC Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

.9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to NRC Departmental Representative.

.10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 SAFETY ASSESSMENT

.1 Perform site specific safety hazard assessment related to project.

1.4 MEETINGS

.1 Schedule and administer Health and Safety meeting with NRC Departmental Representative prior to commencement of Work.

1.5 CONSTRUCTOR AND EMPLOYER

.1 Sign-of and comply with the health and safety policies of the Constructor.

.2 Provide all reports to the Constructor as required.

~~1.6 PROJECT/SITE CONDITIONS~~

~~.1 Work at site will involve contact with:~~

~~.1 Asbestos.~~
~~.2 Lead~~
~~.3 PCB's~~
~~.4 Silica~~
~~.5 Ozone Depleting Substances (OSD)~~
~~.6 Mercury~~
~~.7 Coal tar~~

~~1.7~~1.6 GENERAL REQUIREMENTS

.1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

.2 NRC Departmental Representative or Constructor may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

~~1.8~~1.7 RESPONSIBILITY

.1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.

.2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

~~1.9~~1.8 COMPLIANCE REQUIREMENTS

.1 Comply with Ontario Health and Safety Act, R.S.O. 1990, and the regulations for Construction Projects 213/91, as amended.

.2 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

~~1.10~~1.9 UNFORSEEN HAZARDS

.1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise NRC Departmental Representative verbally and in writing.

~~1.11~~1.10 HEALTH AND SAFETY CO-ORDINATOR

.1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:

.1 Have site-related working experience specific to activities associated with demolition, abatement, and new construction.

.2 Have working knowledge of occupational safety and health regulations.

.3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

.5 Be on site during execution of Work.

~~1.12~~1.11 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with NRC Departmental Representative.

~~1.13~~1.12 CORRECTION OF NON-COMPLIANCE

.1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by NRC Departmental Representative.

.2 Provide NRC Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.

.3 NRC Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

~~1.14~~1.13 BLASTING

.1 Blasting or other use of explosives is not permitted.

~~1.15~~1.14 POWDER ACTUATED DEVICES

.1 Use powder actuated devices only after receipt of written permission from NRC Departmental Representative.

~~1.16~~1.15 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 Not used.

Part 3 Execution

3.1 Not used.

END OF SECTION

Part 1 General

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.2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

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.2 Have working knowledge of occupational safety and health regulations.

.3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.

.4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.

.5 Be on site during execution of Work.

~~1.12~~1.11 POSTING OF DOCUMENTS

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.2 Provide NRC Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.

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~~1.16~~1.15 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 Not used.

Part 3 Execution

3.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.

.2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.

.2 Canadian Standards Association (CSA International)

.1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA-0121-M1978(R2003), Douglas Fir Plywood.

.3 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.

.4 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.

1.2 INSTALLATION AND REMOVAL

.1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.

.2 Identify areas which have to be gravelled to prevent tracking of mud.

.3 Indicate use of supplemental or other staging area.

.4 Provide construction facilities in order to execute work expeditiously.

.5 Remove from site all such work after use.

1.3 SCAFFOLDING

.1 Scaffolding in accordance with CAN/CSA-S269.2.

.2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms temporary stairs.

~~1.4 HOISTING~~

~~.1 Provide, operate and maintain hoists, cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.~~

~~.2 Hoists, cranes to be operated by qualified operator.~~

~~1.5~~1.4 SITE STORAGE/LOADING

.1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

~~1.6~~1.5 CONSTRUCTION PARKING

.1 Parking will be permitted on site **with approval/discretion of NRC Departmental Representative,** provided it does not disrupt performance of Work.

.2 Provide and maintain adequate access to project site.

~~1.7 SECURITY~~

~~.1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.~~

~~1.8~~1.6 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

.2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

~~1.9~~1.7 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

.3 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside building. Permanent facilities may be used on approval of NRC Departmental Representative.

~~1.10~~1.8 CONSTRUCTION SIGNAGE

.1 No other signs or advertisements, other than warning signs, are permitted on site.

.2 Signs and notices for safety and instruction in both official languages Graphic symbols to CAN/CSA-Z321.

~~1.11~~1.9 PROTECTION AND MAINTENANCE OF TRAFFIC

.1 Provide access and temporary relocated roads as necessary to maintain traffic.

.2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by NRC Departmental Representative .

.3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs

.4 Protect travelling public from damage to person and property.

.5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.

.6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.

.7 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

.8 Dust control: adequate to ensure safe operation at all times.

.9 Lighting: to assure full and clear visibility for full width of work areas during night work operations.

.10 Provide snow removal during period of Work.

~~1.12~~1.10 CLEAN-UP

.1 Remove construction debris, waste materials, packaging material from work site daily.

.2 Clean dirt or mud tracked onto paved or surfaced roadways.

.3 Store materials resulting from demolition activities that are salvageable.

.4 Stack stored new or salvaged material not in construction facilities.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.

.2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.

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.1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA-0121-M1978(R2003), Douglas Fir Plywood.

.3 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.

.4 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.

1.2 INSTALLATION AND REMOVAL

.1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.

.2 Identify areas which have to be gravelled to prevent tracking of mud.

.3 Indicate use of supplemental or other staging area.

.4 Provide construction facilities in order to execute work expeditiously.

.5 Remove from site all such work after use.

1.3 SCAFFOLDING

.1 Scaffolding in accordance with CAN/CSA-S269.2.

.2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms temporary stairs.

~~1.4 HOISTING~~

~~.1 Provide, operate and maintain hoists, cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.~~

~~.2 Hoists, cranes to be operated by qualified operator.~~

~~1.5~~1.4 SITE STORAGE/LOADING

.1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

~~1.6~~1.5 CONSTRUCTION PARKING

.1 Parking will be permitted on site **with approval/discretion of NRC Departmental Representative,** provided it does not disrupt performance of Work.

.2 Provide and maintain adequate access to project site.

~~1.7 SECURITY~~

~~.1 Provide and pay for responsible security personnel to guard site and contents of site after working hours and during holidays.~~

~~1.8~~1.6 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.

.2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

~~1.9~~1.7 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

.3 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside building. Permanent facilities may be used on approval of NRC Departmental Representative.

~~1.10~~1.8 CONSTRUCTION SIGNAGE

.1 No other signs or advertisements, other than warning signs, are permitted on site.

.2 Signs and notices for safety and instruction in both official languages Graphic symbols to CAN/CSA-Z321.

~~1.11~~1.9 PROTECTION AND MAINTENANCE OF TRAFFIC

.1 Provide access and temporary relocated roads as necessary to maintain traffic.

.2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by NRC Departmental Representative .

.3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs

.4 Protect travelling public from damage to person and property.

.5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.

.6 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.

.7 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

.8 Dust control: adequate to ensure safe operation at all times.

.9 Lighting: to assure full and clear visibility for full width of work areas during night work operations.

.10 Provide snow removal during period of Work.

~~1.12~~1.10 CLEAN-UP

.1 Remove construction debris, waste materials, packaging material from work site daily.

.2 Clean dirt or mud tracked onto paved or surfaced roadways.

.3 Store materials resulting from demolition activities that are salvageable.

.4 Stack stored new or salvaged material not in construction facilities.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

.1 Contractor's Inspection: Contractor to conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.

.1 Notify NRC Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.

.2 Request NRC Departmental Representative’s inspection.

.2 NRC Departmental Representative’s Inspection:

.1 NRC Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.

.2 Contractor to correct Work as directed.

.3 Completion Tasks: submit written certificates that tasks have been performed as follows:

.1 Work: completed and inspected for compliance with Contract Documents.

.2 Defects: corrected and deficiencies completed.

.3 Equipment and systems: tested, adjusted, balanced and fully operational.

.4 Operation of systems: demonstrated to Owner's personnel.

.5 Commissioning: completed in accordance with 01 91 13 - General Commissioning (Cx) Requirements and copies of final Commissioning Report submitted to NRC Departmental Representative.

.6 Work: complete and ready for final inspection.

.4 Final Inspection:

.1 When completion tasks are done, request final inspection of Work by NRC Departmental Representative.

.2 When Work incomplete according to NRC Departmental Representative, complete outstanding items and request re-inspection.

.5 Declaration of Substantial Performance: when NRC Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

.6 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.

.7 Final Payment:

.1 When NRC Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

.8 Payment of Holdback: after issuance of Certificate of Substantial Performance of Work, submit application for payment of holdback amount in accordance with contractual agreement.

1.2 FINAL CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Acceptance of Work Procedures:

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END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Pre-warranty Meeting:

.1 Convene meeting one week prior to contract completion with contractor's representative and NRC Departmental Representative to:

.1 Verify Project requirements.

.2 Review manufacturer's installation instructions and warranty requirements.

.2 NRC Departmental Representative to establish communication procedures for:

.1 Notifying construction warranty defects.

.2 Determine priorities for type of defects.

.3 Determine reasonable response time.

.3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.

.4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section ~~00~~ **01** 10 00 General Instructions.

.2 Two weeks prior to Substantial Performance of the Work, submit to the NRC Departmental Representative, ~~four~~ final copies of operating and maintenance manuals in English and French. **Refer to Section 01 10 00 – General Instructions for number of copies required.**

.3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.

.4 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

.1 Organize data as instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used correlate data into related consistent groupings.

.1 Identify contents of each binder on spine.

.4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab.

.1 Bind in with text; fold larger drawings to size of text pages.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume: provide title of project;

.1 Date of submission; names.

.2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data.

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

1.5 AS -BUILT DOCUMENTS AND SAMPLES

.1 Maintain, in addition to requirements in General Conditions, at site for NRC Departmental Representative one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by NRC Departmental Representative.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by NRC Departmental Representative.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 References to related shop drawings and modifications.

.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

.7 Provide digital photos, if requested, for site records.

1.7 FINAL SURVEY

.1 Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.8 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts.

.1 Give function, normal operation characteristics and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Additional requirements: as specified in individual specification sections.

1.9 MATERIALS AND FINISHES

.1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.

.1 Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional requirements: as specified in individual specifications sections.

1.10 MAINTENANCE MATERIALS

.1 Spare Parts:

.1 Provide spare parts, in quantities specified in individual specification sections.
.2 Provide items of same manufacture and quality as items in Work.
.3 Deliver to location as directed; place and store.
.4 Receive and catalogue items.
.1 Submit inventory listing to NRC Departmental Representative .
.2 Include approved listings in Maintenance Manual.
.5 Obtain receipt for delivered products and submit prior to final payment.

.2 Extra Stock Materials:

.1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
.2 Provide items of same manufacture and quality as items in Work.
.3 Deliver to location as directed; place and store.
.4 Receive and catalogue items.
.1 Submit inventory listing to NRC Departmental Representative.
.2 Include approved listings in Maintenance Manual.
.5 Obtain receipt for delivered products and submit prior to final payment.

.3 Special Tools:

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue items.

.1 Submit inventory listing to NRC Departmental Representative .

.2 Include approved listings in Maintenance Manual.

1.11 DELIVERY, STORAGE AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by NRC Departmental Representative.

1.12 WARRANTIES AND BONDS

.1 Develop warranty management plan to contain information relevant to Warranties.

.2 Submit warranty management plan, 30 days before planned pre-warranty conference, to NRC Departmental Representative approval.

.3 Warranty management plan to include required actions and documents to assure that NRC Departmental Representative receives warranties to which it is entitled.

.4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

.5 Submit, warranty information made available during construction phase, to NRC Departmental Representative for approval prior to each monthly pay estimate.

.6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

.7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.8 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, by NRC Departmental Representative.

.9 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include: roofs, HVAC balancing, pumps, motors, transformers, and commissioned systems such as fire protection, alarm systems, sprinkler systems, lightning protection systems.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.10 Respond in timely manner to oral or written notification of required construction warranty repair work.

.11 Written verification to follow oral instructions.

.1 Failure to respond will be cause for the NRC Departmental Representative to proceed with action against Contractor.

1.13 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by NRC Departmental Representative.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate following information on tag:

.1 Type of product/material.
.2 Model number.
.3 Serial number.
.4 Contract number.
.5 Warranty period.
.6 Inspector's signature.
.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

.1 Pre-warranty Meeting:

.1 Convene meeting one week prior to contract completion with contractor's representative and NRC Departmental Representative to:

.1 Verify Project requirements.

.2 Review manufacturer's installation instructions and warranty requirements.

.2 NRC Departmental Representative to establish communication procedures for:

.1 Notifying construction warranty defects.

.2 Determine priorities for type of defects.

.3 Determine reasonable response time.

.3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.

.4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section ~~00~~ **01** 10 00 General Instructions.

.2 Two weeks prior to Substantial Performance of the Work, submit to the NRC Departmental Representative, ~~four~~ final copies of operating and maintenance manuals in English and French. **Refer to Section 01 10 00 – General Instructions for number of copies required.**

.3 Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.

.4 Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

.1 Organize data as instructional manual.

.2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.

.3 When multiple binders are used correlate data into related consistent groupings.

.1 Identify contents of each binder on spine.

.4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

.5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.

.6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

.7 Text: manufacturer's printed data, or typewritten data.

.8 Drawings: provide with reinforced punched binder tab.

.1 Bind in with text; fold larger drawings to size of text pages.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

.1 Table of Contents for Each Volume: provide title of project;

.1 Date of submission; names.

.2 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.

.3 Schedule of products and systems, indexed to content of volume.

.2 For each product or system:

.1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

.3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

.4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

.5 Typewritten Text: as required to supplement product data.

.1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

1.5 AS -BUILT DOCUMENTS AND SAMPLES

.1 Maintain, in addition to requirements in General Conditions, at site for NRC Departmental Representative one record copy of:

.1 Contract Drawings.

.2 Specifications.

.3 Addenda.

.4 Change Orders and other modifications to Contract.

.5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

.2 Store record documents and samples in field office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

.5 Keep record documents and samples available for inspection by NRC Departmental Representative.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by NRC Departmental Representative.

.2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

.3 Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

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.5 Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

.6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

.7 Provide digital photos, if requested, for site records.

1.7 FINAL SURVEY

.1 Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.8 EQUIPMENT AND SYSTEMS

.1 For each item of equipment and each system include description of unit or system, and component parts.

.1 Give function, normal operation characteristics and limiting conditions.

.2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

.2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.

.1 Include regulation, control, stopping, shut-down, and emergency instructions.

.2 Include summer, winter, and any special operating instructions.

.5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

.6 Provide servicing and lubrication schedule, and list of lubricants required.

.7 Include manufacturer's printed operation and maintenance instructions.

.8 Include sequence of operation by controls manufacturer.

.9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

.10 Provide installed control diagrams by controls manufacturer.

.11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

.13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

.14 Additional requirements: as specified in individual specification sections.

1.9 MATERIALS AND FINISHES

.1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.

.1 Provide information for re-ordering custom manufactured products.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional requirements: as specified in individual specifications sections.

1.10 MAINTENANCE MATERIALS

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.3 Deliver to location as directed; place and store.
.4 Receive and catalogue items.
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.2 Include approved listings in Maintenance Manual.
.5 Obtain receipt for delivered products and submit prior to final payment.

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.3 Special Tools:

.1 Provide special tools, in quantities specified in individual specification section.

.2 Provide items with tags identifying their associated function and equipment.

.3 Deliver to location as directed; place and store.

.4 Receive and catalogue items.

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.2 Include approved listings in Maintenance Manual.

1.11 DELIVERY, STORAGE AND HANDLING

.1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.

.2 Store in original and undamaged condition with manufacturer's seal and labels intact.

.3 Store components subject to damage from weather in weatherproof enclosures.

.4 Store paints and freezable materials in a heated and ventilated room.

.5 Remove and replace damaged products at own expense and for review by NRC Departmental Representative.

1.12 WARRANTIES AND BONDS

.1 Develop warranty management plan to contain information relevant to Warranties.

.2 Submit warranty management plan, 30 days before planned pre-warranty conference, to NRC Departmental Representative approval.

.3 Warranty management plan to include required actions and documents to assure that NRC Departmental Representative receives warranties to which it is entitled.

.4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.

.5 Submit, warranty information made available during construction phase, to NRC Departmental Representative for approval prior to each monthly pay estimate.

.6 Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

.7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

.8 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, by NRC Departmental Representative.

.9 Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include: roofs, HVAC balancing, pumps, motors, transformers, and commissioned systems such as fire protection, alarm systems, sprinkler systems, lightning protection systems.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

.10 Respond in timely manner to oral or written notification of required construction warranty repair work.

.11 Written verification to follow oral instructions.

.1 Failure to respond will be cause for the NRC Departmental Representative to proceed with action against Contractor.

1.13 WARRANTY TAGS

.1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by NRC Departmental Representative.

.2 Attach tags with copper wire and spray with waterproof silicone coating.

.3 Leave date of acceptance until project is accepted for occupancy.

.4 Indicate following information on tag:

.1 Type of product/material.
.2 Model number.
.3 Serial number.
.4 Contract number.
.5 Warranty period.
.6 Inspector's signature.
.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

1.2 REFERENCES

.1 American Water Works Association (AWWA)

.2 National Fire Protection Association (NFPA)

.1 NFPA-13-02, Installation of Sprinkler Systems Handbook.

.2 NFPA-14-02, Automatic Sprinkler Systems Handbook.

.3 NFPA-20-03, Standard for the Installation of Stationary Fire Pumps for Fire Protection.

.3 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

.1 Provide a fully functional facility:

.1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.

.2 Facility user and O M personnel have been fully trained in aspects of installed systems.

.3 Optimized life cycle costs.

.4 Complete documentation relating to installed equipment and systems.

.2 Term "Cx" in this section means "Commissioning".

.3 Use this Cx Plan as master planning document for Cx:

.1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.

.2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.

.3 Sets out deliverables relating to O M, process and administration of Cx.

.4 Describes process of verification of how built works meet Owner’s requirements.

.5 Produces a complete functional system prior to issuance of Certificate of Occupancy.

.6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:

.1 Overview of Cx.

.2 General description of elements that make up Cx Plan.

.3 Process and methodology for successful Cx.

.4 Acronyms:

.1 Cx - Commissioning.
.2 BMM - Building Management Manual.
.3 EMCS - Energy Monitoring and Control Systems.
.4 MSDS - Material Safety Data Sheets.
.5 PI - Product Information.
.6 PV - Performance Verification.
.7 TAB - Testing, Adjusting and Balancing.
.8 WHMIS - Workplace Hazardous Materials Information System.

.5 Commissioning terms used in this Section:

.1 Bumping: short term start-up to prove ability to start and prove correct rotation.
.2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

.1 Cx Plan to be 100% completed within 12 weeks of award of contract to take into account:

.1 Approved shop drawings and product data.
.2 Approved changes to contract.
.3 Contractor's project schedule.
.4 Cx schedule.
.5 Contractor's, Sub-contractors, suppliers' requirements.
.6 Project construction team's and Cx team's requirements.

.2 Submit completed Cx Plan to NRC Departmental Representative and obtain written approval.

1.5 REFINEMENT OF CX PLAN

.1 During construction phase, revise, refine and update Cx Plan to include:

.1 Changes resulting from Client program modifications.
.2 Approved design and construction changes.

.2 Revise, refine and update every ~~6~~ **3** months during construction phase. At each revision, indicate revision number and date.

.3 Submit each revised Cx Plan to NRC Departmental Representative for review and obtain written approval.

.4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

.1 NRC Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.

.2 Project Manager will select Cx Team consisting of following members:

.1 NRC Departmental Representative is responsible for:

.1 Review of Cx documentation from operational perspective.

.2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.

.3 Protection of health, safety and comfort of occupants and O M personnel.

.4 Monitoring of Cx activities, training, development of Cx documentation.

.5 Work closely with members of Cx Team.

.6 Organizing Cx.

.7 Monitoring operations Cx activities.

.8 Witnessing, certifying accuracy of reported results.

.9 Witnessing and certifying TAB and other tests.

.10 Developing BMM.

.11 Ensuring implementation of final Cx Plan.

.12 Performing verification of performance of installed systems and equipment.

.13 Implementation of Training Plan.

.2 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:

.1 Testing.

.2 TAB.

.3 Performance of Cx activities.

.4 Delivery of training and Cx documentation.

.5 Assigning one person as point of contact with Consultant and NRC Departmental Representative for administrative and coordination purposes.

.3 Contractor's Cx agent implements specified Cx activities including:

.1 Demonstrations.

.2 Updating commissioning plan

.3 Commissioning Forms – submit for approval

.4 Training.

.5 Oversee Testing and Commissioning.

.6 Preparation, submission of test reports.

.4 Consultant shall:

.1 Respond to any design issues or queries identified

.2 Assist as necessary

.5 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:

.1 Receiving facility.

.2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

.1 Employ the following Cx participants to verify performance of equipment and systems:

.1 Installation contractor/subcontractor:

.1 Equipment and systems except as noted.

.2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.

.1 To include performance verification.

.3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.

.4 Specialist Cx agency:

.1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.

.5 Client: responsible for intrusion and access security systems.

.6 Ensure that Cx participant:

.1 Could complete work within scheduled time frame.

.2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of O M personnel, including:

.1 Modify ventilation rates to meet changes in off-gassing.

.2 Changes to heating or cooling loads beyond scope of EMCS.

.3 Changes to EMCS control strategies beyond level of training provided to O M personnel.

.4 Redistribution of electrical services.

.5 Modifications of fire alarm systems.

.6 Modifications to voice communications systems.

.7 Provide names of participants to NRC Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

.1 Cx Structural and Architectural Systems:

.1 Architectural and structural:

.1 Equipment: Dock levellers

.2 Commission mechanical systems and associated equipment:

.1 Plumbing systems:

.1 Domestic CWS and HWS.

.2 Regular sanitary waste systems.

.3 Sewage pumps

.4 Storm water systems.

.5 Sump pumps

.6 Vacuum Waste System

.2 HVAC and exhaust systems:

.1 HVAC systems

.2 General exhaust systems

.3 Exhaust systems and related systems

~~.4 Laboratory fume hoods and related systems.~~

~~.5~~**.4** Heat recovery systems

~~.6~~**.5** Smoke control systems installed is contract.

.3 Fire and life safety systems:

~~.1 Special fire suppression systems:~~

~~.2 Wet pipe sprinkler systems.~~

~~.3 Dry pipe sprinkler systems.~~

~~.4 Standpipe and hose systems.~~

~~.5 Total flooding fire extinguishing systems.~~

~~.6~~**.1** Fire extinguishers.

.4 Noise and vibration control systems for mechanical systems.

.5 Seismic restraint and control measures.

.6 IAQ environmental control systems:

.1 Indoor conditions

.2 Indoor air quality (IAQ)

.3 Environmental control systems

.7 EMCS: **All system controls**

.8 Energy metering systems for steam, chilled water, electricity.

.3 Commission electrical systems and equipment:

.1 Low voltage below 750 V:

.1 Low voltage equipment.

.2 Low voltage distribution systems.

.3 Central clock systems.

.4 Voice communications systems.
.5 Audio/visual systems
.6 Electronic data and communications information systems.
.2 Emergency power generation systems.
.3 Lighting systems:
.1 Lighting equipment.
.2 Distribution systems.
.3 Emergency lighting systems, including battery packs.
.4 Fire exit emergency signage.
.4 Fire alarm systems, equipment:
.1 Annunciators.
.2 Control panels.
.3 Fire alarm battery banks.

1.9 DELIVERABLES RELATING TO O M PERSPECTIVES

.1 General requirements:
.1 Compile English documentation.
.2 Documentation to be computer-compatible format ready for inputting for data management.
.2 Provide deliverables:
.1 Warranties.
.2 Project record documentation.
.3 Inventory of spare parts, special tools and maintenance materials.
.4 Maintenance Management System (MMS) identification system used.
.5 WHMIS information.
.6 MSDS data sheets.
.7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

.1 General:
.1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
.2 Definitions:
.1 Cx as used in this section includes:
.1 Cx of components, equipment, systems, subsystems, and integrated systems.
.2 Factory inspections and performance verification tests.

.3 Deliverables: provide:

.1 Cx Specifications.
.2 Startup, pre-Cx activities and documentation for systems, and equipment.
.3 Completed installation checklists (ICL).
.4 Completed product information (PI) report forms.
.5 Completed performance verification (PV) report forms.
.6 Results of Performance Verification Tests and Inspections.
.7 Description of Cx activities and documentation.
.8 Description of Cx of integrated systems and documentation.
.9 Tests witnessed by NRC Departmental Representative:
.10 Tests performed by Owner.
.11 Training Plans.
.12 Cx Reports.
.13 Prescribed activities during warranty period.

.4 NRC Departmental Representative to witness and certify tests and reports of results provided to NRC Departmental Representative.

.5 NRC Departmental Representative to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Items listed in this Cx Plan include the following:

.1 Pre-Start-Up inspections: by NRC Departmental Representative prior to permission to start up and rectification of deficiencies to NRC Departmental Representative's satisfaction.
.2 NRC Departmental Representative to use approved check lists.
.3 NRC Departmental Representative will monitor all of these pre-start-up inspections.
.4 Include completed documentation with Cx report.
.5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by NRC Departmental Representative and does not form part of Cx specifications.
.6 NRC Departmental Representative will monitor these inspections and tests.
.7 Include completed documentation in Cx report.

.2 Pre-Cx activities - MECHANICAL:

.1 Plumbing systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.
.2 Complete pre-start-up checks and complete relevant documentation.
.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

.2 HVAC equipment and systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.

.2 At this time, complete pre-start-up checks and complete relevant documentation.

.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

.4 Perform TAB on systems. TAB reports to be approved by NRC Departmental Representative.

.3 EMCS:

.1 EMCS trending to be available as supporting documentation for performance verification.

.2 Perform point-by-point testing in parallel with start-up.

.3 Carry out point-by-point verification.

.4 Demonstrate performance of systems, to be witnessed by NRC Departmental Representative prior to start of 30 day Final Acceptance Test period.

.5 Perform final Cx and operational tests during demonstration period and 30 day test period.

.6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".

.3 Pre-Cx activities - LIFE SAFETY SYSTEMS

.1 Include equipment and systems identified above.

.2 Reports of test results to be witnessed and certified by NRC Departmental Representative before verification.

.4 Pre-Cx activities - ELECTRICAL:

.1 Low voltage distribution systems under 750 V:

.1 Requires independent testing agency to perform pre- energization and post-energization tests.

.2 Emergency power generation systems

.3 Lighting systems:

.1 Emergency lighting systems:

.1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.

.4 Fire alarm systems: test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements. NRC Departmental Representative has witnessed and certified report, demonstrate devices and zones to NRC Departmental Representative.

.5 Low voltage systems: these include:

.1 Clock, communications, low voltage lighting control systems and data communications systems.

.2 Special systems such as Simultaneous Translation systems, MPs Call systems, Messenger Call systems, Division Bell systems.

.6 Security, surveillance and intrusion alarm systems: to include verification by NRC Departmental Representative.

.7 Lightning protection systems.

.8 Watchman's tour systems.

1.12 START-UP

.1 Start-up components, equipment and systems.

.2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, all equipment, systems:

.3 NRC Departmental Representative to monitor all of these start-up activities.

.1 Rectify start-up deficiencies to satisfaction of NRC Departmental Representative.

.4 Performance Verification (PV):

.1 Approved Cx Agent to perform.

.1 Repeat when necessary until results are acceptable to NRC Departmental Representative.

.2 Use procedures modified generic procedures to suit project requirements.

.3 NRC Departmental Representative to witness and certify reported results using approved PI and PV forms.

.4 NRC Departmental Representative to approve completed PV reports and provide to NRC Departmental Representative.

.5 NRC Departmental Representative reserves right to verify reported results at random.

.6 Failure of randomly selected item shall result in rejection of PV report or report of system start up and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures developed by NRC Departmental Representative and approved by NRC Departmental Representative.

.2 NRC Departmental Representative to monitor Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.4 NRC Departmental Representative to witness, certify reported results of, Cx activities and forward to NRC Departmental Representative.

.5 NRC Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

.1 Cx to be performed by specified Cx specialist, using procedures developed by NRC Departmental Representative and approved by NRC Departmental Representative.

.2 Tests to be witnessed by NRC Departmental Representative and documented on approved report forms.

.3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by NRC Departmental Representative and submitted to NRC Departmental Representative for review.

.4 NRC Departmental Representative reserves right to verify percentage of reported results.

.5 Integrated systems to include:

.1 HVAC and associated systems forming part of integrated HVAC systems.

.2 Smoke control systems.

.3 Stair shaft pressurization systems.

.4 Indoor air quality.

.5 Environmental space conditions.

.6 Fire alarm systems.

~~.7 Fire pumps and controllers.~~

~~.8~~**.7** Voice communications systems.

~~.9~~**.8** Emergency power generator.

~~.10~~**.9** Transfer switch and controllers.

~~.11~~**.10** Emergency lighting systems.

.6 Identification:

.1 In later stages of Cx, before hand-over and acceptance, Contractor, Property Manager and Cx Manager to co-operate to complete inventory data sheets and provide assistance in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

.1 General:

.1 Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.19 CX SCHEDULES

.1 Prepare detailed critical path Cx Schedule and submit to NRC Departmental Representative for review and approval same time as project Construction Schedule. Include:

.1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:

.1 Design criteria, design intents.

.2 Pre-TAB review: 28 days after contract award, and before construction starts.

.3 Cx agents' credentials: 60 days before start of Cx.

.4 Cx procedures: 3 months after award of contract.

.5 Cx Report format: 3 months after contract award.

.6 Discussion of heating/cooling loads for Cx: 3 months before start-up.

.7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.

.8 Notification of intention to start TAB: 21 days before start of TAB.

.9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.

.10 Notification of intention to start Cx: 14 days before start of Cx.

.11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.

.12 Identification of deferred Cx.

.13 Implementation of training plans.

.14 Cx of smoke management/control systems: after Cx of related systems is completed and 7 days before proposed date of Cx these systems.

.15 Cx reports: immediately upon successful completion of Cx.

.2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.

.3 ~~6~~**12** months in Cx schedule for verification of performance in all seasons and wear conditions.

.2 After approval, incorporate Cx Schedule into Construction Schedule.

.3 Consultant, Contractor, Contractor's Cx agent, and NRC Departmental Representative will monitor progress of Cx against this schedule.

1.20 CX REPORTS

.1 Submit reports of tests, witnessed and certified by NRC Departmental Representative to NRC Departmental Representative who will verify reported results.

.2 Include completed and certified PV reports in properly formatted Cx Reports.

.3 Before reports are accepted, reported results to be subject to verification by NRC Departmental Representative.

1.21 ACTIVITIES DURING WARRANTY PERIOD

.1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:

.1 Fine tuning of HVAC systems.

.2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.

.3 Full-scale emergency evacuation exercises.

1.22 TESTS TO BE PERFORMED BY OWNER/USER

.1 None is anticipated on this project.

1.23 TRAINING PLANS

.1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

1.24 FINAL SETTINGS

.1 Upon completion of Cx to satisfaction of NRC Departmental Representative lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.

1.2 REFERENCES

.1 American Water Works Association (AWWA)

.2 National Fire Protection Association (NFPA)

.1 NFPA-13-02, Installation of Sprinkler Systems Handbook.

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1.3 GENERAL

.1 Provide a fully functional facility:

.1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.

.2 Facility user and O M personnel have been fully trained in aspects of installed systems.

.3 Optimized life cycle costs.

.4 Complete documentation relating to installed equipment and systems.

.2 Term "Cx" in this section means "Commissioning".

.3 Use this Cx Plan as master planning document for Cx:

.1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.

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.5 Produces a complete functional system prior to issuance of Certificate of Occupancy.

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.1 Overview of Cx.

.2 General description of elements that make up Cx Plan.

.3 Process and methodology for successful Cx.

.4 Acronyms:

.1 Cx - Commissioning.
.2 BMM - Building Management Manual.
.3 EMCS - Energy Monitoring and Control Systems.
.4 MSDS - Material Safety Data Sheets.
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.8 WHMIS - Workplace Hazardous Materials Information System.

.5 Commissioning terms used in this Section:

.1 Bumping: short term start-up to prove ability to start and prove correct rotation.
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.5 Contractor's, Sub-contractors, suppliers' requirements.
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.2 Submit completed Cx Plan to NRC Departmental Representative and obtain written approval.

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.1 During construction phase, revise, refine and update Cx Plan to include:

.1 Changes resulting from Client program modifications.
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.2 Revise, refine and update every ~~6~~ **3** months during construction phase. At each revision, indicate revision number and date.

.3 Submit each revised Cx Plan to NRC Departmental Representative for review and obtain written approval.

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.3 Protection of health, safety and comfort of occupants and O M personnel.

.4 Monitoring of Cx activities, training, development of Cx documentation.

.5 Work closely with members of Cx Team.

.6 Organizing Cx.

.7 Monitoring operations Cx activities.

.8 Witnessing, certifying accuracy of reported results.

.9 Witnessing and certifying TAB and other tests.

.10 Developing BMM.

.11 Ensuring implementation of final Cx Plan.

.12 Performing verification of performance of installed systems and equipment.

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.2 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:

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.4 Completed product information (PI) report forms.
.5 Completed performance verification (PV) report forms.
.6 Results of Performance Verification Tests and Inspections.
.7 Description of Cx activities and documentation.
.8 Description of Cx of integrated systems and documentation.
.9 Tests witnessed by NRC Departmental Representative:
.10 Tests performed by Owner.
.11 Training Plans.
.12 Cx Reports.
.13 Prescribed activities during warranty period.

.4 NRC Departmental Representative to witness and certify tests and reports of results provided to NRC Departmental Representative.

.5 NRC Departmental Representative to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Items listed in this Cx Plan include the following:

.1 Pre-Start-Up inspections: by NRC Departmental Representative prior to permission to start up and rectification of deficiencies to NRC Departmental Representative's satisfaction.
.2 NRC Departmental Representative to use approved check lists.
.3 NRC Departmental Representative will monitor all of these pre-start-up inspections.
.4 Include completed documentation with Cx report.
.5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by NRC Departmental Representative and does not form part of Cx specifications.
.6 NRC Departmental Representative will monitor these inspections and tests.
.7 Include completed documentation in Cx report.

.2 Pre-Cx activities - MECHANICAL:

.1 Plumbing systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.
.2 Complete pre-start-up checks and complete relevant documentation.
.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

.2 HVAC equipment and systems:

.1 "Bump" each item of equipment in its "stand-alone" mode.

.2 At this time, complete pre-start-up checks and complete relevant documentation.

.3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

.4 Perform TAB on systems. TAB reports to be approved by NRC Departmental Representative.

.3 EMCS:

.1 EMCS trending to be available as supporting documentation for performance verification.

.2 Perform point-by-point testing in parallel with start-up.

.3 Carry out point-by-point verification.

.4 Demonstrate performance of systems, to be witnessed by NRC Departmental Representative prior to start of 30 day Final Acceptance Test period.

.5 Perform final Cx and operational tests during demonstration period and 30 day test period.

.6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".

.3 Pre-Cx activities - LIFE SAFETY SYSTEMS

.1 Include equipment and systems identified above.

.2 Reports of test results to be witnessed and certified by NRC Departmental Representative before verification.

.4 Pre-Cx activities - ELECTRICAL:

.1 Low voltage distribution systems under 750 V:

.1 Requires independent testing agency to perform pre- energization and post-energization tests.

.2 Emergency power generation systems

.3 Lighting systems:

.1 Emergency lighting systems:

.1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.

.4 Fire alarm systems: test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements. NRC Departmental Representative has witnessed and certified report, demonstrate devices and zones to NRC Departmental Representative.

.5 Low voltage systems: these include:

.1 Clock, communications, low voltage lighting control systems and data communications systems.

.2 Special systems such as Simultaneous Translation systems, MPs Call systems, Messenger Call systems, Division Bell systems.

.6 Security, surveillance and intrusion alarm systems: to include verification by NRC Departmental Representative.

.7 Lightning protection systems.

.8 Watchman's tour systems.

1.12 START-UP

.1 Start-up components, equipment and systems.

.2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, all equipment, systems:

.3 NRC Departmental Representative to monitor all of these start-up activities.

.1 Rectify start-up deficiencies to satisfaction of NRC Departmental Representative.

.4 Performance Verification (PV):

.1 Approved Cx Agent to perform.

.1 Repeat when necessary until results are acceptable to NRC Departmental Representative.

.2 Use procedures modified generic procedures to suit project requirements.

.3 NRC Departmental Representative to witness and certify reported results using approved PI and PV forms.

.4 NRC Departmental Representative to approve completed PV reports and provide to NRC Departmental Representative.

.5 NRC Departmental Representative reserves right to verify reported results at random.

.6 Failure of randomly selected item shall result in rejection of PV report or report of system start up and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

.1 Perform Cx by specified Cx agency using procedures developed by NRC Departmental Representative and approved by NRC Departmental Representative.

.2 NRC Departmental Representative to monitor Cx activities.

.3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

.4 NRC Departmental Representative to witness, certify reported results of, Cx activities and forward to NRC Departmental Representative.

.5 NRC Departmental Representative reserves right to verify a percentage of reported results at no cost to contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

.1 Cx to be performed by specified Cx specialist, using procedures developed by NRC Departmental Representative and approved by NRC Departmental Representative.

.2 Tests to be witnessed by NRC Departmental Representative and documented on approved report forms.

.3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by NRC Departmental Representative and submitted to NRC Departmental Representative for review.

.4 NRC Departmental Representative reserves right to verify percentage of reported results.

.5 Integrated systems to include:

.1 HVAC and associated systems forming part of integrated HVAC systems.

.2 Smoke control systems.

.3 Stair shaft pressurization systems.

.4 Indoor air quality.

.5 Environmental space conditions.

.6 Fire alarm systems.

~~.7 Fire pumps and controllers.~~

~~.8~~**.7** Voice communications systems.

~~.9~~**.8** Emergency power generator.

~~.10~~**.9** Transfer switch and controllers.

~~.11~~**.10** Emergency lighting systems.

.6 Identification:

.1 In later stages of Cx, before hand-over and acceptance, Contractor, Property Manager and Cx Manager to co-operate to complete inventory data sheets and provide assistance in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

.1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

.1 General:

.1 Because of risk assessment, complete Cx of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

1.19 CX SCHEDULES

.1 Prepare detailed critical path Cx Schedule and submit to NRC Departmental Representative for review and approval same time as project Construction Schedule. Include:

.1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:

.1 Design criteria, design intents.

.2 Pre-TAB review: 28 days after contract award, and before construction starts.

.3 Cx agents' credentials: 60 days before start of Cx.

.4 Cx procedures: 3 months after award of contract.

.5 Cx Report format: 3 months after contract award.

.6 Discussion of heating/cooling loads for Cx: 3 months before start-up.

.7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.

.8 Notification of intention to start TAB: 21 days before start of TAB.

.9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.

.10 Notification of intention to start Cx: 14 days before start of Cx.

.11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.

.12 Identification of deferred Cx.

.13 Implementation of training plans.

.14 Cx of smoke management/control systems: after Cx of related systems is completed and 7 days before proposed date of Cx these systems.

.15 Cx reports: immediately upon successful completion of Cx.

.2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.

.3 ~~6~~**12** months in Cx schedule for verification of performance in all seasons and wear conditions.

.2 After approval, incorporate Cx Schedule into Construction Schedule.

.3 Consultant, Contractor, Contractor's Cx agent, and NRC Departmental Representative will monitor progress of Cx against this schedule.

1.20 CX REPORTS

.1 Submit reports of tests, witnessed and certified by NRC Departmental Representative to NRC Departmental Representative who will verify reported results.

.2 Include completed and certified PV reports in properly formatted Cx Reports.

.3 Before reports are accepted, reported results to be subject to verification by NRC Departmental Representative.

1.21 ACTIVITIES DURING WARRANTY PERIOD

.1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:

.1 Fine tuning of HVAC systems.

.2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.

.3 Full-scale emergency evacuation exercises.

1.22 TESTS TO BE PERFORMED BY OWNER/USER

.1 None is anticipated on this project.

1.23 TRAINING PLANS

.1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.

1.24 FINAL SETTINGS

.1 Upon completion of Cx to satisfaction of NRC Departmental Representative lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 This Section specifies roles and responsibilities of Commissioning Training and applies to all project sections.

1.2 TRAINEES

.1 Trainees: personnel selected for operating and maintaining this facility. Includes Facility Manager, building operators, maintenance staff, security staff, and technical specialists as required.

.2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

.1 NRC Departmental Representative will provide:

.1 Descriptions of systems.

.2 Instruction on design philosophy, design criteria, and design intent.

.2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:

.1 Start-Up, operation, shut-down of equipment, components and systems.

.2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.

.3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.

.3 Contractor and equipment manufacturer to provide instruction on:

.1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING OBJECTIVES

.1 Training to be detailed and duration to ensure:

.1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.

.2 Effective on-going inspection, measurements of system performance.

.3 Proper preventive maintenance, diagnosis and trouble-shooting.

.4 Ability to update documentation.

.5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

.1 Instructors to be responsible for content and quality.

.2 Training materials to include:

.1 "As-Built" Contract Documents.

.2 Operating Manual.

.3 Maintenance Manual.

.4 Management Manual.

.5 TAB and PV Reports.

.3 Project Manager, Commissioning Manager and Facility Manager will review training manuals.

.4 Training materials to be in a format that permits future training procedures to same degree of detail.

.5 Supplement training materials:

.1 Transparencies for overhead projectors.

.2 Multimedia presentations.

.3 Manufacturer's training videos.

.4 Equipment models.

1.6 SCHEDULING

.1 Include in Commissioning Schedule time for training.

.2 Deliver training during regular working hours, training sessions to be 3 hours in length.

.3 Training to be completed prior to acceptance of facility.

.4 Each training module shall be presented twice to ensure staff availability.

1.7 RESPONSIBILITIES

.1 Be responsible for:

.1 Implementation of training activities,

.2 Coordination among instructors,

.3 Quality of training, training materials,

.2 NRC Departmental Representative will evaluate training and materials.

.3 Upon completion of training, provide written report, signed by Instructors, witnessed by NRC Departmental Representative.

1.8 TRAINING CONTENT

.1 Training to include demonstrations by Instructors using the installed equipment and systems.

.2 Content includes:

.1 Review of facility and occupancy profile.

.2 Functional requirements.

.3 System philosophy, limitations of systems and emergency procedures.

.4 Review of system layout, equipment, components and controls.

.5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.

.6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.

.7 Maintenance and servicing.

.8 Trouble-shooting diagnosis.

.9 Inter-Action among systems during integrated operation.

.10 Review of O M documentation.

.3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

1.9 VIDEO-BASED TRAINING

.1 Manufacturer's videotapes to be used as training tool with NRC Departmental Representative's review and written approval 3 months prior to commencement of scheduled training.

.2 On-Site training videos:

.1 Videotape training sessions for use during future training.

.2 To be performed after systems are fully commissioned.

.3 Organize into several short modules to permit incorporation of changes.

.3 Production methods to be professional quality.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

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Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

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END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, include but not limited to: poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or materials that endanger human health or environment if handled improperly.

.2 Reference Standards:

.1 CSA International

.1 CSA S350-M1980(R2003), Code of Practice for Safety in Demolition of Structures.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section and on-site installation, with Contractor's Representative and NRC Departmental Representative to:

.1 Verify project requirements.

.2 Verify existing site conditions adjacent to demolition work.

.3 Co-ordination with other construction subtrades.

1.3 ACTION AND INFORMATIONA SUBMITTALS

.1 Shop Drawings:

.1 Submit for review and approval demolition drawings, diagrams or details showing sequence of demolition work, and supporting structures, shoring and underpinning.

.2 Submit demolition drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.4 QUALITY ASSURANCE

.1 Regulatory Requirements: Ensure Work is performed in compliance with Provincial and Municipal regulations.

1.5 SITE CONDITIONS

.1 Environmental protection:

.1 Ensure Work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.

.2 Fires and burning of waste or materials is not permitted on site.

.3 Do not bury rubbish waste materials.

.4 Do not dispose of waste or volatile materials including but not limited to: mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary sewers.

.1 Ensure proper disposal procedures are maintained throughout project.

.5 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers, or onto adjacent properties.

.6 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with authorities having jurisdiction.

.7 Protect trees, plants and foliage on site and adjacent properties where indicated.

.8 Prevent extraneous materials from contaminating air beyond application area, by providing temporary enclosures during demolition work.

.9 Cover or wet down dry materials and waste to prevent blowing dust and debris. Control dust on all temporary roads.

1.6 EXISTING

.1 Structures to be demolished are based on their condition on date that tender is accepted, and at time of examination prior to tendering.

.1 Remove, protect and store salvaged items as directed by NRC Departmental Representative. Deliver to NRC Departmental Representative as directed.

Part 2 Products

2.1 EQUIPMENT

.1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

Part 3 Execution

3.1 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to: requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during demolition.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal after completion of demolition work.

.2 Protection of in-place conditions:

.1 Prevent movement, settlement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades properties parts of existing building to remain.

.1 Provide bracing, shoring and underpinning as required.

.2 Repair damage caused by demolition as directed by NRC Departmental Representative.

.2 Support affected structures and, if safety of structure being demolished or adjacent structures or services appears to be endangered, take preventative measures, stop Work and immediately notify NRC Departmental Representative.

.3 Prevent debris from blocking surface drainage system, mechanical and electrical systems which must remain in operation.

.3 Surface Preparation:

.1 Disconnect and re-route electrical ~~and telephone~~ service lines entering buildings to be demolished.

.1 Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of demolition.

.2 Do not disrupt active or energized utilities traversing premises designated to remain undisturbed.

3.2 DEMOLITION

.1 Do demolition work in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

.2 Blasting operations not permitted during demolition.

.3 Remove contaminated or dangerous materials as defined by authorities having jurisdiction, relating to environmental protection, from site and dispose of in safe manner to minimize danger at site or during disposal.

.4 Demolish parts of structure structures.

.5 To permit construction of addition and as indicated.

.6 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as work progresses.

.7 At end of each day's work, leave Work in safe and stable condition.

.1 Protect interiors of parts not to be demolished from exterior elements at all times.

.8 Demolish to minimize dusting.

.9 Remove and dispose of demolished materials except where noted otherwise and in accordance with authorities having jurisdiction.

.10 Use natural lighting to do Work where possible.

.1 Shut off lighting except those required for security purposes at end of each day.

END OF SECTION

Part 1 General

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.1 Ensure proper disposal procedures are maintained throughout project.

.5 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers, or onto adjacent properties.

.6 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with authorities having jurisdiction.

.7 Protect trees, plants and foliage on site and adjacent properties where indicated.

.8 Prevent extraneous materials from contaminating air beyond application area, by providing temporary enclosures during demolition work.

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2.1 EQUIPMENT

.1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

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.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to: requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during demolition.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal after completion of demolition work.

.2 Protection of in-place conditions:

.1 Prevent movement, settlement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades properties parts of existing building to remain.

.1 Provide bracing, shoring and underpinning as required.

.2 Repair damage caused by demolition as directed by NRC Departmental Representative.

.2 Support affected structures and, if safety of structure being demolished or adjacent structures or services appears to be endangered, take preventative measures, stop Work and immediately notify NRC Departmental Representative.

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.3 Surface Preparation:

.1 Disconnect and re-route electrical ~~and telephone~~ service lines entering buildings to be demolished.

.1 Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of demolition.

.2 Do not disrupt active or energized utilities traversing premises designated to remain undisturbed.

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.4 Demolish parts of structure structures.

.5 To permit construction of addition and as indicated.

.6 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as work progresses.

.7 At end of each day's work, leave Work in safe and stable condition.

.1 Protect interiors of parts not to be demolished from exterior elements at all times.

.8 Demolish to minimize dusting.

.9 Remove and dispose of demolished materials except where noted otherwise and in accordance with authorities having jurisdiction.

.10 Use natural lighting to do Work where possible.

.1 Shut off lighting except those required for security purposes at end of each day.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C109 / C109M - 11b Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

.2 ASTM C348 - 08 Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

.3 ASTM E84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.2 ACTION SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature, and mixing and application instructions.

1.3 INFORMATION SUBMITTALS

.1 Certificates: provide manufacturer's product certificates certifying materials comply with specified requirements.

1.4 QUALITY ASSURANCE

.1 Applicators: Authorized by the manufacturer using approved mixing and pumping equipment approved.

.2 Pre-installation meeting: Prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Departmental Representative of the date and time of the meeting.

.3 Manufacturer’s site inspection: Have the manufacturer’s technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer’s inspection reports and verification that the work of this Section is correctly installed.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials in their original, unopened packages, and protected from exposure to the elements. Remove damaged or deteriorated materials shall be removed from the premises.

1.6 SITE CONDITIONS

.1 Before, during and after installation of work, ensure building interior is enclosed and maintained at a temperature above 10 degrees C.

Part 2 Products

2.1 MATERIALS

.1 Floor underlayment: Cementitious underlayment, minimum compressive strength after 28 days 38 MPa, meeting the following:

.1 Dry Density: Approximately 2003 kg/m^3

.2 Compressive Strength (ASTM C109): Typical:

.1 20.6 MPa at 3 days

.2 31 MPa at 7 days

.3 38 MPa at 28 days

.3 Flexural Strength (ASTM C348): 8.7 MPa at 28 days.

.4 Surface Burning Characteristics (ASTM E84): Typical:

.1 Flame spread - 0

.2 Fuel Contribution - 0

.3 Smoke Development - 0

.5 Feather edge thickness: as indicated on drawings.

.2 Aggregate: Washed masonry, plaster or silica sand meeting requirements of the manufacturer for intended end use.

.3 Mix water: Potable, free from impurities.

.4 Sealer: manufacturer's recommended sealer.

.5 Primer: Ethylene - vinyl acetate copolymer.

.6 Crack filler: Quick setting patching compound, compatible with floor underlayment.

2.2 MIX

.1 Mix proportions and methods shall be in strict accordance with product manufacturer recommendations.

Part 3 Execution

3.1 PREPARATION

.1 Subfloor shall be structurally sound. Shot blast or scarify steel trowel concrete, concrete with sealer or curing compound, slick or smooth concrete. Clean subfloor

to remove mud, oil, grease, and other contaminating factors before application of work.

.2 Fill cracks and voids with crack filler where leakage of underlayment could occur.

.3 Prime subfloor in accordance with manufacturer's recommendations.

.4 Expansion Joints: Allow joints to continue through the underlayment at the same width.

3.2 APPLICATION

.1 Do not commence work until the building is enclosed, including roof, windows, doors, and other fenestration.

.2 Spread and screed underlayment to a smooth surface. Except at authorized joints, place underlayment as continuously as possible until application is complete, so that no underlayment slurry is placed against underlayment product that has obtained its initial set.

.3 Provide continuous ventilation and adequate heat to rapidly remove moisture from the area until the underlayment has set and cured.

.4 Apply sealer to underlayment that is to receive glue down floor coverings.

.5 Clean floor areas where the underlayment has been damaged and seal regardless of floor covering to be used. Where floor covering manufacturers require special adhesive or installation systems, their requirements supersede these requirements.

3.3 FIELD QUALITY CONTROL

.1 Slump Test: Test underlayment as it is being pumped using a 50 mm x 100 mm cylinder resulting in a patty size of 225 mm plus or minus 25 mm diameter.

.2 At least one set of 3 molded cube samples shall be taken from each day's application. Cubes shall be tested as recommended by the manufacturer in accordance with modified ASTM C 109. Make test results available to the Departmental Representative.

3.4 PROTECTION

.1 Temporary Bracing During construction, place temporary wood planking over underlayment wherever it will be subject to heavy wheeled or concentrated loads.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C109 / C109M - 11b Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

.2 ASTM C348 - 08 Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.

.3 ASTM E84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.2 ACTION SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature, and mixing and application instructions.

1.3 INFORMATION SUBMITTALS

.1 Certificates: provide manufacturer's product certificates certifying materials comply with specified requirements.

1.4 QUALITY ASSURANCE

.1 Applicators: Authorized by the manufacturer using approved mixing and pumping equipment approved.

.2 Pre-installation meeting: Prior to commencing work of this Section, arrange for manufacturer's technical representative to visit the site and review preparatory and installation procedures to be followed, conditions under which the work will be done, and inspect the surfaces to receive the work of this Section. Advise the Departmental Representative of the date and time of the meeting.

.3 Manufacturer’s site inspection: Have the manufacturer’s technical representative inspect the Work at suitable intervals during application and at conclusion of the work of this Section, to ensure the Work is correctly installed. When requested, submit manufacturer’s inspection reports and verification that the work of this Section is correctly installed.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials in their original, unopened packages, and protected from exposure to the elements. Remove damaged or deteriorated materials shall be removed from the premises.

1.6 SITE CONDITIONS

.1 Before, during and after installation of work, ensure building interior is enclosed and maintained at a temperature above 10 degrees C.

Part 2 Products

2.1 MATERIALS

.1 Floor underlayment: Cementitious underlayment, minimum compressive strength after 28 days 38 MPa, meeting the following:

.1 Dry Density: Approximately 2003 kg/m^3

.2 Compressive Strength (ASTM C109): Typical:

.1 20.6 MPa at 3 days

.2 31 MPa at 7 days

.3 38 MPa at 28 days

.3 Flexural Strength (ASTM C348): 8.7 MPa at 28 days.

.4 Surface Burning Characteristics (ASTM E84): Typical:

.1 Flame spread - 0

.2 Fuel Contribution - 0

.3 Smoke Development - 0

.5 Feather edge thickness: as indicated on drawings.

.2 Aggregate: Washed masonry, plaster or silica sand meeting requirements of the manufacturer for intended end use.

.3 Mix water: Potable, free from impurities.

.4 Sealer: manufacturer's recommended sealer.

.5 Primer: Ethylene - vinyl acetate copolymer.

.6 Crack filler: Quick setting patching compound, compatible with floor underlayment.

2.2 MIX

.1 Mix proportions and methods shall be in strict accordance with product manufacturer recommendations.

Part 3 Execution

3.1 PREPARATION

.1 Subfloor shall be structurally sound. Shot blast or scarify steel trowel concrete, concrete with sealer or curing compound, slick or smooth concrete. Clean subfloor

to remove mud, oil, grease, and other contaminating factors before application of work.

.2 Fill cracks and voids with crack filler where leakage of underlayment could occur.

.3 Prime subfloor in accordance with manufacturer's recommendations.

.4 Expansion Joints: Allow joints to continue through the underlayment at the same width.

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.1 Do not commence work until the building is enclosed, including roof, windows, doors, and other fenestration.

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.3 Provide continuous ventilation and adequate heat to rapidly remove moisture from the area until the underlayment has set and cured.

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.5 Clean floor areas where the underlayment has been damaged and seal regardless of floor covering to be used. Where floor covering manufacturers require special adhesive or installation systems, their requirements supersede these requirements.

3.3 FIELD QUALITY CONTROL

.1 Slump Test: Test underlayment as it is being pumped using a 50 mm x 100 mm cylinder resulting in a patty size of 225 mm plus or minus 25 mm diameter.

.2 At least one set of 3 molded cube samples shall be taken from each day's application. Cubes shall be tested as recommended by the manufacturer in accordance with modified ASTM C 109. Make test results available to the Departmental Representative.

3.4 PROTECTION

.1 Temporary Bracing During construction, place temporary wood planking over underlayment wherever it will be subject to heavy wheeled or concentrated loads.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 05 31 00, Steel Decking.

1.2 REFERENCES

.1 ASTM International Inc.

.1 ASTM A36/A36M-08, Standard Specification for Carbon Structural Steel.

.2 ASTM A193/A193M-08, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Applications.

.3 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.4 ASTM A325-07a, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

.5 ASTM A325M-08, Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength Metric.

.6 ASTM A490M-04ae, Standard Specification for High-Strength Steel Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints Metric.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-85.10-99, Protective Coatings for Metals.

.3 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA).

.1 Handbook of the Canadian Institute of Steel Construction.

.2 CISC/CPMA Standard 2-75, Quick-Drying Primer for use on Structural Steel.

.4 Canadian Standards Association (CSA International)

.1 CSA G40.20/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

.3 CAN/CSA-S16-01(R2007), Limit States Design of Steel Structures.

.4 CAN/CSA-S136-07, North American Specifications for the Design of Cold Formed Steel Structural Members.

.5 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.

.6 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.

.7 CSA W55.3-1965(R2003), Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.

.8 CSA W59-03, Welded Steel Construction (Metal Arc Welding).

.5 Master Painters Institute

.1 MPI-INT 5.1-08, Structural Steel and Metal Fabrications.

.2 MPI-EXT 5.1-08, Structural Steel and Metal Fabrications.

.6 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International

.1 NACE No. 3/SSPC SP-6-06, Commercial Blast Cleaning.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Division 01.

.2 Shop Drawings:

.1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.3 Erection drawings:

.1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:

.1 Description of methods.

.2 Sequence of erection.

.3 Type of equipment used in erection.

.4 Temporary bracings.

.4 Fabrication drawings:

.1 Submit fabrication drawings showing designed assemblies, components and connections are stamped and signed by qualified professional engineer licensed in the Province of Ontario, Canada.

.5 Samples:

.1 Prepare sample of typical exposed structural connections in accordance with AISC Specifications of Architecturally exposed structural steel for approval of NRC Departmental Representative. Samples to be judged upon alignment of surfaces, uniform contact between surfaces, smoothness and uniformity of finished welds. When approved, sample units will serve as a standard for workmanship, appearance and material acceptable for entire project.

.6 Source Quality Control Submittals:

.1 Submit 3 copies of mill test reports 4 weeks prior to fabrication of structural steel.

.1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project.

.2 Provide mill test reports certified by metallurgists qualified to practice in Province of Ontario, Canada.

.7 Fabricator Reports:

.1 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication conform to applicable material and products standards specified and indicated.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Division 01.

.2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance Division 01.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Design details and connections in accordance with requirements of CAN/CSA-S16 and CAN/CSA-S136, with CSA-S136.1 to resist forces, moments, shears and allow for movements indicated.

.2 Shear connections:

.1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction" when connection for shear only (standard connection) is required.

.2 Select or design connections to support reaction from maximum uniformly distributed load that can be safely supported by beam in bending, provided no point loads act on beam, when shears are not indicated.

.3 For composite construction select or design minimum end connection to resist reaction resulting from factored movement resistance as tabulated in the "Handbook of the Canadian Institute of Steel Construction" assuming 100% shear connection with depth of steel deck and/or slab shown on drawings.

.4 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Province of Ontario, Canada for non-standard connections.

2.2 MATERIALS

.1 Structural steel: toCSA-G40.20/G40.21, Grade as indicated, 300W and/or CAN/CSA-S136.

.2 Anchor bolts: to CSA-G40.20/G40.21, Grade 300W, ASTM A36/A36M.

.3 High strength anchor bolts: to ASTM A193/A193M, Grade 50.

.4 Bolts, nuts and washers: to ASTM A307, ASTM A325, ASTM A325M, ASTM A490/A490M.

.5 Welding materials: to CSA W48 Series, CSA W59 and certified by Canadian Welding Bureau.

.6 Shop paint primer: to CISC/CPMA2-75 solvent reducible alkyd, red oxide grey.

.7 Hot dip galvanizing: galvanize steel, where indicated, to CAN/CSA-G164, minimum zinc coating of 600 g/m^2.

.8 Shear studs: to CSA W59, Appendix H.

2.3 FABRICATION

.1 Fabricate structural steel in accordance with CAN/CSA-S16, CAN/CSA-S136 and in accordance with reviewed shop drawings.

.2 Install shear studs in accordance with CSA W59.

.3 Continuously seal members by continuous welds.

2.4 SHOP PAINTING

.1 Clean, prepare surfaces and shop prime structural steel in accordance with CAN/CSA-S16, CAN/CSA-S136, except where members to be encased in concrete.

.2 Clean members, remove loose mill scale, rust, oil, dirt and foreign matter. Prepare surface according to NACE No.3/SSPC-SP-6.

.3 Apply one coat of primer in shop to steel surfaces to achieve minimum dry film thickness of 2.95 to 3.20 mils, except:

.1 Surfaces to be encased in concrete.

.2 Surfaces to receive field installed stud shear connections.

.3 Surfaces and edges to be field welded.

.4 Faying surfaces of slip-critical connections.

.5 Below grade surfaces in contact with soil.

.4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.

.5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.

.6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 GENERAL

.1 Structural steel work: in accordance with CAN/CSA-S16 CAN/CSA-S136.

.2 Welding: in accordance with CSA W59.

.3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

3.3 CONNECTION TO EXISTING WORK

.1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to NRC Departmental Representative for direction before commencing fabrication.

3.4 MARKING

.1 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.

.2 Match marking: shop mark bearing assemblies and splices for fit and match.

3.5 ERECTION

.1 Erect structural steel, as indicated and in accordance with CAN/CSA-S16, CAN/CSA-S136 and in accordance with reviewed erection drawings.

.2 Field cutting or altering structural members: to approval of NRC Departmental Representative.

.3 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.

.4 Continuously seal members by continuous welds where indicated. Grind smooth.

3.6 FIELD QUALITY CONTROL

.1 Inspection and testing of materials and workmanship will be carried out by testing laboratory designated by NRC Departmental Representative.

.2 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by NRC Departmental Representative.

.3 Submit test reports to NRC Departmental Representative within 2 weeks of completion of inspection.

.4 NRC Departmental Representative Owner will pay costs of tests as specified in Division 01.

.5 Test shear studs in accordance with CSA W59.

3.7 FIELD PAINTING

.1 Paint in accordance with Section 09 91 23 - Interior Painting.

.1 Touch up damaged surfaces and surfaces without shop coat with primer to NACE No.3/SSPC-SP-6 except as specified otherwise. Apply in accordance: MPI Architectural Painting Specification Manual.

3.8 CLEANING

.1 Clean in accordance with Division 01.

.2 Waste Management: separate waste materials for reuse recycling in accordance with Division 01.

3.9 EXISTING STEEL

.1 Facilitate inspection of roof steel structure for corrosion and loss of section once ceiling is removed and scaffold is in place.

~~.2 Blast clean steel as directed by Consultant.~~

~~.3 Reinforce where required.~~

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 05 31 00, Steel Decking.

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.1 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication conform to applicable material and products standards specified and indicated.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Division 01.

.2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance Division 01.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Design details and connections in accordance with requirements of CAN/CSA-S16 and CAN/CSA-S136, with CSA-S136.1 to resist forces, moments, shears and allow for movements indicated.

.2 Shear connections:

.1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction" when connection for shear only (standard connection) is required.

.2 Select or design connections to support reaction from maximum uniformly distributed load that can be safely supported by beam in bending, provided no point loads act on beam, when shears are not indicated.

.3 For composite construction select or design minimum end connection to resist reaction resulting from factored movement resistance as tabulated in the "Handbook of the Canadian Institute of Steel Construction" assuming 100% shear connection with depth of steel deck and/or slab shown on drawings.

.4 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Province of Ontario, Canada for non-standard connections.

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.1 Structural steel: toCSA-G40.20/G40.21, Grade as indicated, 300W and/or CAN/CSA-S136.

.2 Anchor bolts: to CSA-G40.20/G40.21, Grade 300W, ASTM A36/A36M.

.3 High strength anchor bolts: to ASTM A193/A193M, Grade 50.

.4 Bolts, nuts and washers: to ASTM A307, ASTM A325, ASTM A325M, ASTM A490/A490M.

.5 Welding materials: to CSA W48 Series, CSA W59 and certified by Canadian Welding Bureau.

.6 Shop paint primer: to CISC/CPMA2-75 solvent reducible alkyd, red oxide grey.

.7 Hot dip galvanizing: galvanize steel, where indicated, to CAN/CSA-G164, minimum zinc coating of 600 g/m^2.

.8 Shear studs: to CSA W59, Appendix H.

2.3 FABRICATION

.1 Fabricate structural steel in accordance with CAN/CSA-S16, CAN/CSA-S136 and in accordance with reviewed shop drawings.

.2 Install shear studs in accordance with CSA W59.

.3 Continuously seal members by continuous welds.

2.4 SHOP PAINTING

.1 Clean, prepare surfaces and shop prime structural steel in accordance with CAN/CSA-S16, CAN/CSA-S136, except where members to be encased in concrete.

.2 Clean members, remove loose mill scale, rust, oil, dirt and foreign matter. Prepare surface according to NACE No.3/SSPC-SP-6.

.3 Apply one coat of primer in shop to steel surfaces to achieve minimum dry film thickness of 2.95 to 3.20 mils, except:

.1 Surfaces to be encased in concrete.

.2 Surfaces to receive field installed stud shear connections.

.3 Surfaces and edges to be field welded.

.4 Faying surfaces of slip-critical connections.

.5 Below grade surfaces in contact with soil.

.4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.

.5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.

.6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 GENERAL

.1 Structural steel work: in accordance with CAN/CSA-S16 CAN/CSA-S136.

.2 Welding: in accordance with CSA W59.

.3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

3.3 CONNECTION TO EXISTING WORK

.1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to NRC Departmental Representative for direction before commencing fabrication.

3.4 MARKING

.1 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.

.2 Match marking: shop mark bearing assemblies and splices for fit and match.

3.5 ERECTION

.1 Erect structural steel, as indicated and in accordance with CAN/CSA-S16, CAN/CSA-S136 and in accordance with reviewed erection drawings.

.2 Field cutting or altering structural members: to approval of NRC Departmental Representative.

.3 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.

.4 Continuously seal members by continuous welds where indicated. Grind smooth.

3.6 FIELD QUALITY CONTROL

.1 Inspection and testing of materials and workmanship will be carried out by testing laboratory designated by NRC Departmental Representative.

.2 Provide safe access and working areas for testing on site, as required by testing agency and as authorized by NRC Departmental Representative.

.3 Submit test reports to NRC Departmental Representative within 2 weeks of completion of inspection.

.4 NRC Departmental Representative Owner will pay costs of tests as specified in Division 01.

.5 Test shear studs in accordance with CSA W59.

3.7 FIELD PAINTING

.1 Paint in accordance with Section 09 91 23 - Interior Painting.

.1 Touch up damaged surfaces and surfaces without shop coat with primer to NACE No.3/SSPC-SP-6 except as specified otherwise. Apply in accordance: MPI Architectural Painting Specification Manual.

3.8 CLEANING

.1 Clean in accordance with Division 01.

.2 Waste Management: separate waste materials for reuse recycling in accordance with Division 01.

3.9 EXISTING STEEL

.1 Facilitate inspection of roof steel structure for corrosion and loss of section once ceiling is removed and scaffold is in place.

~~.2 Blast clean steel as directed by Consultant.~~

~~.3 Reinforce where required.~~

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 06 10 00 - Rough Carpentry.

.2 07 92 00 - Joint Sealants.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI A208.1-09, Particleboard.
.2 ANSI A208.2-09, Medium Density Fiberboard (MDF) for Interior Applications.

.2 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)

.1 Architectural Woodwork Standards Illustrated, 2nd edition, (2014).

.3 CSA International

.1 CSA B111-74(R2003), Wire Nails, Spikes and Staples.
.2 CSA O121-08, Douglas Fir Plywood.
.3 CSA O141-05(R2009), Softwood Lumber.
.4 CSA O151-09, Canadian Softwood Plywood.
.5 CSA O153-M1980(R2008), Poplar Plywood.

.4 Green Seal Environmental Standards (GS)

.1 GS-11-11, Paints and Coatings.
.2 GS-36-11, Commercial Adhesives.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 National Electrical Manufacturers Association (NEMA)

.1 ANSI/NEMA LD-3-05, High-Pressure Decorative Laminates (HPDL).

.7 National Lumber Grades Authority (NLGA)

.1 Standard Grading Rules for Canadian Lumber 2010.

.8 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2011, Architectural Coatings.
.2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for architectural woodwork and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies of WHMIS MSDS.

.2 Shop Drawings:

~~.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.~~

~~.2~~.1 Indicate details of construction, profiles, jointing, fastening and other related details.

.1 Scales: profiles full size, details half full size.

~~.3~~.2 Indicate materials, thicknesses, finishes and hardware.

~~.4~~.3 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.

.3 Samples:

.1 Submit for review and acceptance of each unit.

.2 Samples will be returned for inclusion into work.

.3 Submit duplicate samples of laminated plastic for colour selection.

.4 Submit duplicate samples of laminated plastic joints, edging, cutouts and postformed profiles.

.4 Certifications: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

.1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.2 Plywood, particleboard, OSB and wood based composite panels to CSA and ANSI standards.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.1 Protect millwork against dampness and damage during and after delivery.

.2 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect architectural woodwork from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

Part 2 Products

2.1 MATERIALS

.1 Softwood lumber: unless specified otherwise, S4S, moisture content 19 % or less in accordance with following standards:

.1 CSA O141.

.2 CAN/CSA-Z809 or FSC or SFI certified.

.3 NLGA Standard Grading Rules for Canadian Lumber.

.4 AWMAC premium grade, moisture content as specified.

.2 Machine stress-rated lumber is acceptable for all purposes.

.3 Hardwood lumber: moisture content 15 % or less in accordance with following standards:

.1 National Hardwood Lumber Association (NHLA).

.2 CAN/CSA-Z809 or FSC or SFI certified.

.3 AWMAC premium grade, moisture content as specified.

.4 Canadian softwood plywood (CSP): to CSA O151, standard construction, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.5 Hardwood plywood: to ANSI/HPVA HP-1, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.6 Poplar plywood (PP): to CSA O153, standard construction, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.7 Interior mat-formed wood particleboard: to ANSI/NPA A208.1, CAN/CSA-Z809 or FSC or SFI certified.

.1 Particleboard resin to contain no added urea-formaldehyde.

.8 Birch plywood: to AWMAC Paint Grade, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.9 Fibreboard must contain less than 10% roundwood by weight, using weighted average over three month period at manufacturing locations.

.1 Fibreboard resin to contain no added urea-formaldehyde.

.2 CAN/CSA-Z809 or FSC or SFI certified.

.10 Hardboard:

.1 To CAN/CGSB-11.3, CAN/CSA-Z809 or FSC or SFI certified.

.2 Hardboard resin to contain no added urea-formaldehyde.

.11 MDF (medium density fibreboard) core: to ANSI A208.2, density 769 kg/m^2, CAN/CSA-Z809 or FSC or SFI certified.

.1 Medium density fibreboard performance requirements to: ANSI A208.2.

.2 MDF resin to contain no added urea-formaldehyde.

.12 Plastic laminate: ANSI/NEMA LD-3~~., high pressure paper base decorative laminates. Unless otherwise specified, use the following:~~

.1 Refer to Section 06 47 00 – Plastic Laminate Finishing.

~~.1 Horizontal postform work: Grade HGP, minimum 1 mm thick.~~

~~.2 Horizontal flat work: Grade HGS, minimum 1.2 mm thick.~~

~~.3 Vertical postform work: Grade VGP, minimum 0.7 mm thick.~~

~~.4 Vertical flat work: Grade VGS minimum 0.7 mm thick.~~

~~.5 Backing sheet: BK, same thickness as facing sheets, sanded one face and manufactured by the same manufacturer as the facing sheet.~~

~~.6~~**.2** Colour: Refer to Section 00 01 30, List of Materials.

.13 Nails and staples: to CSA B111.

.14 Wood screws: type and size to suit application.

.15 Splines: wood.

.16 Sealant: in accordance with Section 07 92 00 - Joint Sealants,

.1 Sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.17 Laminated plastic adhesive:

.1 Adhesive: as recommended by manufacturer.

.2 Adhesives: VOC limit 30 120 g/L maximum to SCAQMD Rule 1168 GS-36.

2.2 MANUFACTURED UNITS

.1 Casework:

.1 Fabricate caseworks to AWMAC premium quality grade.

.2 Furring, blocking, nailing strips, grounds and rough bucks and sleepers.

.1 S2S is acceptable.

.2 Board sizes: "standard" or better grade.

.3 Dimension sizes: "standard" light framing or better grade.

.4 Urea-formaldehyde free.

.3 Framing, NLGA grade.

.4 Case bodies (ends, divisions and bottoms).

.1 Softwood and poplar plywood DFP or CSP or PP, square edge, 19 mm thick.

.2 Hardwood plywood:

.1 Thickness: 19mm.

.3 Particleboard, grade 19mm thick.

.5 Backs:

.1 Softwood and poplar plywood DFP or CSP or PP, square edge, 19 mm thick.

.2 Hardwood plywood:

.1 Thickness: 19mm.

.3 Particleboard, 19mm thick.

.6 Shelving:

.1 Softwood and poplar plywood DFP or CSP or PP grade, square edge, 19mm thick.

.2 Edge banding: provide 10 mm thick solid matching wood strip on plywood, particleboard edges 12 mm or thicker, exposed in final assembly. Strips same width as plywood, particleboard. Matching colour in HPL.

.2 Drawers:

.1 Fabricate drawers to AWMAC premium grade supplemented as follows:

.2 Sides and Backs.

.1 Thermofused melamine: 12mm thick.

.3 Bottoms:

.1 Softwood and poplar plywood DFP or CSP or PP grade, square edge, 12mm thick.

.4 Fronts:

.1 Medium density fibreboard: 19mm thick, HPL.

.3 Casework Doors:

.1 Fabricate doors to AWMAC premium grade supplemented as follows:

.2 Medium Density Fibreboard, laminated with HPL.

2.3 FABRICATION

.1 Set nails and countersink screws apply stained plain wood filler to indentations, sand smooth and leave ready to receive finish.

.2 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.

.3 Shelving to cabinetwork to be adjustable unless otherwise noted.

.4 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.

.5 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

.6 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.

.7 Ensure adjacent parts of continuous laminate work match in colour and pattern.

.8 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 3000 mm. Keep joints 600 mm from sink cutouts.

.9 Form shaped profiles and bends as indicated, using postforming grade laminate to laminate manufacturer's instructions.

.10 Use straight self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.

.11 Apply laminate backing sheet to reverse side of core of plastic laminate work.

.12 Apply laminated plastic liner sheet to interior of cabinetry.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for architectural woodwork installation in accordance with manufacturer's instructions.

.1 Visually inspect substrate.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Do architectural woodwork to Quality Standards of AWMAC.

.2 Install prefinished millwork at locations shown on drawings.

.1 Position accurately, level, plumb straight.

.3 Fasten and anchor millwork securely.

.1 Supply and install heavy duty fixture attachments for wall mounted cabinets.

.4 Use draw bolts in countertop joints.

.5 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.

.6 At junction of plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant in accordance with Section 07 92 00 - Joint Sealants.

.7 Apply water resistant building paper over wood framing members in contact with masonry or cementitious construction.

.8 Fit hardware accurately and securely in accordance with manufacturer's written instructions.

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.1 Clean millwork and cabinet work inside cupboards and drawers and outside surfaces.

.2 Remove excess glue from surfaces.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect millwork and cabinet work from damage until final inspection.

.2 Protect installed products and components from damage during construction.

.3 Repair damage to adjacent materials caused by architectural woodwork installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 06 10 00 - Rough Carpentry.

.2 07 92 00 - Joint Sealants.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI A208.1-09, Particleboard.
.2 ANSI A208.2-09, Medium Density Fiberboard (MDF) for Interior Applications.

.2 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)

.1 Architectural Woodwork Standards Illustrated, 2nd edition, (2014).

.3 CSA International

.1 CSA B111-74(R2003), Wire Nails, Spikes and Staples.
.2 CSA O121-08, Douglas Fir Plywood.
.3 CSA O141-05(R2009), Softwood Lumber.
.4 CSA O151-09, Canadian Softwood Plywood.
.5 CSA O153-M1980(R2008), Poplar Plywood.

.4 Green Seal Environmental Standards (GS)

.1 GS-11-11, Paints and Coatings.
.2 GS-36-11, Commercial Adhesives.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 National Electrical Manufacturers Association (NEMA)

.1 ANSI/NEMA LD-3-05, High-Pressure Decorative Laminates (HPDL).

.7 National Lumber Grades Authority (NLGA)

.1 Standard Grading Rules for Canadian Lumber 2010.

.8 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2011, Architectural Coatings.
.2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for architectural woodwork and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies of WHMIS MSDS.

.2 Shop Drawings:

~~.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.~~

~~.2~~.1 Indicate details of construction, profiles, jointing, fastening and other related details.

.1 Scales: profiles full size, details half full size.

~~.3~~.2 Indicate materials, thicknesses, finishes and hardware.

~~.4~~.3 Indicate locations of service outlets in casework, typical and special installation conditions, and connections, attachments, anchorage and location of exposed fastenings.

.3 Samples:

.1 Submit for review and acceptance of each unit.

.2 Samples will be returned for inclusion into work.

.3 Submit duplicate samples of laminated plastic for colour selection.

.4 Submit duplicate samples of laminated plastic joints, edging, cutouts and postformed profiles.

.4 Certifications: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

.1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.2 Plywood, particleboard, OSB and wood based composite panels to CSA and ANSI standards.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.1 Protect millwork against dampness and damage during and after delivery.

.2 Store millwork in ventilated areas, protected from extreme changes of temperature or humidity.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect architectural woodwork from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

Part 2 Products

2.1 MATERIALS

.1 Softwood lumber: unless specified otherwise, S4S, moisture content 19 % or less in accordance with following standards:

.1 CSA O141.

.2 CAN/CSA-Z809 or FSC or SFI certified.

.3 NLGA Standard Grading Rules for Canadian Lumber.

.4 AWMAC premium grade, moisture content as specified.

.2 Machine stress-rated lumber is acceptable for all purposes.

.3 Hardwood lumber: moisture content 15 % or less in accordance with following standards:

.1 National Hardwood Lumber Association (NHLA).

.2 CAN/CSA-Z809 or FSC or SFI certified.

.3 AWMAC premium grade, moisture content as specified.

.4 Canadian softwood plywood (CSP): to CSA O151, standard construction, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.5 Hardwood plywood: to ANSI/HPVA HP-1, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.6 Poplar plywood (PP): to CSA O153, standard construction, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.7 Interior mat-formed wood particleboard: to ANSI/NPA A208.1, CAN/CSA-Z809 or FSC or SFI certified.

.1 Particleboard resin to contain no added urea-formaldehyde.

.8 Birch plywood: to AWMAC Paint Grade, CAN/CSA-Z809 or FSC or SFI certified.

.1 Plywood resin to contain no added urea-formaldehyde.

.9 Fibreboard must contain less than 10% roundwood by weight, using weighted average over three month period at manufacturing locations.

.1 Fibreboard resin to contain no added urea-formaldehyde.

.2 CAN/CSA-Z809 or FSC or SFI certified.

.10 Hardboard:

.1 To CAN/CGSB-11.3, CAN/CSA-Z809 or FSC or SFI certified.

.2 Hardboard resin to contain no added urea-formaldehyde.

.11 MDF (medium density fibreboard) core: to ANSI A208.2, density 769 kg/m^2, CAN/CSA-Z809 or FSC or SFI certified.

.1 Medium density fibreboard performance requirements to: ANSI A208.2.

.2 MDF resin to contain no added urea-formaldehyde.

.12 Plastic laminate: ANSI/NEMA LD-3~~., high pressure paper base decorative laminates. Unless otherwise specified, use the following:~~

.1 Refer to Section 06 47 00 – Plastic Laminate Finishing.

~~.1 Horizontal postform work: Grade HGP, minimum 1 mm thick.~~

~~.2 Horizontal flat work: Grade HGS, minimum 1.2 mm thick.~~

~~.3 Vertical postform work: Grade VGP, minimum 0.7 mm thick.~~

~~.4 Vertical flat work: Grade VGS minimum 0.7 mm thick.~~

~~.5 Backing sheet: BK, same thickness as facing sheets, sanded one face and manufactured by the same manufacturer as the facing sheet.~~

~~.6~~**.2** Colour: Refer to Section 00 01 30, List of Materials.

.13 Nails and staples: to CSA B111.

.14 Wood screws: type and size to suit application.

.15 Splines: wood.

.16 Sealant: in accordance with Section 07 92 00 - Joint Sealants,

.1 Sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.17 Laminated plastic adhesive:

.1 Adhesive: as recommended by manufacturer.

.2 Adhesives: VOC limit 30 120 g/L maximum to SCAQMD Rule 1168 GS-36.

2.2 MANUFACTURED UNITS

.1 Casework:

.1 Fabricate caseworks to AWMAC premium quality grade.

.2 Furring, blocking, nailing strips, grounds and rough bucks and sleepers.

.1 S2S is acceptable.

.2 Board sizes: "standard" or better grade.

.3 Dimension sizes: "standard" light framing or better grade.

.4 Urea-formaldehyde free.

.3 Framing, NLGA grade.

.4 Case bodies (ends, divisions and bottoms).

.1 Softwood and poplar plywood DFP or CSP or PP, square edge, 19 mm thick.

.2 Hardwood plywood:

.1 Thickness: 19mm.

.3 Particleboard, grade 19mm thick.

.5 Backs:

.1 Softwood and poplar plywood DFP or CSP or PP, square edge, 19 mm thick.

.2 Hardwood plywood:

.1 Thickness: 19mm.

.3 Particleboard, 19mm thick.

.6 Shelving:

.1 Softwood and poplar plywood DFP or CSP or PP grade, square edge, 19mm thick.

.2 Edge banding: provide 10 mm thick solid matching wood strip on plywood, particleboard edges 12 mm or thicker, exposed in final assembly. Strips same width as plywood, particleboard. Matching colour in HPL.

.2 Drawers:

.1 Fabricate drawers to AWMAC premium grade supplemented as follows:

.2 Sides and Backs.

.1 Thermofused melamine: 12mm thick.

.3 Bottoms:

.1 Softwood and poplar plywood DFP or CSP or PP grade, square edge, 12mm thick.

.4 Fronts:

.1 Medium density fibreboard: 19mm thick, HPL.

.3 Casework Doors:

.1 Fabricate doors to AWMAC premium grade supplemented as follows:

.2 Medium Density Fibreboard, laminated with HPL.

2.3 FABRICATION

.1 Set nails and countersink screws apply stained plain wood filler to indentations, sand smooth and leave ready to receive finish.

.2 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.

.3 Shelving to cabinetwork to be adjustable unless otherwise noted.

.4 Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes and other fixtures.

.5 Shop assemble work for delivery to site in size easily handled and to ensure passage through building openings.

.6 Obtain governing dimensions before fabricating items which are to accommodate or abut appliances, equipment and other materials.

.7 Ensure adjacent parts of continuous laminate work match in colour and pattern.

.8 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 3000 mm. Keep joints 600 mm from sink cutouts.

.9 Form shaped profiles and bends as indicated, using postforming grade laminate to laminate manufacturer's instructions.

.10 Use straight self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.

.11 Apply laminate backing sheet to reverse side of core of plastic laminate work.

.12 Apply laminated plastic liner sheet to interior of cabinetry.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for architectural woodwork installation in accordance with manufacturer's instructions.

.1 Visually inspect substrate.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Do architectural woodwork to Quality Standards of AWMAC.

.2 Install prefinished millwork at locations shown on drawings.

.1 Position accurately, level, plumb straight.

.3 Fasten and anchor millwork securely.

.1 Supply and install heavy duty fixture attachments for wall mounted cabinets.

.4 Use draw bolts in countertop joints.

.5 Scribe and cut as required to fit abutting walls and to fit properly into recesses and to accommodate piping, columns, fixtures, outlets or other projecting, intersecting or penetrating objects.

.6 At junction of plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant in accordance with Section 07 92 00 - Joint Sealants.

.7 Apply water resistant building paper over wood framing members in contact with masonry or cementitious construction.

.8 Fit hardware accurately and securely in accordance with manufacturer's written instructions.

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.1 Clean millwork and cabinet work inside cupboards and drawers and outside surfaces.

.2 Remove excess glue from surfaces.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect millwork and cabinet work from damage until final inspection.

.2 Protect installed products and components from damage during construction.

.3 Repair damage to adjacent materials caused by architectural woodwork installation.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 04 04 99 –Masonry for Minor Works

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C920-11, Standard Specification for Elastomeric Joint Sealants

.2 ASTM D412 – 06ae2, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

.3 ASTM E96/E96M – 10, Standard Test Methods for Water Vapor Transmission of Materials.

.4 ASTM E283 – 04: Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.5 ASTM E2357 – 11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

.2 Canadian General Standards Board (CGSB)

.1 CGSB 37-GP-56M85: Membrane, Modified, Bituminous, Prefabricated, and Reinforced.

.2 CGSB 71-GP-24M85: Adhesive, Flexible, for Bonding Cellular Polystyrene Insulation

1.3 SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings: Provide drawings of special joint conditions and locations.

.3 Product data: Submit manufacturer's product data sheets on products, characteristics, performance criteria, and limitations, installation instructions indicating preparation, installation requirements, product storage and handling criteria.

.4 Samples: Two 150 mm x 150 mm samples of sheet air barriers.

1.4 QUALITY ASSURANCE

.1 Perform Work in accordance with requirements for materials and installation.

.2 Perform Work in accordance with National Air Barrier Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.

.3 Perform Work in accordance with Canadian Urethane Foam Contractors Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.

.4 Maintain one copy of documents on site.

1.5 QUALIFICATIONS

.1 Applicator: Company specializing in performing work of this section with minimum 5 years experience with installation of air/vapour barrier systems. Completed installation must be approved by the material manufacturer.

.2 Applicator: Company who is currently licensed by National Air Barrier Association, Canadian Urethane Foam Contractors Association or other certifying organization must maintain their license throughout the duration of the project.

1.6 PRE- INSTALLATION MEETINGS

.1 Convene one week prior to commencing Work of this section.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer=s written instructions.

.2 Avoid spillage. Immediately notify NRC Departmental Representative if spillage occurs and start clean up procedures.

.3 Clean spills and leave area as it was prior to spill.

~~**1.8 WASTE MANAGEMENT AND DISPOSAL**~~

~~.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.~~

~~.2 Place materials defined as hazardous or toxic waste in designated containers.~~

~~.3 Ensure emptied containers are sealed and stored safely for disposal away from children.~~

~~1.9~~1.8 PROJECT ENVIRONMENTAL REQUIREMENTS

.1 Do not install solvent curing sealants or vapour release adhesive materials in enclosed spaces without ventilation. Ventilate enclosed spaces.

.2 Maintain temperature and humidity recommended by materials manufactures before, during and after installation.

~~1.10~~1.9 SEQUENCING

.1 Sequence work to permit installation of materials in conjunction with related materials and seals.

~~1.11~~1.10 WARRANTY

.1 For sealant and sheet materials the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 24 months.

.2 Warranty: Include coverage of installed sealant and sheet materials which fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

Part 2 Products

2.1 SHEET MATERIALS

.1 Sheet air/vapour barrier membrane: SBS modified bitumen, self-adhering sheet membrane complete with a cross-laminated polyethylene film, having the following physical properties:

.1 Thickness: 1.0 mm (40 mils)
.2 Air leakage: <0.005 L/s.m² @ 75 Pa to ASTM E283-91
.3 Tested to ASTM E 2357 for the air barrier assembly
.4 Water vapour permeance: 1.6 ng/Pa.m².s (0.03 perms) to ASTM E96
.5 Low temperature flexibility: -30 °C to CGSB 37-GP-56M
.6 Elongation: 200% to ASTM D412-modifed.

2.2 ACCESSORIES

.1 Primer for self-adhering membranes at temperatures above -4 degrees C: polymer emulsion based adhesive, quick setting, having the following physical properties:

.1 Weight: 1.0 kg/l
.2 Solids by weight: 53%
.3 Water based, no solvent odours
.4 Drying time (initial set): 30 minutes at 50%RH and 20 degrees C.

.2 Liquid air seal mastic and insulation adhesive: synthetic, trowel applied, rubber based adhesive, compatible with air/vapour barrier membrane, substrate and insulation, having the following characteristics:

.1 Air leakage: 0.013 L/s.m² @ 100 Pa.
.2 Water vapour permeance: 1.7 ng/Pa.m².s. (0.03 perms).
.3 Long term flexibility: to CGSB 71-GP-24M.
.4 Chemical resistance: Alkalis and salt.

.3 Termination Sealant: moisture cure, medium modulus polymer modified sealing compound, compatible with sheet air barrier and substrate, having the following physical properties:

.1 Complies with ASTM C 920, Type S, Grade NS, Class 25.

.2 Elongation: 450 – 550%.

.4 Termination Sealant: polymer modified sealing compound, compatible with sheet waterproofing membrane and substrate, having the following characteristics:

.1 Solids by volume: 70%.

.2 Vapour permeance: 2.9 ng/Pa.m^2.s, ASTM E96.

.3 Chemical resistance: Alkalis, calcium chloride, mild acid and salt solutions.

.5 Thinner and cleaner for Sheet: As recommended by sheet material manufacturer.

.6 Attachments: Galvanized steel bars and anchors.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that surfaces and conditions are ready to accept the Work of this section.

.2 Ensure all surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer’s requirements.

.3 Report any unsatisfactory conditions to the NRC Departmental Representative in writing.

.4 Do not start work until deficiencies have been corrected. Commencement of Work implies acceptance of conditions.

3.2 PREPARATION

.1 Remove loose or foreign matter which might impair adhesion of materials.

.2 Ensure all substrates are clean of oil or excess dust; all masonry joints struck flush, and open joints filled; and all concrete surfaces free of large voids, spalled areas or sharp protrusions.

.3 Ensure all substrates are free of surface moisture prior to application of self-adhesive membrane and primer.

.4 Ensure metal closures are free of sharp edges and burrs.

.5 Prime all surfaces prior to application of membranes in accordance with manufacturer's instructions.

3.3 INSTALLATION

.1 Install the membrane in strict accordance with the manufacturer's written instructions and the representative's on site instructions.

.2 Ensure complete coverage of and adhesion to all substrate to receive the air/vapour barrier membrane, including all wall protrusions. Co-operate with other Sections to ensure continuity of the barrier.

.3 Apply membranes to primed substrate in accordance with manufacturer's recommendations and written instructions.

.4 Apply membrane so that horizontal joints overlap with the upper sheet over the lower sheet, shingle style. Lap all horizontal joints minimum 50 mm all side joints minimum 64 mm and all end joints minimum 150 mm. Stagger vertical joints to avoid four way joints.

.5 Apply a trowelled head of mastic to all terminations of the membrane at the end of a day's work and at membrane terminations.

.6 Reinforce all inside and outside corners with a continuous 300 mm wide sheet membrane prior to installing the air/vapour barrier.

.7 Fill gaps and joints with mastic and reinforce with a continuous 300 mm wide sheet membrane prior to installing the air/vapour barrier.

.8 Use mastic at all protrusions and difficult detail areas and provide a minimum 64 mm overlap with the sheet membrane.

.9 Apply air/vapour barrier so that the exterior wall is air tight, with air tight junctures at openings, penetrations and edges.

.10 Inspect air/vapour barrier for continuity immediately prior to installation of insulation. Do not cover the air/vapour barrier until it has been inspected.

.11 Repair punctures, rips and tears with pieces of membrane completely adhered to the damaged membrane.

.12 Where punctures and tears are extensive, replace entire damaged section.

.13 Install membrane over doors, and other openings to exterior walls.

.14 At openings, extend membrane 200 mm beyond jambs, heads and sills.

.15 Use mastic or fixing bars to adhere membrane to doors to maintain continuity of the barrier.

3.4 PROTECTION OF WORK

.1 Do not permit adjacent work to damage work of this section.

.2 Ensure finished Work is protected from climatic conditions.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 04 04 99 –Masonry for Minor Works

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM C920-11, Standard Specification for Elastomeric Joint Sealants

.2 ASTM D412 – 06ae2, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

.3 ASTM E96/E96M – 10, Standard Test Methods for Water Vapor Transmission of Materials.

.4 ASTM E283 – 04: Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

.5 ASTM E2357 – 11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

.2 Canadian General Standards Board (CGSB)

.1 CGSB 37-GP-56M85: Membrane, Modified, Bituminous, Prefabricated, and Reinforced.

.2 CGSB 71-GP-24M85: Adhesive, Flexible, for Bonding Cellular Polystyrene Insulation

1.3 SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop drawings: Provide drawings of special joint conditions and locations.

.3 Product data: Submit manufacturer's product data sheets on products, characteristics, performance criteria, and limitations, installation instructions indicating preparation, installation requirements, product storage and handling criteria.

.4 Samples: Two 150 mm x 150 mm samples of sheet air barriers.

1.4 QUALITY ASSURANCE

.1 Perform Work in accordance with requirements for materials and installation.

.2 Perform Work in accordance with National Air Barrier Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.

.3 Perform Work in accordance with Canadian Urethane Foam Contractors Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.

.4 Maintain one copy of documents on site.

1.5 QUALIFICATIONS

.1 Applicator: Company specializing in performing work of this section with minimum 5 years experience with installation of air/vapour barrier systems. Completed installation must be approved by the material manufacturer.

.2 Applicator: Company who is currently licensed by National Air Barrier Association, Canadian Urethane Foam Contractors Association or other certifying organization must maintain their license throughout the duration of the project.

1.6 PRE- INSTALLATION MEETINGS

.1 Convene one week prior to commencing Work of this section.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer=s written instructions.

.2 Avoid spillage. Immediately notify NRC Departmental Representative if spillage occurs and start clean up procedures.

.3 Clean spills and leave area as it was prior to spill.

~~**1.8 WASTE MANAGEMENT AND DISPOSAL**~~

~~.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.~~

~~.2 Place materials defined as hazardous or toxic waste in designated containers.~~

~~.3 Ensure emptied containers are sealed and stored safely for disposal away from children.~~

~~1.9~~1.8 PROJECT ENVIRONMENTAL REQUIREMENTS

.1 Do not install solvent curing sealants or vapour release adhesive materials in enclosed spaces without ventilation. Ventilate enclosed spaces.

.2 Maintain temperature and humidity recommended by materials manufactures before, during and after installation.

~~1.10~~1.9 SEQUENCING

.1 Sequence work to permit installation of materials in conjunction with related materials and seals.

~~1.11~~1.10 WARRANTY

.1 For sealant and sheet materials the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 24 months.

.2 Warranty: Include coverage of installed sealant and sheet materials which fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

Part 2 Products

2.1 SHEET MATERIALS

.1 Sheet air/vapour barrier membrane: SBS modified bitumen, self-adhering sheet membrane complete with a cross-laminated polyethylene film, having the following physical properties:

.1 Thickness: 1.0 mm (40 mils)
.2 Air leakage: <0.005 L/s.m² @ 75 Pa to ASTM E283-91
.3 Tested to ASTM E 2357 for the air barrier assembly
.4 Water vapour permeance: 1.6 ng/Pa.m².s (0.03 perms) to ASTM E96
.5 Low temperature flexibility: -30 °C to CGSB 37-GP-56M
.6 Elongation: 200% to ASTM D412-modifed.

2.2 ACCESSORIES

.1 Primer for self-adhering membranes at temperatures above -4 degrees C: polymer emulsion based adhesive, quick setting, having the following physical properties:

.1 Weight: 1.0 kg/l
.2 Solids by weight: 53%
.3 Water based, no solvent odours
.4 Drying time (initial set): 30 minutes at 50%RH and 20 degrees C.

.2 Liquid air seal mastic and insulation adhesive: synthetic, trowel applied, rubber based adhesive, compatible with air/vapour barrier membrane, substrate and insulation, having the following characteristics:

.1 Air leakage: 0.013 L/s.m² @ 100 Pa.
.2 Water vapour permeance: 1.7 ng/Pa.m².s. (0.03 perms).
.3 Long term flexibility: to CGSB 71-GP-24M.
.4 Chemical resistance: Alkalis and salt.

.3 Termination Sealant: moisture cure, medium modulus polymer modified sealing compound, compatible with sheet air barrier and substrate, having the following physical properties:

.1 Complies with ASTM C 920, Type S, Grade NS, Class 25.

.2 Elongation: 450 – 550%.

.4 Termination Sealant: polymer modified sealing compound, compatible with sheet waterproofing membrane and substrate, having the following characteristics:

.1 Solids by volume: 70%.

.2 Vapour permeance: 2.9 ng/Pa.m^2.s, ASTM E96.

.3 Chemical resistance: Alkalis, calcium chloride, mild acid and salt solutions.

.5 Thinner and cleaner for Sheet: As recommended by sheet material manufacturer.

.6 Attachments: Galvanized steel bars and anchors.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that surfaces and conditions are ready to accept the Work of this section.

.2 Ensure all surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer’s requirements.

.3 Report any unsatisfactory conditions to the NRC Departmental Representative in writing.

.4 Do not start work until deficiencies have been corrected. Commencement of Work implies acceptance of conditions.

3.2 PREPARATION

.1 Remove loose or foreign matter which might impair adhesion of materials.

.2 Ensure all substrates are clean of oil or excess dust; all masonry joints struck flush, and open joints filled; and all concrete surfaces free of large voids, spalled areas or sharp protrusions.

.3 Ensure all substrates are free of surface moisture prior to application of self-adhesive membrane and primer.

.4 Ensure metal closures are free of sharp edges and burrs.

.5 Prime all surfaces prior to application of membranes in accordance with manufacturer's instructions.

3.3 INSTALLATION

.1 Install the membrane in strict accordance with the manufacturer's written instructions and the representative's on site instructions.

.2 Ensure complete coverage of and adhesion to all substrate to receive the air/vapour barrier membrane, including all wall protrusions. Co-operate with other Sections to ensure continuity of the barrier.

.3 Apply membranes to primed substrate in accordance with manufacturer's recommendations and written instructions.

.4 Apply membrane so that horizontal joints overlap with the upper sheet over the lower sheet, shingle style. Lap all horizontal joints minimum 50 mm all side joints minimum 64 mm and all end joints minimum 150 mm. Stagger vertical joints to avoid four way joints.

.5 Apply a trowelled head of mastic to all terminations of the membrane at the end of a day's work and at membrane terminations.

.6 Reinforce all inside and outside corners with a continuous 300 mm wide sheet membrane prior to installing the air/vapour barrier.

.7 Fill gaps and joints with mastic and reinforce with a continuous 300 mm wide sheet membrane prior to installing the air/vapour barrier.

.8 Use mastic at all protrusions and difficult detail areas and provide a minimum 64 mm overlap with the sheet membrane.

.9 Apply air/vapour barrier so that the exterior wall is air tight, with air tight junctures at openings, penetrations and edges.

.10 Inspect air/vapour barrier for continuity immediately prior to installation of insulation. Do not cover the air/vapour barrier until it has been inspected.

.11 Repair punctures, rips and tears with pieces of membrane completely adhered to the damaged membrane.

.12 Where punctures and tears are extensive, replace entire damaged section.

.13 Install membrane over doors, and other openings to exterior walls.

.14 At openings, extend membrane 200 mm beyond jambs, heads and sills.

.15 Use mastic or fixing bars to adhere membrane to doors to maintain continuity of the barrier.

3.4 PROTECTION OF WORK

.1 Do not permit adjacent work to damage work of this section.

.2 Ensure finished Work is protected from climatic conditions.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Division 26, Electrical

1.2 REFERENCES

.1 ASTM International

.1 ASTM A 653/A 653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.3 Green Seal Environmental Standards (GS)

.1 GS-36-00, Commercial Adhesives.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for door components and grilles and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

~~.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.~~

~~.2~~**.1** Indicate each type of door, arrangement of hardware, required clearances, electrical characteristics including voltage, size of motors, auxiliary controls and wiring diagrams.

~~.3~~**.2** Indicate assembly details and dimensions of fabrication, required clearances and electrical connections.

.4 Samples:

.1 Submit for review and acceptance of each unit.

.2 Samples will be returned for inclusion into work.

.5 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for overhead coiling doors, and hardware for incorporation into manual.

1.5 QUALITY ASSURANCE

.1 Certifications: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect overhead coiling doors from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

Part 2 Products

2.1 DESIGN CRITERIA

.1 Design rolling door curtain and assembly to withstand wind load of 960 Pa within door opening area.

2.2 MATERIALS

.1 Galvanized steel sheet: to ASTM A653/A653M, commercial quality with Coating Designation Z275.

.2 Doors:

.1 Door face sheets to interior doors 0.9 mm minimum base thickness.

.2 Door face sheets to exterior doors 1.2 mm minimum base thickness.

.3 Adhesives and Sealants: VOC limit to GS-36.

2.3 DOOR FABRICATION

.1 Coiling door curtain interlocking flat slat sections:

.1 Roll formed steel: 75 mm wide, galvanized.

.2 Ensure bottom bar is equipped with tubular neoprene weatherstrip.

.3 Where wind locks are required:

.1 Rivet alternate end locks to slat ends.

.2 Rivet alternate wind locks to slat ends.

.4 Where wind locks are not required:

.1 Rivet continuous end locks to slat ends.

.5 Non-fire rated doors, up to 4800 mm wide:

.1 Provide bottom bar of extruded aluminum section, equipped with tubular neoprene weatherstrip.

.6 Non-fire rated doors, more than 4800 mm wide:

.1 Provide bottom bar of double equal weight steel angles, equipped with tubular neoprene weatherstrip.

.7 Form guides of metal angles of sections of 4.8 mm minimum thickness for between jambs or face of wall installation. Equip guides of non-fire rated doors with tubular neoprene weatherstrip.

.8 Construct counterbalance assembly of heat treated torsion spring with 25% overload factor.

.1 Enclose spring in steel pipe to support door curtain and counterbalance mechanism with maximum deflection of 1/360th of opening width.

.2 Include ball bearings at rotating points and spring tension adjusting wheel, accessible for setting.

.9 Support counterbalance assembly on 5 mm minimum thickness steel plate brackets, forming end enclosures.

.10 Enclose counterbalance assembly with galvanized steel sheet formed hood, equipped with weatherstripping.

.11 Finish and Colour: two coat baked-on polyester, standard colour, as selected by NRC Departmental Representative.

2.4 OPERATION

.1 Equip door for operation by:

.1 Electric motor operator.

2.5 ELECTRICAL OPERATOR

.1 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA and ULC approval with EEMAC enclosures.

.2 Motor: high starting torque, instant reversing, capacity to operate grille at 200 mm per second, removable without affecting emergency chain device or setting of

limit switches. Equip motor with overload protection, centrifugal clutch and electric brake.

.3 Motor size matching gear reducer with gears running in oil bath.

.4 Controller units with integral motor reversing starter, 3 heater elements for overload protection, including pushbuttons and control relays as applicable.

.5 Operation:

.1 Remote push button stations: surface mounted, in locations indicated, with OPEN-STOP-CLOSE push buttons.

.6 Design brake to stop and hold doors in any position.

.7 Include hand chain interlocked auxiliary operator to disconnect motor mechanically and electrically when engaged and allow manual operation of door.

.8 Safety switch: electro mechanical or electro pneumatic device full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.

.9 Mounting brackets: galvanized steel, size and thickness to suit conditions.

.10 Control circuit: 24 VAC.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for overhead coiling doors and grilles installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Install doors in accordance with manufacturer's printed instructions.

.3 Install electrical motors, controller units, pushbutton stations, relays and other electrical equipment required for door operation.

.4 Install electric wiring from power supply located near door.

.5 Adjust door operating components to ensure smooth opening and closing of doors.

3.3 FIELD QUALITY CONTROL

.1 Test coiling door in presence of NRC Departmental Representative.

.2 Have manufacturer of products supplied under this Section review Work involved in handling, installation, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.

.3 Manufacturer's Field Services:

.1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product within 3 days.

.4 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.5 Ensure manufacturer's representative is present before and during critical periods of installation construction of field joints and testing.

.6 Schedule site visits to review Work at stages listed:

.1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of Work, after cleaning is carried out.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.1 Remove traces of primer, caulking; clean doors and frames.

.4 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by overhead coiling door and grille installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Division 26, Electrical

1.2 REFERENCES

.1 ASTM International

.1 ASTM A 653/A 653M-11, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.3 Green Seal Environmental Standards (GS)

.1 GS-36-00, Commercial Adhesives.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for door components and grilles and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

~~.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.~~

~~.2~~**.1** Indicate each type of door, arrangement of hardware, required clearances, electrical characteristics including voltage, size of motors, auxiliary controls and wiring diagrams.

~~.3~~**.2** Indicate assembly details and dimensions of fabrication, required clearances and electrical connections.

.4 Samples:

.1 Submit for review and acceptance of each unit.

.2 Samples will be returned for inclusion into work.

.5 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for overhead coiling doors, and hardware for incorporation into manual.

1.5 QUALITY ASSURANCE

.1 Certifications: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect overhead coiling doors from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

Part 2 Products

2.1 DESIGN CRITERIA

.1 Design rolling door curtain and assembly to withstand wind load of 960 Pa within door opening area.

2.2 MATERIALS

.1 Galvanized steel sheet: to ASTM A653/A653M, commercial quality with Coating Designation Z275.

.2 Doors:

.1 Door face sheets to interior doors 0.9 mm minimum base thickness.

.2 Door face sheets to exterior doors 1.2 mm minimum base thickness.

.3 Adhesives and Sealants: VOC limit to GS-36.

2.3 DOOR FABRICATION

.1 Coiling door curtain interlocking flat slat sections:

.1 Roll formed steel: 75 mm wide, galvanized.

.2 Ensure bottom bar is equipped with tubular neoprene weatherstrip.

.3 Where wind locks are required:

.1 Rivet alternate end locks to slat ends.

.2 Rivet alternate wind locks to slat ends.

.4 Where wind locks are not required:

.1 Rivet continuous end locks to slat ends.

.5 Non-fire rated doors, up to 4800 mm wide:

.1 Provide bottom bar of extruded aluminum section, equipped with tubular neoprene weatherstrip.

.6 Non-fire rated doors, more than 4800 mm wide:

.1 Provide bottom bar of double equal weight steel angles, equipped with tubular neoprene weatherstrip.

.7 Form guides of metal angles of sections of 4.8 mm minimum thickness for between jambs or face of wall installation. Equip guides of non-fire rated doors with tubular neoprene weatherstrip.

.8 Construct counterbalance assembly of heat treated torsion spring with 25% overload factor.

.1 Enclose spring in steel pipe to support door curtain and counterbalance mechanism with maximum deflection of 1/360th of opening width.

.2 Include ball bearings at rotating points and spring tension adjusting wheel, accessible for setting.

.9 Support counterbalance assembly on 5 mm minimum thickness steel plate brackets, forming end enclosures.

.10 Enclose counterbalance assembly with galvanized steel sheet formed hood, equipped with weatherstripping.

.11 Finish and Colour: two coat baked-on polyester, standard colour, as selected by NRC Departmental Representative.

2.4 OPERATION

.1 Equip door for operation by:

.1 Electric motor operator.

2.5 ELECTRICAL OPERATOR

.1 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA and ULC approval with EEMAC enclosures.

.2 Motor: high starting torque, instant reversing, capacity to operate grille at 200 mm per second, removable without affecting emergency chain device or setting of

limit switches. Equip motor with overload protection, centrifugal clutch and electric brake.

.3 Motor size matching gear reducer with gears running in oil bath.

.4 Controller units with integral motor reversing starter, 3 heater elements for overload protection, including pushbuttons and control relays as applicable.

.5 Operation:

.1 Remote push button stations: surface mounted, in locations indicated, with OPEN-STOP-CLOSE push buttons.

.6 Design brake to stop and hold doors in any position.

.7 Include hand chain interlocked auxiliary operator to disconnect motor mechanically and electrically when engaged and allow manual operation of door.

.8 Safety switch: electro mechanical or electro pneumatic device full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.

.9 Mounting brackets: galvanized steel, size and thickness to suit conditions.

.10 Control circuit: 24 VAC.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for overhead coiling doors and grilles installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Install doors in accordance with manufacturer's printed instructions.

.3 Install electrical motors, controller units, pushbutton stations, relays and other electrical equipment required for door operation.

.4 Install electric wiring from power supply located near door.

.5 Adjust door operating components to ensure smooth opening and closing of doors.

3.3 FIELD QUALITY CONTROL

.1 Test coiling door in presence of NRC Departmental Representative.

.2 Have manufacturer of products supplied under this Section review Work involved in handling, installation, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.

.3 Manufacturer's Field Services:

.1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product within 3 days.

.4 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.5 Ensure manufacturer's representative is present before and during critical periods of installation construction of field joints and testing.

.6 Schedule site visits to review Work at stages listed:

.1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of Work, after cleaning is carried out.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.1 Remove traces of primer, caulking; clean doors and frames.

.4 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by overhead coiling door and grille installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM D523-08, Standard Test Method for Specular Gloss.

.2 ASTM D822-01(2006), Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

.2 CSA International

.1 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

.2 Arrange for site visit with NRC Departmental Representative prior to start of Work to examine existing site conditions adjacent to demolition Work.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for doors, hardware, and accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate sizes, service rating, types, materials, operating mechanisms, glazing locations and details, hardware and accessories, required clearances and electrical connections.

.4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.5 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

.6 Manufacturers Reports:

.1 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in Part 3 - FIELD QUALITY CONTROL.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for sectional metal doors for incorporation into manual.

1.5 QUALITY ASSURANCE

.1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.2 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect sectional metal doors, hardware and accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN / PERFORMANCE CRITERIA

.1 Design exterior door assembly to withstand wind loads in accordance with building code requirements with a maximum horizontal deflection of 1/240 of opening width.

.2 Design door assembly to withstand minimum 100,000 cycles per annum, and minimum 20 years total life cycle.

.3 Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components

2.2 MATERIALS

.1 Galvanized steel sheet: commercial quality Z275 zinc coating.

.2 Insulation: CFC-free and HCFC-free polyurethane, fully encapsulated.

.1 Thermal Values: R-value of 17.50; U-value of 0.057.

.3 Glazing: Partial glazing of steel panels set in 2-piece high-impact black polymer frame:

.1 12.5 mm Insulated Tempered Glass.

.4 Cable: multi-strand galvanized steel aircraft cable.

2.3 FABRICATION

.1 Fabricate 51 mm thick insulated steel sectional overhead doors, with flush panels of roll formed steel sections as indicated.

.1 Door Sections: Shall be of steel/polyurethane/steel sandwich type construction with thermal break.

.2 Exterior Steel: 0.38 mm, hot-dipped galvanized.

.3 Ends: Hot-dipped galvanized steel, full height with end caps, 18 gauge.

.2 Fabricate work with materials and with component dimensions and gauges, reinforcing, attached anchors and fastenings of adequate strength to prevent warping, buckling, opening of joints and seams, loosening of hardware, distortion and displacement within limits of intended and specified use.

.3 Conceal and weld connections wherever possible.

.4 Fit joints and junctions between components tightly and in true planes.

.5 Isolate from each other dissimilar metals, and metal from concrete or masonry to prevent electrolysis.

.6 Install glazing, sizes and number of lights as indicated.

.7 Assemble components by means of spot or arc welding or coated rivet system or adhesive and self tapping screws to manufacturer's recommendations.

2.4 HARDWARE

.1 Track: standard hardware with 75 mm size minimum 2.28 mm core thickness galvanized steel track to suit loading required and clearances available.

.2 Track Supports: 2.3 mm core thickness continuous galvanized steel angle track supports.

.3 Spring Counterbalance: Sized to weight of the door, with a helically wound, oil tempered torsion spring mounted on a steel shaft; cable drum of die cast aluminum with high strength galvanized aircraft cable. Sized with a minimum 5 to 1 safety factor.

.4 Top roller carrier: galvanized steel minimum 2.28 mm thick, adjustable.

.5 Rollers: full floating, grease packed hardened steel, ball bearing minimum 75 mm diameter, stamped tire.

.6 Roller brackets: adjustable, galvanized steel, minimum 2.5 mm thick.

.7 Hinges: standard duty industrial 2.28 mm thick, galvanized steel.

.8 Cable: minimum 4 mm diameter galvanized steel aircraft cable.

2.5 ACCESSORIES

.1 Overhead horizontal track and operator supports: galvanized steel, type and size to suit installation.

.2 Track guards: 5 mm thick formed sheet 1500 mm high track guards.

.3 Pusher springs.

.4 Weatherstripping:

.1 Sills: double contact, bulb type full width extruded neoprene weatherstrip.

.2 Jambs and head: extruded aluminum and arctic grade vinyl weatherstrip to manufacturer's standard.

.5 Finish ferrous hardware items with minimum zinc coating of 300 g/m^2 to CAN/CSA-G164.

2.6 PREFINISHED STEEL SHEET

.1 Prefinished steel with factory applied silicone modified polyester.

.1 Class F2S.

.2 Colour selected by NRC Departmental Representative from manufacturer's standard range.

.3 Specular gloss: 30 units +/-5 in accordance with ASTM D523.

.4 Coating thickness: not less than 25 micrometres.

.5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:

.1 Outdoor exposure period 1000 hours.

.2 Humidity resistance exposure period 1000 hours.

2.7 OPERATORS

.1 Equip doors for operation by:

.1 Hand, two handles on inside outside face of door.

.2 Chain hoist with nylon rope galvanized steel chain.

.2 Cable fail safe device.

.1 Able to stop door immediately if cable breaks on door free fall. Breaking capacity 500 kg.

2.8 ELECTRICAL OPERATOR

.1 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA approval with CSA enclosure type EEMAC 4.

.2 Power supply: 600 V, 3 phase, 60 Hz.

.1 Motor Heavy Duty, of size and type as recommended by manufacturer.

.3 Controller units with integral motor reversing starter, solenoid operated brake, 3 heater elements for overload protection, including pushbuttons and control relays as applicable.

.4 Operation:

.1 Remote pushbutton stations: surface mounted, with "OPEN-STOP-CLOSE" designations on pushbuttons in English and French.

.2 Cable control: pendant hung control to open and electric eyes to close.

.3 Control locations: Interior.

.5 Safety switch: combination roll rubber with limit switches for full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.

.6 Provide disconnect device to allow for manual operation in event of power failure.

.7 Automatic illumination complete with time delay, self extinguishing.

.8 Door speed: 300 mm per second.

.9 Control transformer: for 24 VAC control voltage.

.10 Mounting brackets: galvanized steel, size and gauge to suit conditions.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for sectional metal doors installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Verify electric power is available and of correct characteristics.

.3 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Install doors and hardware in accordance with manufacturer's instructions.

.3 Rigidly support rail and operator and secure to supporting structure.

.4 Touch-up steel doors with primer where galvanized finish damaged during fabrication.

.5 Install operator including electrical motors, controller units, pushbutton stations, relays and other electrical equipment required for door operation.

.6 Lubricate and adjust door operating components to ensure smooth opening and closing of doors.

.7 Adjust weatherstripping to form a weather tight seal.

.8 Adjust doors for smooth operation.

3.3 ELECTRICAL WIRING

.1 Power shall be brought up to circuit breaker/disconnect switch adjacent to controller under Electrical Division and in conformance with requirements specified therein.

.2 Wiring from motor to switches, controls, starters, safety devices and other items requiring power shall be carried out under this section.

.3 Use EMT conduit for fixed wiring. Use purpose-made and approved type flexible cables or cords at applicable locations; adequately support so as not to impede access or foul moving parts of equipment.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product within 3 days of review.

.2 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule manufacturer's representative site visits to review Work at stages listed:

.1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.

.2 Once during progress of Work.

.3 Upon completion of Work, after cleaning is carried out.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.1 Remove traces of primer; clean doors and frames.

.2 Clean glass and glazing materials with approved non-abrasive cleaner.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by sectional metal door installation.

.3 Do not permit construction traffic through overhead door openings after adjustment and cleaning.

.4 Protect installed products until completion of project.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM D523-08, Standard Test Method for Specular Gloss.

.2 ASTM D822-01(2006), Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

.2 CSA International

.1 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

.2 Arrange for site visit with NRC Departmental Representative prior to start of Work to examine existing site conditions adjacent to demolition Work.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for doors, hardware, and accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate sizes, service rating, types, materials, operating mechanisms, glazing locations and details, hardware and accessories, required clearances and electrical connections.

.4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.5 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

.6 Manufacturers Reports:

.1 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in Part 3 - FIELD QUALITY CONTROL.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for sectional metal doors for incorporation into manual.

1.5 QUALITY ASSURANCE

.1 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.2 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect sectional metal doors, hardware and accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN / PERFORMANCE CRITERIA

.1 Design exterior door assembly to withstand wind loads in accordance with building code requirements with a maximum horizontal deflection of 1/240 of opening width.

.2 Design door assembly to withstand minimum 100,000 cycles per annum, and minimum 20 years total life cycle.

.3 Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components

2.2 MATERIALS

.1 Galvanized steel sheet: commercial quality Z275 zinc coating.

.2 Insulation: CFC-free and HCFC-free polyurethane, fully encapsulated.

.1 Thermal Values: R-value of 17.50; U-value of 0.057.

.3 Glazing: Partial glazing of steel panels set in 2-piece high-impact black polymer frame:

.1 12.5 mm Insulated Tempered Glass.

.4 Cable: multi-strand galvanized steel aircraft cable.

2.3 FABRICATION

.1 Fabricate 51 mm thick insulated steel sectional overhead doors, with flush panels of roll formed steel sections as indicated.

.1 Door Sections: Shall be of steel/polyurethane/steel sandwich type construction with thermal break.

.2 Exterior Steel: 0.38 mm, hot-dipped galvanized.

.3 Ends: Hot-dipped galvanized steel, full height with end caps, 18 gauge.

.2 Fabricate work with materials and with component dimensions and gauges, reinforcing, attached anchors and fastenings of adequate strength to prevent warping, buckling, opening of joints and seams, loosening of hardware, distortion and displacement within limits of intended and specified use.

.3 Conceal and weld connections wherever possible.

.4 Fit joints and junctions between components tightly and in true planes.

.5 Isolate from each other dissimilar metals, and metal from concrete or masonry to prevent electrolysis.

.6 Install glazing, sizes and number of lights as indicated.

.7 Assemble components by means of spot or arc welding or coated rivet system or adhesive and self tapping screws to manufacturer's recommendations.

2.4 HARDWARE

.1 Track: standard hardware with 75 mm size minimum 2.28 mm core thickness galvanized steel track to suit loading required and clearances available.

.2 Track Supports: 2.3 mm core thickness continuous galvanized steel angle track supports.

.3 Spring Counterbalance: Sized to weight of the door, with a helically wound, oil tempered torsion spring mounted on a steel shaft; cable drum of die cast aluminum with high strength galvanized aircraft cable. Sized with a minimum 5 to 1 safety factor.

.4 Top roller carrier: galvanized steel minimum 2.28 mm thick, adjustable.

.5 Rollers: full floating, grease packed hardened steel, ball bearing minimum 75 mm diameter, stamped tire.

.6 Roller brackets: adjustable, galvanized steel, minimum 2.5 mm thick.

.7 Hinges: standard duty industrial 2.28 mm thick, galvanized steel.

.8 Cable: minimum 4 mm diameter galvanized steel aircraft cable.

2.5 ACCESSORIES

.1 Overhead horizontal track and operator supports: galvanized steel, type and size to suit installation.

.2 Track guards: 5 mm thick formed sheet 1500 mm high track guards.

.3 Pusher springs.

.4 Weatherstripping:

.1 Sills: double contact, bulb type full width extruded neoprene weatherstrip.

.2 Jambs and head: extruded aluminum and arctic grade vinyl weatherstrip to manufacturer's standard.

.5 Finish ferrous hardware items with minimum zinc coating of 300 g/m^2 to CAN/CSA-G164.

2.6 PREFINISHED STEEL SHEET

.1 Prefinished steel with factory applied silicone modified polyester.

.1 Class F2S.

.2 Colour selected by NRC Departmental Representative from manufacturer's standard range.

.3 Specular gloss: 30 units +/-5 in accordance with ASTM D523.

.4 Coating thickness: not less than 25 micrometres.

.5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:

.1 Outdoor exposure period 1000 hours.

.2 Humidity resistance exposure period 1000 hours.

2.7 OPERATORS

.1 Equip doors for operation by:

.1 Hand, two handles on inside outside face of door.

.2 Chain hoist with nylon rope galvanized steel chain.

.2 Cable fail safe device.

.1 Able to stop door immediately if cable breaks on door free fall. Breaking capacity 500 kg.

2.8 ELECTRICAL OPERATOR

.1 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA approval with CSA enclosure type EEMAC 4.

.2 Power supply: 600 V, 3 phase, 60 Hz.

.1 Motor Heavy Duty, of size and type as recommended by manufacturer.

.3 Controller units with integral motor reversing starter, solenoid operated brake, 3 heater elements for overload protection, including pushbuttons and control relays as applicable.

.4 Operation:

.1 Remote pushbutton stations: surface mounted, with "OPEN-STOP-CLOSE" designations on pushbuttons in English and French.

.2 Cable control: pendant hung control to open and electric eyes to close.

.3 Control locations: Interior.

.5 Safety switch: combination roll rubber with limit switches for full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.

.6 Provide disconnect device to allow for manual operation in event of power failure.

.7 Automatic illumination complete with time delay, self extinguishing.

.8 Door speed: 300 mm per second.

.9 Control transformer: for 24 VAC control voltage.

.10 Mounting brackets: galvanized steel, size and gauge to suit conditions.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for sectional metal doors installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Verify electric power is available and of correct characteristics.

.3 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.2 Install doors and hardware in accordance with manufacturer's instructions.

.3 Rigidly support rail and operator and secure to supporting structure.

.4 Touch-up steel doors with primer where galvanized finish damaged during fabrication.

.5 Install operator including electrical motors, controller units, pushbutton stations, relays and other electrical equipment required for door operation.

.6 Lubricate and adjust door operating components to ensure smooth opening and closing of doors.

.7 Adjust weatherstripping to form a weather tight seal.

.8 Adjust doors for smooth operation.

3.3 ELECTRICAL WIRING

.1 Power shall be brought up to circuit breaker/disconnect switch adjacent to controller under Electrical Division and in conformance with requirements specified therein.

.2 Wiring from motor to switches, controls, starters, safety devices and other items requiring power shall be carried out under this section.

.3 Use EMT conduit for fixed wiring. Use purpose-made and approved type flexible cables or cords at applicable locations; adequately support so as not to impede access or foul moving parts of equipment.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product within 3 days of review.

.2 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule manufacturer's representative site visits to review Work at stages listed:

.1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.

.2 Once during progress of Work.

.3 Upon completion of Work, after cleaning is carried out.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.1 Remove traces of primer; clean doors and frames.

.2 Clean glass and glazing materials with approved non-abrasive cleaner.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by sectional metal door installation.

.3 Do not permit construction traffic through overhead door openings after adjustment and cleaning.

.4 Protect installed products until completion of project.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 07 21 16 - Blanket Insulation.

.2 Section 07 26 00 – Vapour Retarders.

.3 Section 07 92 00 - Joint Sealants.

.4 Section 07 84 00 - Firestopping.

.5 Section 08 11 00 - Metal doors and Frames.

.6 Section 09 22 16 - Non-Structural Metal Framing.

.7 Section 09 91 23 - Interior Painting.

1.2 REFERENCES

.1 ASTM International

.1 ASTM C 475-02(2007), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

.2 ASTM C 514-04(2009e1), Standard Specification for Nails for the Application of Gypsum Board.

.3 ASTM C 840-08, Standard Specification for Application and Finishing of Gypsum Board.

.4 ASTM C 954-07, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.

.5 ASTM C 1002-07, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.6 ASTM C 1047-09, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

.7 ASTM C 1396/C 1396M-09a, Standard Specification for Gypsum Wallboard.

.2 Association of the Wall and Ceilings Industries International (AWCI)

.1 AWCI Levels of Gypsum Board Finish-97.

.3 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2007, Architectural Coatings.

.2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

.4 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store gypsum board assemblies materials level off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.

.3 Protect from weather, elements and damage from construction operations.

.4 Handle gypsum boards to prevent damage to edges, ends or surfaces.

.5 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

1.5 AMBIENT CONDITIONS

.1 Maintain temperature 10 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimumafter completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 Products

2.1 MATERIALS

.1 Standard board: to ASTM C 1396/C 1396M regular, thickness as indicated on drawings x maximum practical length, ends square cut, edges squared.

.2 Water-resistant board: to ASTM C 1396/C 1396M regular, thickness as indicated on drawings x maximum practical length, ends square cut, edges squared.

.3 Metal furring runners, hangers, tie wires, inserts, anchors.

.4 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.

.5 Resilient clips, drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

.6 Steel drill screws: to ASTM C 954.

.7 Casing beads, corner beads, control joints and edge trim: to ASTM C 1047,zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one piece length per location.

.8 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

.1 VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.2 Acoustic sealant: in accordance with Section 07 92 00 - Joint Sealants.

.9 Polyethylene: to CAN/CGSB-51.34, Type 2.

.10 Joint compound: to ASTM C 475, asbestos-free.

2.2 FINISHES

.1 Texture finish: asbestos-free standard white texture coating and primer-sealer, recommended by gypsum board manufacturer.

.1 Primer: VOC limit 50 g/L maximum to GS-11 SCAQMD Rule 1113.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 ERECTION

.1 Do application and finishing of gypsum board to ASTM C 840 except where specified otherwise.

.2 Do application of gypsum sheathing to ASTM C 1280.

.3 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C 840 except where specified otherwise.

.4 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

.5 Install work level to tolerance of 1:1200.

.6 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.

.7 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.

.8 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.

.9 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

.10 Install wall furring for gypsum board wall finishes to ASTM C 840, except where specified otherwise.

.11 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.

.12 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

.1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.

.2 Apply single, double layer gypsum board to metal furring or framing using screw fasteners for first layer and for second layer. Maximum spacing of screws 300 mm on centre.

.1 Single-Layer Application:

.1 Apply gypsum board on ceilings prior to application of walls to ASTM C 840.

.2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.

.2 Double-Layer Application:

.1 Install gypsum board for base layer and exposed gypsum board for face layer.

.2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.

.3 Apply base layers at right angles to supports unless otherwise indicated.

.4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250mm with base layer joints.

.3 Apply water-resistant gypsum board where wall tiles to be applied and adjacent to slop sinks, janitors closets. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads. Do not apply joint treatment on areas to receive tile finish.

.4 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, in partitions where perimeter sealed with acoustic sealant.

.5 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.

.6 Install gypsum board with face side out.

.7 Do not install damaged or damp boards.

.8 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

.1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150mm on centre.

.2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.

.3 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.

.4 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.

.5 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:

.1 Levels of finish:

.1 Level 2: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable.

.1 Applicable to: Lower level Service rooms/workshops only.

.2 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.

.1 Applicable to: All main level rooms, lower level offices/ corridors/observation rooms.

.3 Level 5: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; apply a thin skim coat of joint compound to entire surface; surfaces smooth and free of tool marks and ridges.

.1 Applicable to: waiting lounge room 125 and Airport terminal room 135 only.

.6 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.

.7 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.

.8 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

.9 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

.10 Apply one coat of white primer sealer over surface to be textured. When dry apply textured finish in accordance with manufacturer's instructions.

.11 Mix joint compound slightly thinner than for joint taping.

.12 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.

.13 Allow skim coat to dry completely.

.14 Remove ridges by light sanding or wiping with damp cloth.

3.5 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

3.7 SCHEDULES

.1 Construct fire rated assemblies where indicated.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 07 21 16 - Blanket Insulation.

.2 Section 07 26 00 – Vapour Retarders.

.3 Section 07 92 00 - Joint Sealants.

.4 Section 07 84 00 - Firestopping.

.5 Section 08 11 00 - Metal doors and Frames.

.6 Section 09 22 16 - Non-Structural Metal Framing.

.7 Section 09 91 23 - Interior Painting.

1.2 REFERENCES

.1 ASTM International

.1 ASTM C 475-02(2007), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

.2 ASTM C 514-04(2009e1), Standard Specification for Nails for the Application of Gypsum Board.

.3 ASTM C 840-08, Standard Specification for Application and Finishing of Gypsum Board.

.4 ASTM C 954-07, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.

.5 ASTM C 1002-07, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

.6 ASTM C 1047-09, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

.7 ASTM C 1396/C 1396M-09a, Standard Specification for Gypsum Wallboard.

.2 Association of the Wall and Ceilings Industries International (AWCI)

.1 AWCI Levels of Gypsum Board Finish-97.

.3 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2007, Architectural Coatings.

.2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

.4 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-07, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store gypsum board assemblies materials level off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.

.3 Protect from weather, elements and damage from construction operations.

.4 Handle gypsum boards to prevent damage to edges, ends or surfaces.

.5 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

1.5 AMBIENT CONDITIONS

.1 Maintain temperature 10 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimumafter completion of joint treatment.

.2 Apply board and joint treatment to dry, frost free surfaces.

.3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 Products

2.1 MATERIALS

.1 Standard board: to ASTM C 1396/C 1396M regular, thickness as indicated on drawings x maximum practical length, ends square cut, edges squared.

.2 Water-resistant board: to ASTM C 1396/C 1396M regular, thickness as indicated on drawings x maximum practical length, ends square cut, edges squared.

.3 Metal furring runners, hangers, tie wires, inserts, anchors.

.4 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.

.5 Resilient clips, drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

.6 Steel drill screws: to ASTM C 954.

.7 Casing beads, corner beads, control joints and edge trim: to ASTM C 1047,zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one piece length per location.

.8 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

.1 VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.2 Acoustic sealant: in accordance with Section 07 92 00 - Joint Sealants.

.9 Polyethylene: to CAN/CGSB-51.34, Type 2.

.10 Joint compound: to ASTM C 475, asbestos-free.

2.2 FINISHES

.1 Texture finish: asbestos-free standard white texture coating and primer-sealer, recommended by gypsum board manufacturer.

.1 Primer: VOC limit 50 g/L maximum to GS-11 SCAQMD Rule 1113.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 ERECTION

.1 Do application and finishing of gypsum board to ASTM C 840 except where specified otherwise.

.2 Do application of gypsum sheathing to ASTM C 1280.

.3 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C 840 except where specified otherwise.

.4 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

.5 Install work level to tolerance of 1:1200.

.6 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.

.7 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.

.8 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.

.9 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

.10 Install wall furring for gypsum board wall finishes to ASTM C 840, except where specified otherwise.

.11 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.

.12 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

.1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.

.2 Apply single, double layer gypsum board to metal furring or framing using screw fasteners for first layer and for second layer. Maximum spacing of screws 300 mm on centre.

.1 Single-Layer Application:

.1 Apply gypsum board on ceilings prior to application of walls to ASTM C 840.

.2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.

.2 Double-Layer Application:

.1 Install gypsum board for base layer and exposed gypsum board for face layer.

.2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.

.3 Apply base layers at right angles to supports unless otherwise indicated.

.4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250mm with base layer joints.

.3 Apply water-resistant gypsum board where wall tiles to be applied and adjacent to slop sinks, janitors closets. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads. Do not apply joint treatment on areas to receive tile finish.

.4 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, in partitions where perimeter sealed with acoustic sealant.

.5 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.

.6 Install gypsum board with face side out.

.7 Do not install damaged or damp boards.

.8 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

.1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150mm on centre.

.2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.

.3 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.

.4 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.

.5 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:

.1 Levels of finish:

.1 Level 2: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable.

.1 Applicable to: Lower level Service rooms/workshops only.

.2 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.

.1 Applicable to: All main level rooms, lower level offices/ corridors/observation rooms.

.3 Level 5: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; apply a thin skim coat of joint compound to entire surface; surfaces smooth and free of tool marks and ridges.

.1 Applicable to: waiting lounge room 125 and Airport terminal room 135 only.

.6 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.

.7 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.

.8 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.

.9 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

.10 Apply one coat of white primer sealer over surface to be textured. When dry apply textured finish in accordance with manufacturer's instructions.

.11 Mix joint compound slightly thinner than for joint taping.

.12 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.

.13 Allow skim coat to dry completely.

.14 Remove ridges by light sanding or wiping with damp cloth.

3.5 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

3.7 SCHEDULES

.1 Construct fire rated assemblies where indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33

.2 Environmental Protection Agency (EPA)

.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Master Painters Institute (MPI)

.1 MPI Architectural Painting Specifications Manual, 2004.

.5 National Fire Code of Canada - 1995

.6 Society for Protective Coatings (SSPC)

.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

.7 Transport Canada (TC)

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34

1.2 QUALITY ASSURANCE

.1 Qualifications:

.1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.

.2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.

.3 Apprentices: working under direct supervision of qualified trades person in accordance with trade regulations.

1.3 SCHEDULING

.1 Submit work schedule for various stages of painting to NRC Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.

.2 Obtain written authorization from NRC Departmental Representative for changes in work schedule.

.3 Schedule painting operations to prevent disruption of occupants.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit product data and instructions for each paint and coating product to be used.

.2 Submit product data for the use and application of paint thinner.

.3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS). Indicate VOCs during application and curing.

.2 Samples:

.1 Submit full range colour sample chips to indicate where colour availability is restricted.

.2 Submit duplicate 200 x 300 mm sample panels of each paint with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:

.1 3 mm plate steel for finishes over metal surfaces.

.2 13 mm birch plywood for finishes over wood surfaces.

.3 50 mm concrete block for finishes over concrete or concrete masonry surfaces.

.4 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.

.3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.

.4 Test reports: submit certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Lead, cadmium and chromium: presence of and amounts.

.2 Mercury: presence of and amounts.

.3 Organochlorines and PCBs: presence of and amounts.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Manufacturer's Instructions:

.1 Submit manufacturer's installation and application instructions.

.7 Closeout Submittals: submit maintenance data for incorporation into manual and include the following:

.1 Product name, type and use.

.2 Manufacturer's product number.

.3 Colour numbers.

.4 MPI Environmentally Friendly classification system rating.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels.

.2 Quantity: provide one - one four litre can of each type and colour of primer, finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

.3 Delivery, storage and protection: comply with NRC Departmental Representative requirements for delivery and storage of extra materials.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling and Unloading:

.1 Pack, ship, handle and unload materials in accordance with manufacturer's written instructions.

.2 Acceptance at Site:

.1 Identify products and materials with labels indicating:

.1 Manufacturer's name and address.

.2 Type of paint or coating.

.3 Compliance with applicable standard.

.4 Colour number in accordance with established colour schedule.

.3 Remove damaged, opened and rejected materials from site.

.4 Storage and Protection:

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

.3 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.

.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

.7 Remove paint materials from storage only in quantities required for same day use.

.8 Fire Safety Requirements:

.1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.

.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

.3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

.9 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling.

.4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with Regional and Municipal, regulations.

.7 Ensure emptied containers are sealed and stored safely.

.8 Unused paint, coating materials must be disposed of at official hazardous material collections site.

.9 Paint, stain and wood preservative finishes and related materials (thinners, and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

.10 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.

.11 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

.12 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:

.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.

.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.

.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.

.4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.

.5 Empty paint cans are to be dry prior to disposal or recycling (where available).

.13 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

.14 Set aside and protect surplus and uncontaminated finish materials. Deliver to or arrange collection for verifiable re-use or re-manufacturing.

1.7 SITE CONDITIONS

.1 Heating, Ventilation and Lighting:

.1 Ventilate enclosed spaces.

.2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.

.3 Provide continuous ventilation for seven days after completion of application of paint.

.4 Coordinate use of existing ventilation system with NRC Departmental Representative and ensure its operation during and after application of paint as required.

.5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.

.6 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Unless pre-approved written approval by product manufacturer, perform no painting when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

.2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.

.4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.

.5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.

.2 Perform painting work when maximum moisture content of the substrate is below:

.1 Allow new concrete and masonry to cure minimum of 28 days.

.2 15% for wood.

.3 12% for plaster and gypsum board.

.3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".

.4 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Surface and Environmental Conditions:

.1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Additional interior application requirements:

.1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

.2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of NRC Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

Part 2 Products

2.1 MATERIALS

.1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.

.2 Provide paint materials for paint systems from single manufacturer.

.3 Conform to latest MPI requirements for interior painting work including preparation and priming.

.4 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.

.5 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.

.6 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:

.1 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.

.7 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

.8 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.

.9 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:

.1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.

.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.

.10 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" E2 rating.

.11 Recycled water-borne surface coatings to contain 50 % post-consumer material by volume.

.12 Recycled water-borne surface coatings must not contain:

.1 Lead in excess of 600.0 ppm weight/weight total solids.

.2 Mercury in excess of 50.0ppm weight/weight total product.

.3 Cadmium in excess of 1.0ppm weight/weight total product.

.4 Hexavelant chromium in excess of 3.0 ppm weight/weight total product.

.5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 COLOURS

~~.1 NRC Departmental Representative will provide Colour Schedule after Contract award.~~

~~.2~~.1 Colour schedule will be based upon selection of five base colours and three accent colours. No more than eight colours will be selected for entire project and no more than three colours will be selected in each area.

~~.3~~.2 Selection of colours from manufacturer’s full range of colours.

~~.4~~.3 Where specific products are available in restricted range of colours, selection based on limited range.

~~.5~~.4 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

.1 Perform colour tinting operations prior to delivery of paint to site.

.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.

.4 Thin paint for spraying in accordance with paint manufacturer's instructions.

.5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

.1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 Degrees	Sheen @ 85 Degrees
Gloss Level 1- Matte Finish (flat)	Max. 5	Max. 10
Gloss Level 2 - Velvet-Like Finish	Max. 10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin-Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

2.5 INTERIOR PAINTING SYSTEMS

.1 Concrete vertical surfaces: including horizontal soffits:

.1 INT 3. 1A - Latex finish (over sealer).

.2 Concrete horizontal surfaces: floors and stairs:

.1 INT 3.2C - Epoxy finish.

.3 Concrete masonry units: smooth and split face block and brick:

.1 INT 4.2A - Latex finish.

.4 Structural steel and metal fabrications: columns, beams, joists:

.1 INT 5.1A - Quick dry enamel semi-gloss finish.

.5 Steel - high heat: (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted):

.1 INT 5.2A - Heat resistant enamel finish, maximum 205 degrees C.

.2 INT 5.2B - Heat resist ant aluminum paint finish, maximum 427 degrees C.

.3 INT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.

.4 INT 5.2D - High heat resistant coating, maximum 593 degrees C.

.6 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.

.1 INT 5.3A - Latex finish.

.2 INT 5.3D - Epoxy finish (over epoxy primer).

.7 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:

.1 INT 9.2A - Latex finish (over latex sealer).

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 GENERAL

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to NRC Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.

.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.3 Maximum moisture content as follows:

.1 Stucco, plaster and gypsum board: 12%.

.2 Concrete: 12%.

.3 Clay and Concrete Block/Brick: 12%.

.4 Wood: 15%.

3.4 PREPARATION

.1 Protection:

.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by NRC Departmental Representative.

.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

.3 Protect factory finished products and equipment.

.4 Protect passing pedestrians, building occupants and general public in and about the building.

.2 Surface Preparation:

.1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.

.2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of NRC Departmental Representative.

.3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.

.2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

.4 Allow surfaces to drain completely and allow to dry thoroughly.

.5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.

.6 Use trigger operated spray nozzles for water hoses.

.7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.

.4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.

.2 Apply wood filler to nail holes and cracks.

.3 Tint filler to match stains for stained woodwork.

.6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

.7 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes blowing with clean dry compressed air or vacuum cleaning.

.8 Touch up of shop primers with primer as specified.

3.5 APPLICATION

.1 Method of application to conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:

.1 Apply paint in uniform layer using brush and/or roller type suitable for application.

.2 Work paint into cracks, crevices and corners.

.3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.

.4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.

.5 Remove runs, sags and brush marks from finished work and repaint.

.3 Spray application:

.1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.

.2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

.3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.

.4 Brush out immediately all runs and sags.

.5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.

.4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.

.5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.7 Sand and dust between coats to remove visible defects.

.8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

.9 Finish inside of cupboards and cabinets as specified for outside surfaces.

.10 Finish closets and alcoves as specified for adjoining rooms.

.11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 MECHANICAL/ ELECTRICAL EQUIPMENT

.1 Second Floor: paint exposed ductwork only.

.2 Lowe level and other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.

.3 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

.4 Do not paint over nameplates.

.5 Keep sprinkler heads free of paint.

.6 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.

.7 Paint fire protection piping red.

.8 Paint disconnect switches for fire alarm system and exit light systems in red enamel.

.9 Paint natural gas piping yellow.

.10 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

.11 Do not paint interior transformers and substation equipment.

3.7 SITE TOLERANCES

.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.

.2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.

.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 FIELD QUALITY CONTROL

.1 Standard of Acceptance:

.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.

.2 Ceilings: no defects visible from floor at 45 degrees degrees to surface when viewed using final lighting source.

.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.2 Advise NRC Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.3 Cooperate with inspection firm and provide access to areas of work.

.4 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by NRC Departmental Representative.

3.9 RESTORATION

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Protect freshly completed surfaces from paint droppings and dust to approval of NRC Departmental Representative. Avoid scuffing newly applied paint.

.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by NRC Departmental Representative.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33

.2 Environmental Protection Agency (EPA)

.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).

.3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Master Painters Institute (MPI)

.1 MPI Architectural Painting Specifications Manual, 2004.

.5 National Fire Code of Canada - 1995

.6 Society for Protective Coatings (SSPC)

.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

.7 Transport Canada (TC)

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34

1.2 QUALITY ASSURANCE

.1 Qualifications:

.1 Contractor: minimum of five years proven satisfactory experience. Provide list of last three comparable jobs including, job name and location, specifying authority, and project manager.

.2 Journeymen: qualified journeymen who have "Tradesman Qualification Certificate of Proficiency" engaged in painting work.

.3 Apprentices: working under direct supervision of qualified trades person in accordance with trade regulations.

1.3 SCHEDULING

.1 Submit work schedule for various stages of painting to NRC Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.

.2 Obtain written authorization from NRC Departmental Representative for changes in work schedule.

.3 Schedule painting operations to prevent disruption of occupants.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit product data and instructions for each paint and coating product to be used.

.2 Submit product data for the use and application of paint thinner.

.3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS). Indicate VOCs during application and curing.

.2 Samples:

.1 Submit full range colour sample chips to indicate where colour availability is restricted.

.2 Submit duplicate 200 x 300 mm sample panels of each paint with specified paint or coating in colours, gloss/sheen and textures required to MPI Architectural Painting Specification Manual standards submitted on following substrate materials:

.1 3 mm plate steel for finishes over metal surfaces.

.2 13 mm birch plywood for finishes over wood surfaces.

.3 50 mm concrete block for finishes over concrete or concrete masonry surfaces.

.4 13 mm gypsum board for finishes over gypsum board and other smooth surfaces.

.3 Retain reviewed samples on-site to demonstrate acceptable standard of quality for appropriate on-site surface.

.4 Test reports: submit certified test reports for paint from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Lead, cadmium and chromium: presence of and amounts.

.2 Mercury: presence of and amounts.

.3 Organochlorines and PCBs: presence of and amounts.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Manufacturer's Instructions:

.1 Submit manufacturer's installation and application instructions.

.7 Closeout Submittals: submit maintenance data for incorporation into manual and include the following:

.1 Product name, type and use.

.2 Manufacturer's product number.

.3 Colour numbers.

.4 MPI Environmentally Friendly classification system rating.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Deliver to extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels.

.2 Quantity: provide one - one four litre can of each type and colour of primer, finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

.3 Delivery, storage and protection: comply with NRC Departmental Representative requirements for delivery and storage of extra materials.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling and Unloading:

.1 Pack, ship, handle and unload materials in accordance with manufacturer's written instructions.

.2 Acceptance at Site:

.1 Identify products and materials with labels indicating:

.1 Manufacturer's name and address.

.2 Type of paint or coating.

.3 Compliance with applicable standard.

.4 Colour number in accordance with established colour schedule.

.3 Remove damaged, opened and rejected materials from site.

.4 Storage and Protection:

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

.3 Store materials and equipment in well ventilated area with temperature range 7 degrees C to 30 degrees C.

.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning and preparation clean and orderly. After completion of operations, return areas to clean condition.

.7 Remove paint materials from storage only in quantities required for same day use.

.8 Fire Safety Requirements:

.1 Provide one 9 kg Type ABC dry chemical fire extinguisher adjacent to storage area.

.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

.3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

.9 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling.

.4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with Regional and Municipal, regulations.

.7 Ensure emptied containers are sealed and stored safely.

.8 Unused paint, coating materials must be disposed of at official hazardous material collections site.

.9 Paint, stain and wood preservative finishes and related materials (thinners, and solvents) are regarded as hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

.10 Material which cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.

.11 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.

.12 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into ground follow these procedures:

.1 Retain cleaning water for water-based materials to allow sediments to be filtered out.

.2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.

.3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.

.4 Dispose of contaminants in approved legal manner in accordance with hazardous waste regulations.

.5 Empty paint cans are to be dry prior to disposal or recycling (where available).

.13 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

.14 Set aside and protect surplus and uncontaminated finish materials. Deliver to or arrange collection for verifiable re-use or re-manufacturing.

1.7 SITE CONDITIONS

.1 Heating, Ventilation and Lighting:

.1 Ventilate enclosed spaces.

.2 Provide heating facilities to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application until paint has cured sufficiently.

.3 Provide continuous ventilation for seven days after completion of application of paint.

.4 Coordinate use of existing ventilation system with NRC Departmental Representative and ensure its operation during and after application of paint as required.

.5 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.

.6 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.2 Temperature, Humidity and Substrate Moisture Content Levels:

.1 Unless pre-approved written approval by product manufacturer, perform no painting when:

.1 Ambient air and substrate temperatures are below 10 degrees C.

.2 Substrate temperature is above 32 degrees C unless paint is specifically formulated for application at high temperatures.

.3 Substrate and ambient air temperatures are not expected to fall within MPI or paint manufacturer's prescribed limits.

.4 The relative humidity is under 85% or when the dew point is more than 3 degrees C variance between the air/surface temperature. Paint should not be applied if the dew point is less than 3 degrees C below the ambient or surface temperature. Use sling psychrometer to establish the relative humidity before beginning paint work.

.5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.

.6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.

.2 Perform painting work when maximum moisture content of the substrate is below:

.1 Allow new concrete and masonry to cure minimum of 28 days.

.2 15% for wood.

.3 12% for plaster and gypsum board.

.3 Test for moisture using calibrated electronic Moisture Meter. Test concrete floors for moisture using "cover patch test".

.4 Test concrete, masonry and plaster surfaces for alkalinity as required.

.3 Surface and Environmental Conditions:

.1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

.2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.

.3 Apply paint when previous coat of paint is dry or adequately cured.

.4 Additional interior application requirements:

.1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

.2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of NRC Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

Part 2 Products

2.1 MATERIALS

.1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.

.2 Provide paint materials for paint systems from single manufacturer.

.3 Conform to latest MPI requirements for interior painting work including preparation and priming.

.4 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) in accordance with MPI Architectural Painting Specification Manual "Approved Product" listing.

.5 Linseed oil, shellac, and turpentine: highest quality product from approved manufacturer listed in MPI Architectural Painting Specification Manual, compatible with other coating materials as required.

.6 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:

.1 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.

.7 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

.8 Flash point: 61.0 degrees C or greater for water-borne surface coatings and recycled water-borne surface coatings.

.9 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:

.1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.

.2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.

.10 Water-borne paints and stains, recycled water-borne surface coatings and water borne varnishes to meet minimum "Environmentally Friendly" E2 rating.

.11 Recycled water-borne surface coatings to contain 50 % post-consumer material by volume.

.12 Recycled water-borne surface coatings must not contain:

.1 Lead in excess of 600.0 ppm weight/weight total solids.

.2 Mercury in excess of 50.0ppm weight/weight total product.

.3 Cadmium in excess of 1.0ppm weight/weight total product.

.4 Hexavelant chromium in excess of 3.0 ppm weight/weight total product.

.5 Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 COLOURS

~~.1 NRC Departmental Representative will provide Colour Schedule after Contract award.~~

~~.2~~.1 Colour schedule will be based upon selection of five base colours and three accent colours. No more than eight colours will be selected for entire project and no more than three colours will be selected in each area.

~~.3~~.2 Selection of colours from manufacturer’s full range of colours.

~~.4~~.3 Where specific products are available in restricted range of colours, selection based on limited range.

~~.5~~.4 Second coat in three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

.1 Perform colour tinting operations prior to delivery of paint to site.

.2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.

.3 Use and add thinner in accordance with paint manufacturer's recommendations. Do not use kerosene or similar organic solvents to thin water-based paints.

.4 Thin paint for spraying in accordance with paint manufacturer's instructions.

.5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

.1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

	Gloss @ 60 Degrees	Sheen @ 85 Degrees
Gloss Level 1- Matte Finish (flat)	Max. 5	Max. 10
Gloss Level 2 - Velvet-Like Finish	Max. 10	10 to 35
Gloss Level 3 - Eggshell Finish	10 to 25	10 to 35
Gloss Level 4 - Satin-Like Finish	20 to 35	min. 35
Gloss Level 5 - Traditional Semi-Gloss Finish	35 to 70	
Gloss Level 6 - Traditional Gloss	70 to 85	
Gloss Level 7 - High Gloss Finish	More than 85	

2.5 INTERIOR PAINTING SYSTEMS

.1 Concrete vertical surfaces: including horizontal soffits:

.1 INT 3. 1A - Latex finish (over sealer).

.2 Concrete horizontal surfaces: floors and stairs:

.1 INT 3.2C - Epoxy finish.

.3 Concrete masonry units: smooth and split face block and brick:

.1 INT 4.2A - Latex finish.

.4 Structural steel and metal fabrications: columns, beams, joists:

.1 INT 5.1A - Quick dry enamel semi-gloss finish.

.5 Steel - high heat: (boilers, furnaces, heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted):

.1 INT 5.2A - Heat resistant enamel finish, maximum 205 degrees C.

.2 INT 5.2B - Heat resist ant aluminum paint finish, maximum 427 degrees C.

.3 INT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.

.4 INT 5.2D - High heat resistant coating, maximum 593 degrees C.

.6 Galvanized metal: doors, frames, railings, misc. steel, pipes, overhead decking, and ducts.

.1 INT 5.3A - Latex finish.

.2 INT 5.3D - Epoxy finish (over epoxy primer).

.7 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock type material", and textured finishes:

.1 INT 9.2A - Latex finish (over latex sealer).

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 GENERAL

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to NRC Departmental Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.

.2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

.3 Maximum moisture content as follows:

.1 Stucco, plaster and gypsum board: 12%.

.2 Concrete: 12%.

.3 Clay and Concrete Block/Brick: 12%.

.4 Wood: 15%.

3.4 PREPARATION

.1 Protection:

.1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by NRC Departmental Representative.

.2 Protect items that are permanently attached such as Fire Labels on doors and frames.

.3 Protect factory finished products and equipment.

.4 Protect passing pedestrians, building occupants and general public in and about the building.

.2 Surface Preparation:

.1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.

.2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

.3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of NRC Departmental Representative.

.3 Clean and prepare surfaces in accordance with MPI Architectural Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.

.2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

.4 Allow surfaces to drain completely and allow to dry thoroughly.

.5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.

.6 Use trigger operated spray nozzles for water hoses.

.7 Many water-based paints cannot be removed with water once dried. Minimize use of mineral spirits or organic solvents to clean up water-based paints.

.4 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.5 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.

.2 Apply wood filler to nail holes and cracks.

.3 Tint filler to match stains for stained woodwork.

.6 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.

.7 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes blowing with clean dry compressed air or vacuum cleaning.

.8 Touch up of shop primers with primer as specified.

3.5 APPLICATION

.1 Method of application to conform to manufacturer's application instructions unless specified otherwise.

.2 Brush and Roller Application:

.1 Apply paint in uniform layer using brush and/or roller type suitable for application.

.2 Work paint into cracks, crevices and corners.

.3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.

.4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple.

.5 Remove runs, sags and brush marks from finished work and repaint.

.3 Spray application:

.1 Provide and maintain equipment that is suitable for intended purpose, capable of atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.

.2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

.3 Apply paint in uniform layer, with overlapping at edges of spray pattern. Back roll first coat application.

.4 Brush out immediately all runs and sags.

.5 Use brushes and rollers to work paint into cracks, crevices and places which are not adequately painted by spray.

.4 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access.

.5 Apply coats of paint continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.6 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.7 Sand and dust between coats to remove visible defects.

.8 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.

.9 Finish inside of cupboards and cabinets as specified for outside surfaces.

.10 Finish closets and alcoves as specified for adjoining rooms.

.11 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.6 MECHANICAL/ ELECTRICAL EQUIPMENT

.1 Second Floor: paint exposed ductwork only.

.2 Lowe level and other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.

.3 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

.4 Do not paint over nameplates.

.5 Keep sprinkler heads free of paint.

.6 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.

.7 Paint fire protection piping red.

.8 Paint disconnect switches for fire alarm system and exit light systems in red enamel.

.9 Paint natural gas piping yellow.

.10 Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.

.11 Do not paint interior transformers and substation equipment.

3.7 SITE TOLERANCES

.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.

.2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.

.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.8 FIELD QUALITY CONTROL

.1 Standard of Acceptance:

.1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.

.2 Ceilings: no defects visible from floor at 45 degrees degrees to surface when viewed using final lighting source.

.3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

.2 Advise NRC Departmental Representative when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

.3 Cooperate with inspection firm and provide access to areas of work.

.4 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by NRC Departmental Representative.

3.9 RESTORATION

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.

.4 Protect freshly completed surfaces from paint droppings and dust to approval of NRC Departmental Representative. Avoid scuffing newly applied paint.

.5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by NRC Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 05 50 00 - Metal Fabrications.

.2 Section 06 10 00 - Rough Carpentry.

.3 Section 10 21 13.13 - ~~Metal~~ **Plastic** Toilet Compartments.

1.2 REFERENCES

.1 ASTM International

.1 ASTM A 167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 ASTM B 456-03, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.

.3 ASTM A 653/A 653M-09, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM A 924/A 924M-09, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.81-M90, Air Drying and Baking Alkyd Primer for Vehicles and Equipment.

.2 CAN/CGSB-1.88-92, Gloss Alkyd Enamel, Air Drying and Baking.

.3 CGSB 31-GP-107MA-90, Non-inhibited Phosphoric Acid Base Metal Conditioner and Rust Remover.

.3 CSA International

.1 CAN/CSA-B651-04, Accessible Design for the Built Environment.

.2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Provide manufacturer's printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit drawings~~ stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada~~**in accordance with Section 01 33 00**.

.2 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars .

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for toilet and bath accessories for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Tools:

.1 Provide special tools required for assembly, disassembly or removal for toilet and bath accessories.

.2 Deliver special tools to NRC Departmental Representative.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors ,in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect toilet and bathroom accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

Part 2 Products

2.1 MATERIALS

.1 Sheet steel: to ASTM A 653/A 653M with ZF001 designation zinc coating.

.2 Stainless steel sheet metal: to ASTM A 167, Type 302, withclear finish.

.3 Stainless steel tubing: Type 302, commercial grade, seamless welded**.**~~, 1.2 mm wall thickness.~~

.4 Fasteners: concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.2 COMPONENTS

.1 Toilet tissue dispenser: Owner supplied.

.2 Paper towel dispenser: Owner supplied.

.3 Soap dispenser: Owner supplied.

.4 Grab bars: 30 mm diameter x 1.6 mm wall tubing of stainless steel, 38 mm diameter wall flanges, concealed screw attachment, flanges welded to tubular bar, provided with steel back plates and all accessories. Knurl bar at area of hand grips. Grab bar material and anchorage to withstand downward pull of 2.2 kN.

.5 Tilt mirror: wall mounted unit, fixed framed mirror 6 mm, stainless steel frame with integral shelf.

.6 Diaper changing station: surface mounted wall unit, polyethylene insert, moulded-in steel-on-steel hinge assembly, moulded-in integral support mechanism, ~~851~~ **850** mm wide x ~~584~~ **546** mm high, concealed gas shock, security lock, tamper resistant hardware, steel backer plate, diaper bag hook, liner dispenser, safety belt, safety instructions in both official languages, labeled with universally accepted symbol "changing station".

.1 Acceptable Material:

.1 Rubbermaid Horizontal Change Station 7818-88.

~~.7 Feminine napkin/tampon dispenser: stainless steel, semi-recessed unit including rough-in frame, min capacity 15 napkins and 20 tampons, free operation, key locked, continuous hinge front panel.~~

~~.8~~**.7** Feminine napkin disposal bin: stainless steel, semi-recessed unit including rough-in frame, continuous hinged door, self closing, embossed with "napkin disposal", "receptacle de serviette-sanitaire", removable stainless steel receptacles fitted with spring clip for deodorizer block.

.8 Feminine napkin disposal bin: stainless steel, surface mounted unit, continuous hinged door, self closing, embossed with "napkin disposal", "receptacle de serviette-sanitaire", removable stainless steel receptacles fitted with spring clip for deodorizer block.

.9 Electronic dryer: power controlled by infrared admitting, receiving electronic control device positioned to dryer on when hands are placed under nozzle. Operation to continue for no more than 80 seconds of continued use.

.1 Acceptable Material:

.1 Dyson Airblade db Hand Dryer.

2.3 FABRICATION

.1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.

.2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.

.3 Brake form sheet metal work with 1.5 mm radius bends.

.4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.

.5 Back paint components where contact is made with building finishes to prevent electrolysis.

.6 Hot dip galvanize concealed ferrous metal anchors and fastening devices to CAN/CSA-G164.

.7 Shop assemble components and package complete with anchors and fittings.

.8 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.

.9 Provide steel anchor plates and components for installation on studding and building framing.

2.4 FINISHES

.1 Chrome and nickel plating: to ASTM B 456, satin finish.

.2 Baked enamel: condition metal by applying one coat of metal conditioner to CGSB 31-GP-107Ma, apply one coat Type 2 primer to CAN/CGSB-1.81 and bake, apply two coats Type 2 enamel to CAN/CGSB-1.88 and bake to hard, durable finish. Sand between final coats. Colour selected from standard range by NRC Departmental Representative.

.3 Manufacturer's or brand names on face of units not acceptable.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrates and surfaces to receive toilet and bathroom accessories previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's instructions prior to toilet and bathroom accessories installation.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from NRC Departmental Representative.

3.2 INSTALLATION

.1 Install and secure accessories rigidly in place as follows:

.1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.

.2 Hollow masonry units, existing plaster or drywall: use toggle bolts drilled into cell or wall cavity.

.3 Solid masonry, marble, stone or concrete: use bolt with lead expansion sleeve set into drilled hole.

.4 Toilet and shower compartments: use male to female through bolts.

.2 Install grab bars on built-in anchors provided by bar manufacturer.

.3 Use tamper proof screws/bolts for fasteners.

.4 Fill units with necessary supplies shortly before final acceptance of building.

3.3 ADJUSTING

.1 Adjust toilet and bathroom accessories components and systems for correct function and operation in accordance with manufacturer's written instructions.

.2 Lubricate moving parts to operate smoothly and fit accurately.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by toilet and bathroom accessories installation.

3.6 SCHEDULE

.1 Locate accessories where indicated~~ and as follows~~. Exact locations determined by NRC Departmental Representative.

~~.2 Combination towel dispenser/waste receptacles: one in each washroom. Maximum height of dispenser and operable part from floor 1200 mm.~~

~~.3 Soap dispenser: one at each wash basin.~~

~~.4 Hand dryer: one in each washroom. Maximum height of dispenser and operable part from floor 1200 mm.~~

~~.5 Grab bar: where indicated. Height of grab bar from floor 750 mm. Side grab bar: maximum distance from rear wall 300 mm, minimum distance passed front edge of toilet 450 mm.~~

~~.6 Tilt mirror: one at each accessible wash basin, height of bottom edge of mirror from floor 1000 mm.~~

~~.7 Diaper changing station: where indicated.~~

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 05 50 00 - Metal Fabrications.

.2 Section 06 10 00 - Rough Carpentry.

.3 Section 10 21 13.13 - ~~Metal~~ **Plastic** Toilet Compartments.

1.2 REFERENCES

.1 ASTM International

.1 ASTM A 167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.2 ASTM B 456-03, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.

.3 ASTM A 653/A 653M-09, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM A 924/A 924M-09, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.81-M90, Air Drying and Baking Alkyd Primer for Vehicles and Equipment.

.2 CAN/CGSB-1.88-92, Gloss Alkyd Enamel, Air Drying and Baking.

.3 CGSB 31-GP-107MA-90, Non-inhibited Phosphoric Acid Base Metal Conditioner and Rust Remover.

.3 CSA International

.1 CAN/CSA-B651-04, Accessible Design for the Built Environment.

.2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Provide manufacturer's printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit drawings~~ stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada~~**in accordance with Section 01 33 00**.

.2 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars .

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for toilet and bath accessories for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Tools:

.1 Provide special tools required for assembly, disassembly or removal for toilet and bath accessories.

.2 Deliver special tools to NRC Departmental Representative.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors ,in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect toilet and bathroom accessories from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

Part 2 Products

2.1 MATERIALS

.1 Sheet steel: to ASTM A 653/A 653M with ZF001 designation zinc coating.

.2 Stainless steel sheet metal: to ASTM A 167, Type 302, withclear finish.

.3 Stainless steel tubing: Type 302, commercial grade, seamless welded**.**~~, 1.2 mm wall thickness.~~

.4 Fasteners: concealed screws and bolts hot dip galvanized, exposed fasteners to match face of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.2 COMPONENTS

.1 Toilet tissue dispenser: Owner supplied.

.2 Paper towel dispenser: Owner supplied.

.3 Soap dispenser: Owner supplied.

.4 Grab bars: 30 mm diameter x 1.6 mm wall tubing of stainless steel, 38 mm diameter wall flanges, concealed screw attachment, flanges welded to tubular bar, provided with steel back plates and all accessories. Knurl bar at area of hand grips. Grab bar material and anchorage to withstand downward pull of 2.2 kN.

.5 Tilt mirror: wall mounted unit, fixed framed mirror 6 mm, stainless steel frame with integral shelf.

.6 Diaper changing station: surface mounted wall unit, polyethylene insert, moulded-in steel-on-steel hinge assembly, moulded-in integral support mechanism, ~~851~~ **850** mm wide x ~~584~~ **546** mm high, concealed gas shock, security lock, tamper resistant hardware, steel backer plate, diaper bag hook, liner dispenser, safety belt, safety instructions in both official languages, labeled with universally accepted symbol "changing station".

.1 Acceptable Material:

.1 Rubbermaid Horizontal Change Station 7818-88.

~~.7 Feminine napkin/tampon dispenser: stainless steel, semi-recessed unit including rough-in frame, min capacity 15 napkins and 20 tampons, free operation, key locked, continuous hinge front panel.~~

~~.8~~**.7** Feminine napkin disposal bin: stainless steel, semi-recessed unit including rough-in frame, continuous hinged door, self closing, embossed with "napkin disposal", "receptacle de serviette-sanitaire", removable stainless steel receptacles fitted with spring clip for deodorizer block.

.8 Feminine napkin disposal bin: stainless steel, surface mounted unit, continuous hinged door, self closing, embossed with "napkin disposal", "receptacle de serviette-sanitaire", removable stainless steel receptacles fitted with spring clip for deodorizer block.

.9 Electronic dryer: power controlled by infrared admitting, receiving electronic control device positioned to dryer on when hands are placed under nozzle. Operation to continue for no more than 80 seconds of continued use.

.1 Acceptable Material:

.1 Dyson Airblade db Hand Dryer.

2.3 FABRICATION

.1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.

.2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.

.3 Brake form sheet metal work with 1.5 mm radius bends.

.4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.

.5 Back paint components where contact is made with building finishes to prevent electrolysis.

.6 Hot dip galvanize concealed ferrous metal anchors and fastening devices to CAN/CSA-G164.

.7 Shop assemble components and package complete with anchors and fittings.

.8 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.

.9 Provide steel anchor plates and components for installation on studding and building framing.

2.4 FINISHES

.1 Chrome and nickel plating: to ASTM B 456, satin finish.

.2 Baked enamel: condition metal by applying one coat of metal conditioner to CGSB 31-GP-107Ma, apply one coat Type 2 primer to CAN/CGSB-1.81 and bake, apply two coats Type 2 enamel to CAN/CGSB-1.88 and bake to hard, durable finish. Sand between final coats. Colour selected from standard range by NRC Departmental Representative.

.3 Manufacturer's or brand names on face of units not acceptable.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrates and surfaces to receive toilet and bathroom accessories previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's instructions prior to toilet and bathroom accessories installation.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval from NRC Departmental Representative.

3.2 INSTALLATION

.1 Install and secure accessories rigidly in place as follows:

.1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.

.2 Hollow masonry units, existing plaster or drywall: use toggle bolts drilled into cell or wall cavity.

.3 Solid masonry, marble, stone or concrete: use bolt with lead expansion sleeve set into drilled hole.

.4 Toilet and shower compartments: use male to female through bolts.

.2 Install grab bars on built-in anchors provided by bar manufacturer.

.3 Use tamper proof screws/bolts for fasteners.

.4 Fill units with necessary supplies shortly before final acceptance of building.

3.3 ADJUSTING

.1 Adjust toilet and bathroom accessories components and systems for correct function and operation in accordance with manufacturer's written instructions.

.2 Lubricate moving parts to operate smoothly and fit accurately.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by toilet and bathroom accessories installation.

3.6 SCHEDULE

.1 Locate accessories where indicated~~ and as follows~~. Exact locations determined by NRC Departmental Representative.

~~.2 Combination towel dispenser/waste receptacles: one in each washroom. Maximum height of dispenser and operable part from floor 1200 mm.~~

~~.3 Soap dispenser: one at each wash basin.~~

~~.4 Hand dryer: one in each washroom. Maximum height of dispenser and operable part from floor 1200 mm.~~

~~.5 Grab bar: where indicated. Height of grab bar from floor 750 mm. Side grab bar: maximum distance from rear wall 300 mm, minimum distance passed front edge of toilet 450 mm.~~

~~.6 Tilt mirror: one at each accessible wash basin, height of bottom edge of mirror from floor 1000 mm.~~

~~.7 Diaper changing station: where indicated.~~

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI A208.1-09, Particleboard.

.2 American National Standards Institute (ANSI)/Business and International Furniture Manufacturers Association (BIFMA) International

.1 ANSI/BIFMA X5.1-11, American National Standard for Office Furnishings, General Purpose Office Chairs - Tests.

.2 ANSI/BIFMA X5.6-10, American National Standard for Office Furnishings - Panel Systems.

.3 BIFMACMD-1-09, BIFMA Chair Measuring Device.

.3 ASTM International

.1 ASTM C 297/C 297M-04(2010), Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions.

.4 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-44.227-2008, Freestanding Office Desk Products and Components.

.2 CAN/CGSB-44.232-2008, Task Chairs for Office Work Environments.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Underwriters' Laboratories Canada (ULC)

.1 CAN/ULC-S102-2010, Standard Method of Test for Surfaces Burning Characteristics of Building Materials and Assemblies.

.7 Underwriters' Laboratories (UL)

.1 UL 1286-2008(R2011), Standard for Office Furnishings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for furniture and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS MSDS.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 33 00 Submittal Procedures.

.2 Operation and Maintenance Data: submit operation and maintenance data for furniture for incorporation into manual.

.3 Supply part numbers of furniture to allow for replacement of worn or damaged furniture parts.

.4 Supply instructions detailing procedures for repairing or replacing worn furniture parts.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect furniture from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

1.5 WARRANTY

.1 Submit written assurance that replacement parts will be available for minimum of 5 years following discontinuation of product manufacture.

.2 Ensure warranties provide for repair rather than replacement.

Part 2 Products

2.1 MATERIALS

.1 Wood: visible wood free from open knots and defects.

.1 Wood veneers: applied to furniture 0.7 minimum mm thick.

.2 Certified Wood to: CAN/CSA-Z809 or FSC or SFI.

.3 Adhesives used to apply wood veneers capable of achieving tensile strength of 552 kPa minimum when tested to ASTM C 297.

2.2 DESKS

.1 Office desks products and components: to CAN/CGSB-44.227.

.2 Type of finish: to CAN/CGSB-44.227, laminates.

.3 Components to be interchangeable right-to-left and left-to right.

.4 Provide cord and cable management capability with reusable covers for each grommet.

.5 Horizontal work surfaces: to CAN/CGSB-44.227.

- .1 Specular gloss: no more than 45 units.
- .2 Width and depth dimensions:
  - .1 Width: 914mm.
  - .2 Depth: 457mm.
  - .3 Fixed height: 730 +/- 25 mm when measured from the floor.
  - .4 Incremental adjustment: no more than 25 mm.
- .3 Type of supports: legs complete with levelling mechanism with vertical adjustment of at least 25 mm.

.6 Preparation for delivery: to CAN/CGSB-44.227 conform to normal commercial practice.

2.3 FREESTANDING MOBILE STORAGE UNITS

.1 Office desks products and components: to CAN/CGSB-44.227.

.2 Type of finish: to CAN/CGSB-44.227, laminates.

.3 Mobile: 381mm x 457mm x 635mm height.

.4 Box/file configuration. File drawer includes file hanging rails.

.5 Casters: minimum of four carpet casters with locking device on two front casters.

.6 Lockable.

2.4 ~~FREESTANDING~~ MOBILE CHECK IN COUNTER

.1 Counter products and components: to CAN/CGSB-44.227.

.2 Type of finish: to CAN/CGSB-44.227, laminates.

.3 Mobile: ~~600~~**750**mm x 1500mm x 1200mm height (2 no) and ~~600~~**750**mm x 800mm x 1200mm height (1no)

.4 High level transaction counter 300mm deep, standard surface ~~600~~**750**mm deep. Box/file configuration.

.1 1 x adjustable /removable shelf w/plam finish on recessed heavy duty pilasters. Box/file configuration 450mm wide on larger unit

.5 Casters: minimum of four heavy duty carpet casters with locking device on all casters.

.6 Lockable.

2.5 STEEL SHELVING UNIT

.1 Steel shelving unit, 18” /450mmx 48”/1220mm x 97”/2460mm, equal to Item #WB796381 by global industrial.ca.

.1 Roll-formed, ribbed steel shelves with box beam reinforced edges.
.2 Quad clips to secure shelves to uprights with adjustment on 1" centers.
.3 Heavy duty 14 gauge steel uprights support shelves.
.4 Closed side and back panels retain loads.
.5 Gray baked enamel with anticorrosion undercoat.
.6 Unit includes 4 uprights, 5 shelves, 4 quad clips per shelf, 1 back and 2 side panels plus all required nuts and bolts.

2.6 GANGED SEATING

.1 Waiting Area Seating: to ANSI/BIWFMA X5.1 and CAN/CGSB-44.232.

.1 Type II: non-tilt seat: fixed back.
.2 Features: to CAN/CGSB-44.232.
.3 Upholstery: to CAN/CGSB-44.232.
  .1 Fabric to meet heavy duty rating for abrasion resistance. To be selected by NRC Departmental Representative from manufacturer's standard range.
.4 Armrests: to CAN/CGSB-44.232.
  .1 Supply chair with fixed armrests.
.5 Preparation for delivery: conform to normal commercial practice.

.2 Acceptable Material.

.1 Bernu Aero Wood by Arconas:
  .1 Area 125: Wood seat and back, die-cast aluminium supports, legs, arms and beam.
  .2 Arm: Cantalever type, with moulded urethane pad.
  .3 Ganged layout as indicated on drawings.

.3 Acceptable Material.

.1 Bernu Aero by Arconas:

.1 Area 135: Contoured steel pan with foam pad seat and back, die-cast aluminium supports, legs, arms and beam.

.2 Arm: Cantalever type, with moulded urethane pad.

.3 Ganged layout as indicated on drawings.

2.7 JANITOR'S CART

.1 Acceptable Material:

.1 Rubbermaid: 6173-88 Cleaning Cart.

.2 Two (2) in total.

2.8 FABRICATION

.1 Manufacture furniture to allow for dismantling and replacing of worn or defective components and recycling options following first use.

.1 Fabricate furniture to allow for remanufacturing or refurbishing of furniture following first use.

.2 Seal exposed surfaces of particleboard constructed with urea formaldehyde adhesives to contain formaldehyde emissions.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI A208.1-09, Particleboard.

.2 American National Standards Institute (ANSI)/Business and International Furniture Manufacturers Association (BIFMA) International

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.3 BIFMACMD-1-09, BIFMA Chair Measuring Device.

.3 ASTM International

.1 ASTM C 297/C 297M-04(2010), Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions.

.4 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-44.227-2008, Freestanding Office Desk Products and Components.

.2 CAN/CGSB-44.232-2008, Task Chairs for Office Work Environments.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Underwriters' Laboratories Canada (ULC)

.1 CAN/ULC-S102-2010, Standard Method of Test for Surfaces Burning Characteristics of Building Materials and Assemblies.

.7 Underwriters' Laboratories (UL)

.1 UL 1286-2008(R2011), Standard for Office Furnishings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for furniture and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS MSDS.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 33 00 Submittal Procedures.

.2 Operation and Maintenance Data: submit operation and maintenance data for furniture for incorporation into manual.

.3 Supply part numbers of furniture to allow for replacement of worn or damaged furniture parts.

.4 Supply instructions detailing procedures for repairing or replacing worn furniture parts.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect furniture from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials.

1.5 WARRANTY

.1 Submit written assurance that replacement parts will be available for minimum of 5 years following discontinuation of product manufacture.

.2 Ensure warranties provide for repair rather than replacement.

Part 2 Products

2.1 MATERIALS

.1 Wood: visible wood free from open knots and defects.

.1 Wood veneers: applied to furniture 0.7 minimum mm thick.

.2 Certified Wood to: CAN/CSA-Z809 or FSC or SFI.

.3 Adhesives used to apply wood veneers capable of achieving tensile strength of 552 kPa minimum when tested to ASTM C 297.

2.2 DESKS

.1 Office desks products and components: to CAN/CGSB-44.227.

.2 Type of finish: to CAN/CGSB-44.227, laminates.

.3 Components to be interchangeable right-to-left and left-to right.

.4 Provide cord and cable management capability with reusable covers for each grommet.

.5 Horizontal work surfaces: to CAN/CGSB-44.227.

- .1 Specular gloss: no more than 45 units.
- .2 Width and depth dimensions:
  - .1 Width: 914mm.
  - .2 Depth: 457mm.
  - .3 Fixed height: 730 +/- 25 mm when measured from the floor.
  - .4 Incremental adjustment: no more than 25 mm.
- .3 Type of supports: legs complete with levelling mechanism with vertical adjustment of at least 25 mm.

.6 Preparation for delivery: to CAN/CGSB-44.227 conform to normal commercial practice.

2.3 FREESTANDING MOBILE STORAGE UNITS

.1 Office desks products and components: to CAN/CGSB-44.227.

.2 Type of finish: to CAN/CGSB-44.227, laminates.

.3 Mobile: 381mm x 457mm x 635mm height.

.4 Box/file configuration. File drawer includes file hanging rails.

.5 Casters: minimum of four carpet casters with locking device on two front casters.

.6 Lockable.

2.4 ~~FREESTANDING~~ MOBILE CHECK IN COUNTER

.1 Counter products and components: to CAN/CGSB-44.227.

.2 Type of finish: to CAN/CGSB-44.227, laminates.

.3 Mobile: ~~600~~**750**mm x 1500mm x 1200mm height (2 no) and ~~600~~**750**mm x 800mm x 1200mm height (1no)

.4 High level transaction counter 300mm deep, standard surface ~~600~~**750**mm deep. Box/file configuration.

.1 1 x adjustable /removable shelf w/plam finish on recessed heavy duty pilasters. Box/file configuration 450mm wide on larger unit

.5 Casters: minimum of four heavy duty carpet casters with locking device on all casters.

.6 Lockable.

2.5 STEEL SHELVING UNIT

.1 Steel shelving unit, 18” /450mmx 48”/1220mm x 97”/2460mm, equal to Item #WB796381 by global industrial.ca.

.1 Roll-formed, ribbed steel shelves with box beam reinforced edges.
.2 Quad clips to secure shelves to uprights with adjustment on 1" centers.
.3 Heavy duty 14 gauge steel uprights support shelves.
.4 Closed side and back panels retain loads.
.5 Gray baked enamel with anticorrosion undercoat.
.6 Unit includes 4 uprights, 5 shelves, 4 quad clips per shelf, 1 back and 2 side panels plus all required nuts and bolts.

2.6 GANGED SEATING

.1 Waiting Area Seating: to ANSI/BIWFMA X5.1 and CAN/CGSB-44.232.

.1 Type II: non-tilt seat: fixed back.
.2 Features: to CAN/CGSB-44.232.
.3 Upholstery: to CAN/CGSB-44.232.
  .1 Fabric to meet heavy duty rating for abrasion resistance. To be selected by NRC Departmental Representative from manufacturer's standard range.
.4 Armrests: to CAN/CGSB-44.232.
  .1 Supply chair with fixed armrests.
.5 Preparation for delivery: conform to normal commercial practice.

.2 Acceptable Material.

.1 Bernu Aero Wood by Arconas:
  .1 Area 125: Wood seat and back, die-cast aluminium supports, legs, arms and beam.
  .2 Arm: Cantalever type, with moulded urethane pad.
  .3 Ganged layout as indicated on drawings.

.3 Acceptable Material.

.1 Bernu Aero by Arconas:

.1 Area 135: Contoured steel pan with foam pad seat and back, die-cast aluminium supports, legs, arms and beam.

.2 Arm: Cantalever type, with moulded urethane pad.

.3 Ganged layout as indicated on drawings.

2.7 JANITOR'S CART

.1 Acceptable Material:

.1 Rubbermaid: 6173-88 Cleaning Cart.

.2 Two (2) in total.

2.8 FABRICATION

.1 Manufacture furniture to allow for dismantling and replacing of worn or defective components and recycling options following first use.

.1 Fabricate furniture to allow for remanufacturing or refurbishing of furniture following first use.

.2 Seal exposed surfaces of particleboard constructed with urea formaldehyde adhesives to contain formaldehyde emissions.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM A126- 04(2009), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM B62- 09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA)

.1 ANSI/AWWA C700- 09, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.

.2 ANSI/AWWA C701- 12, Standard for Cold Water Meters-Turbine Type for Customer Service.

.3 ANSI/AWWA C702- 10, Standard for Cold Water Meters-Compound Type.

.3 CSA International

.1 CSA-B64 Series- 11, Backflow Preventers and Vacuum Breakers.

.2 CSA B79- 08, Commercial and Residential Drains and Cleanouts.

.3 CAN/CSA-B356- 10, Water Pressure Reducing Valves for Domestic Water Supply Systems.

.4 Efficiency Valuation Organization (EVO)

.1 International Performance Measurement and Verification Protocol (IPMVP).

.1 IPMVP 2007 Version.

.5 Plumbing and Drainage Institute (PDI)

.1 PDI-G101- R2010, Testing and Rating Procedure for Grease Interceptors with Appendix of Installation and Maintenance.

.2 PDI-WH201- R2010, Water Hammer Arresters Standard.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to on-site installation, with contractor's representative NRC Departmental Representative to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for plumbing products and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements. Indicate VOC's:

.3 Shop Drawings:

.1 Indicate on drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions construction and assembly details accessories.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturers' Field Reports: manufacturers' field reports specified.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect plumbing materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FLOOR DRAINS

.1 Floor Drains and Trench Drains: to ASME A112.6.3-2001.

.2 Type FD1: foot traffic areas; cast iron body round, adjustable head, nickel bronze strainer, integral seepage pan, and flashing collar, trip seal primer tapping, no hub outlet.

.1 Equivalent to Jay R. Smith 2005Y

.3 Type FD2: wheel traffic areas (mechanical rooms, basement corridor, workshops); cast iron body round, adjustable head, heavy duty nickel bronze strainer, integral seepage pan, and flashing collar, trip seal primer tapping, no hub outlet.

.1 Equivalent to Jay R. Smith 2005AHD

.4 Type FFD: funnel floor drain (mechanical rooms); cast iron body round, adjustable head, heavy duty nickel bronze strainer with integral oval funnel, integral seepage pan, and flashing collar, trip seal primer tapping, no hub outlet.

.1 Equivalent to Jay R. Smith 2005AHD-F19

2.2 ROOF DRAINS

.1 Type 1: cast iron body, under deck clamp and sump receiver to suit roof construction, flashing clamp ring with integral gravel stop, bearing pan, polyethylene dome.

.1 Equivalent to Jay R Smith 1010

2.3 CLEANOUTS

.1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

.2 Access Covers:

.1 Wall Access: face or wall type, stainless steel square cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

.2 Floor Access: round cast iron body and frame with adjustable secured nickel bronze top and:

.1 Plugs: bolted bronze with neoprene gasket.

.2 Cover for Unfinished Concrete Floors: cast iron round, gasket, vandal-proof screws.

.1 Equivalent to Jay R. Smith 4220

.3 Cover for Terrazzo Finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.

.1 Equivalent to Jay R. Smith 4180-CAN

.4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.

.5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

.1 Equivalent to Jay R. Smith 4021S-Y

2.4 NON-FREEZE WALL HYDRANTS

.1 Recessed type with integral vacuum breaker-backflow preventor, NPS 3/4 hose outlet, removable operating key. Chrome plated brassfinish.

.2 To ASSE 1019

.1 Equivalent to Watts series HY42

2.5 WATER HAMMER ARRESTORS

.1 Hard drawn copper body with machined lead-free brass piston, NPT solid hex brass, air chamber precharged to 422 kPa.

.2 PDI WH201 approved

.3 ANSI A112.26.1M approved

.1 Equivalent to Watts Series LF15

2.6 BACK FLOW PREVENTERS

.1 Preventers: to CSA-B64 Series, application as indicated,

.2 reduced pressure principle type, complete with strainer, isolation ball valves, differential pressure relief valve between two positively seated check valves – Watts Series 909

.3 double check valve assembly

.4 Dual check valve with intermediate atmospheric vent, complete with union connections, stainless steel internals, rubber seated checks, ASSE approved – Watts 9D.

2.7 VACUUM BREAKERS

.1 Breakers: to CSA-B64 Series, vacuum breaker.

2.8 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

2.9 WATER MAKE-UP ASSEMBLY

.1 Complete with backflow preventer pressure gauge on inlet and outlet, pressure reducing valve to CAN/CSA-B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.

2.10 WATER METERS

.1 Compound type to ANSI/AWWA C702.

.2 Accessories: remote readout device and interface with BMS.

.3 For model and type contact Joe Sollazzo @ 1-438-837-7229 or joe.sollazzo@ca.endress.com

2.11 TRAP SEAL PRIMERS

.1 Brass, with integral vacuum breaker, NPS 1/2 solder ends, NPS 1/2 drip line connection.

.1 Equivalent to P.P.P Inc Model P0-500

2.12 STRAINERS

.1 860 kPa, Y type with 20 mesh, monel, bronze or stainless steel removable screen.

.2 NPS 2 and under, bronze body, screwed ends, with brass cap.

.3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

2.13 VACUUM PUMP TANK (SUPPLIED BY OWNER)

.1 Vacuum tank:

.1 300 gallon – 6mm (1/4") A36 Grade Carbon Steel

.2 Single Compartment, 914mm (36") diameter x 1829mm (6') long

.3 Offset construction

.4 Two flanged & Dished tank heads

.5 Exterior seams submerged arc welded (SAW)

.2 The Vacuum Tank shall be furnished will all of the following accessories:

.1 Rails – standard style, 25mm A36 Carbon Steel

.2 Discharge port – 100mm threaded nipple, male NPT

.3 Valve – Brass Lever – 75mm Female NPT x Female NPT with 75mm Male Camlock NPT & Female Camlock Dust Cap.

.4 Valve – Brass Level – 100mm Female NPT x Female NPT with 100mm Male Camlock NPT & Female Camlock Dust Cap.

.5 Manway – 914mm (36") with 305mm (12") Neck, 8 Wingnut, 6mm (1/4") A36 Carbon Steel, Rear Mounted

.6 Accessory Package – Conde – For Super & SDS Pump Models, includes Oil Catch Muffler, Primary & Secondary Shutoffs, Pre-Filters

.7 Hose Hangers – 150mm (6") Driver's Side

.8 Sight Eyes (2) – 125mm (5") Glass with Carbon Steel Weldment

.9 Vacuum/Pressure Gauge – 115mm (4.5") Standard with Guard

.10 Pressure Relief Valve – 38mm (1.5") Brass (109 L/S) with Guard.

.11 Vacuum Relief Valve – 38mm (1.5") Brass (175 L/S)

.12 SDS-12 Conde 85 L/S (Vacuum/Pressure) pump belt driven with 10 HP three phase electric motor platform.

.13 Pump Platform – Standard (LMT)

.14 Paint Preparation – Wash, Phosphatization, Primer (< 3785 L or < 1000 Gal)

.15 Paint – Standard – 1890 L – 3591 L (500 – 950 Gal) Tank, Bright White.

.16 3m long 75mm diameter reinforced flexible drain hose with threaded coupling for connecting to tank discharge and plain end for discharge into sanitary.

.17 Recessed floor box with hinged cover for access to capped sanitary wye in floor to drain tank.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing specialities and accessories installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.3 INSTALLATION

.1 Install in accordance with National Plumbing Code of Canada.

.2 Install in accordance with manufacturer's instructions and as specified.

3.4 CLEANOUTS

.1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.

.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.5 NON-FREEZE WALL HYDRANTS

.1 Install 600 mm above finished grade and as indicated.

3.6 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures.

3.7 BACK FLOW PREVENTERS

.1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.

.1 Drains.

.2 Backwater Valves.

.3 Water Make-up Assembly.

.4 Grease Interceptors.

.2 Pipe discharge to terminate over nearest funnel floor drain.

3.8 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Install at bottom of risers, at low points to drain systems, and as indicated.

3.9 TRAP SEAL PRIMERS

.1 Install for floor drains and elsewhere, as indicated.

.2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of NRC Departmental Representative.

.3 Install soft copper tubing to floor drain.

3.10 STRAINERS

.1 Install with sufficient room to remove basket for maintenance.

3.11 WATER METERS

.1 Install water meter as indicated.

3.12 WATER MAKE-UP ASSEMBLY

.1 Install on valved bypass.

.2 Pipe discharge from relief valve to nearest floor drain.

3.13 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

3.14 TESTING AND ADJUSTING

.1 General:

.1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13- General Commissioning (Cx) Requirements : General Requirements, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.3 Application tolerances:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

.4 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.5 Floor drains:

.1 Verify operation of trap seal primer.

.2 Prime, using trap primer. Adjust flow rate to suit site conditions.

.3 Check operations of flushing features.

.4 Check security, accessibility, removability of strainer.

.5 Clean out baskets.

.6 Vacuum breakers, backflow preventers, backwater valves:

.1 Test tightness, accessibility for O M of cover and of valve.

.2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.

.3 Verify visibility of discharge from open ports.

.7 Roof drains:

.1 Check location at low points in roof.

.2 Check security, removability of dome.

.3 Adjust weirs to suit actual roof slopes, meet requirements of design.

.4 Clean out sumps.

.5 Verify provisions for movement of roof systems.

.8 Access doors:

.1 Verify size and location relative to items to be accessed.

.9 Cleanouts:

.1 Verify covers are gas-tight, secure, yet readily removable.

.10 Water hammer arrestors:

.1 Verify proper installation of correct type of water hammer arrester.

.11 Wall, ground hydrants:

.1 Verify complete drainage, freeze protection.

.2 Verify operation of vacuum breakers.

.12 Pressure regulators, PRV assemblies:

.1 Adjust settings to suit locations, flow rates, pressure conditions.

.13 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.14 Hose bibbs, sediment faucets:

.1 Verify that flow and pressure meet design criteria.

.2 Check for leaks, replace compression washer if required.

.15 Hydronic system water Make-up Assembly:

.1 Verify flow, pressure, and connection.

.16 Water meters:

.1 Verify location and accessibility.

.2 Test meter reading accuracy.

3.15 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.

.2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

3.16 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.17 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM A126- 04(2009), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM B62- 09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA)

.1 ANSI/AWWA C700- 09, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.

.2 ANSI/AWWA C701- 12, Standard for Cold Water Meters-Turbine Type for Customer Service.

.3 ANSI/AWWA C702- 10, Standard for Cold Water Meters-Compound Type.

.3 CSA International

.1 CSA-B64 Series- 11, Backflow Preventers and Vacuum Breakers.

.2 CSA B79- 08, Commercial and Residential Drains and Cleanouts.

.3 CAN/CSA-B356- 10, Water Pressure Reducing Valves for Domestic Water Supply Systems.

.4 Efficiency Valuation Organization (EVO)

.1 International Performance Measurement and Verification Protocol (IPMVP).

.1 IPMVP 2007 Version.

.5 Plumbing and Drainage Institute (PDI)

.1 PDI-G101- R2010, Testing and Rating Procedure for Grease Interceptors with Appendix of Installation and Maintenance.

.2 PDI-WH201- R2010, Water Hammer Arresters Standard.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to on-site installation, with contractor's representative NRC Departmental Representative to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for plumbing products and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements. Indicate VOC's:

.3 Shop Drawings:

.1 Indicate on drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions construction and assembly details accessories.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturers' Field Reports: manufacturers' field reports specified.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect plumbing materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FLOOR DRAINS

.1 Floor Drains and Trench Drains: to ASME A112.6.3-2001.

.2 Type FD1: foot traffic areas; cast iron body round, adjustable head, nickel bronze strainer, integral seepage pan, and flashing collar, trip seal primer tapping, no hub outlet.

.1 Equivalent to Jay R. Smith 2005Y

.3 Type FD2: wheel traffic areas (mechanical rooms, basement corridor, workshops); cast iron body round, adjustable head, heavy duty nickel bronze strainer, integral seepage pan, and flashing collar, trip seal primer tapping, no hub outlet.

.1 Equivalent to Jay R. Smith 2005AHD

.4 Type FFD: funnel floor drain (mechanical rooms); cast iron body round, adjustable head, heavy duty nickel bronze strainer with integral oval funnel, integral seepage pan, and flashing collar, trip seal primer tapping, no hub outlet.

.1 Equivalent to Jay R. Smith 2005AHD-F19

2.2 ROOF DRAINS

.1 Type 1: cast iron body, under deck clamp and sump receiver to suit roof construction, flashing clamp ring with integral gravel stop, bearing pan, polyethylene dome.

.1 Equivalent to Jay R Smith 1010

2.3 CLEANOUTS

.1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

.2 Access Covers:

.1 Wall Access: face or wall type, stainless steel square cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

.2 Floor Access: round cast iron body and frame with adjustable secured nickel bronze top and:

.1 Plugs: bolted bronze with neoprene gasket.

.2 Cover for Unfinished Concrete Floors: cast iron round, gasket, vandal-proof screws.

.1 Equivalent to Jay R. Smith 4220

.3 Cover for Terrazzo Finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.

.1 Equivalent to Jay R. Smith 4180-CAN

.4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.

.5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

.1 Equivalent to Jay R. Smith 4021S-Y

2.4 NON-FREEZE WALL HYDRANTS

.1 Recessed type with integral vacuum breaker-backflow preventor, NPS 3/4 hose outlet, removable operating key. Chrome plated brassfinish.

.2 To ASSE 1019

.1 Equivalent to Watts series HY42

2.5 WATER HAMMER ARRESTORS

.1 Hard drawn copper body with machined lead-free brass piston, NPT solid hex brass, air chamber precharged to 422 kPa.

.2 PDI WH201 approved

.3 ANSI A112.26.1M approved

.1 Equivalent to Watts Series LF15

2.6 BACK FLOW PREVENTERS

.1 Preventers: to CSA-B64 Series, application as indicated,

.2 reduced pressure principle type, complete with strainer, isolation ball valves, differential pressure relief valve between two positively seated check valves – Watts Series 909

.3 double check valve assembly

.4 Dual check valve with intermediate atmospheric vent, complete with union connections, stainless steel internals, rubber seated checks, ASSE approved – Watts 9D.

2.7 VACUUM BREAKERS

.1 Breakers: to CSA-B64 Series, vacuum breaker.

2.8 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

2.9 WATER MAKE-UP ASSEMBLY

.1 Complete with backflow preventer pressure gauge on inlet and outlet, pressure reducing valve to CAN/CSA-B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.

2.10 WATER METERS

.1 Compound type to ANSI/AWWA C702.

.2 Accessories: remote readout device and interface with BMS.

.3 For model and type contact Joe Sollazzo @ 1-438-837-7229 or joe.sollazzo@ca.endress.com

2.11 TRAP SEAL PRIMERS

.1 Brass, with integral vacuum breaker, NPS 1/2 solder ends, NPS 1/2 drip line connection.

.1 Equivalent to P.P.P Inc Model P0-500

2.12 STRAINERS

.1 860 kPa, Y type with 20 mesh, monel, bronze or stainless steel removable screen.

.2 NPS 2 and under, bronze body, screwed ends, with brass cap.

.3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

2.13 VACUUM PUMP TANK (SUPPLIED BY OWNER)

.1 Vacuum tank:

.1 300 gallon – 6mm (1/4") A36 Grade Carbon Steel

.2 Single Compartment, 914mm (36") diameter x 1829mm (6') long

.3 Offset construction

.4 Two flanged & Dished tank heads

.5 Exterior seams submerged arc welded (SAW)

.2 The Vacuum Tank shall be furnished will all of the following accessories:

.1 Rails – standard style, 25mm A36 Carbon Steel

.2 Discharge port – 100mm threaded nipple, male NPT

.3 Valve – Brass Lever – 75mm Female NPT x Female NPT with 75mm Male Camlock NPT & Female Camlock Dust Cap.

.4 Valve – Brass Level – 100mm Female NPT x Female NPT with 100mm Male Camlock NPT & Female Camlock Dust Cap.

.5 Manway – 914mm (36") with 305mm (12") Neck, 8 Wingnut, 6mm (1/4") A36 Carbon Steel, Rear Mounted

.6 Accessory Package – Conde – For Super & SDS Pump Models, includes Oil Catch Muffler, Primary & Secondary Shutoffs, Pre-Filters

.7 Hose Hangers – 150mm (6") Driver's Side

.8 Sight Eyes (2) – 125mm (5") Glass with Carbon Steel Weldment

.9 Vacuum/Pressure Gauge – 115mm (4.5") Standard with Guard

.10 Pressure Relief Valve – 38mm (1.5") Brass (109 L/S) with Guard.

.11 Vacuum Relief Valve – 38mm (1.5") Brass (175 L/S)

.12 SDS-12 Conde 85 L/S (Vacuum/Pressure) pump belt driven with 10 HP three phase electric motor platform.

.13 Pump Platform – Standard (LMT)

.14 Paint Preparation – Wash, Phosphatization, Primer (< 3785 L or < 1000 Gal)

.15 Paint – Standard – 1890 L – 3591 L (500 – 950 Gal) Tank, Bright White.

.16 3m long 75mm diameter reinforced flexible drain hose with threaded coupling for connecting to tank discharge and plain end for discharge into sanitary.

.17 Recessed floor box with hinged cover for access to capped sanitary wye in floor to drain tank.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing specialities and accessories installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.3 INSTALLATION

.1 Install in accordance with National Plumbing Code of Canada.

.2 Install in accordance with manufacturer's instructions and as specified.

3.4 CLEANOUTS

.1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.

.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.5 NON-FREEZE WALL HYDRANTS

.1 Install 600 mm above finished grade and as indicated.

3.6 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures.

3.7 BACK FLOW PREVENTERS

.1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.

.1 Drains.

.2 Backwater Valves.

.3 Water Make-up Assembly.

.4 Grease Interceptors.

.2 Pipe discharge to terminate over nearest funnel floor drain.

3.8 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Install at bottom of risers, at low points to drain systems, and as indicated.

3.9 TRAP SEAL PRIMERS

.1 Install for floor drains and elsewhere, as indicated.

.2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of NRC Departmental Representative.

.3 Install soft copper tubing to floor drain.

3.10 STRAINERS

.1 Install with sufficient room to remove basket for maintenance.

3.11 WATER METERS

.1 Install water meter as indicated.

3.12 WATER MAKE-UP ASSEMBLY

.1 Install on valved bypass.

.2 Pipe discharge from relief valve to nearest floor drain.

3.13 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

3.14 TESTING AND ADJUSTING

.1 General:

.1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13- General Commissioning (Cx) Requirements : General Requirements, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.3 Application tolerances:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

.4 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.5 Floor drains:

.1 Verify operation of trap seal primer.

.2 Prime, using trap primer. Adjust flow rate to suit site conditions.

.3 Check operations of flushing features.

.4 Check security, accessibility, removability of strainer.

.5 Clean out baskets.

.6 Vacuum breakers, backflow preventers, backwater valves:

.1 Test tightness, accessibility for O M of cover and of valve.

.2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.

.3 Verify visibility of discharge from open ports.

.7 Roof drains:

.1 Check location at low points in roof.

.2 Check security, removability of dome.

.3 Adjust weirs to suit actual roof slopes, meet requirements of design.

.4 Clean out sumps.

.5 Verify provisions for movement of roof systems.

.8 Access doors:

.1 Verify size and location relative to items to be accessed.

.9 Cleanouts:

.1 Verify covers are gas-tight, secure, yet readily removable.

.10 Water hammer arrestors:

.1 Verify proper installation of correct type of water hammer arrester.

.11 Wall, ground hydrants:

.1 Verify complete drainage, freeze protection.

.2 Verify operation of vacuum breakers.

.12 Pressure regulators, PRV assemblies:

.1 Adjust settings to suit locations, flow rates, pressure conditions.

.13 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.14 Hose bibbs, sediment faucets:

.1 Verify that flow and pressure meet design criteria.

.2 Check for leaks, replace compression washer if required.

.15 Hydronic system water Make-up Assembly:

.1 Verify flow, pressure, and connection.

.16 Water meters:

.1 Verify location and accessibility.

.2 Test meter reading accuracy.

3.15 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.

.2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

3.16 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.17 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-B45 Series- 02(R2008) , Plumbing Fixtures.

.2 CAN/CSA-B125.3- 05 , Plumbing Fittings.

.3 CAN/CSA-B651- 04 , Accessible Design for the Built Environment.

.2 Green Seal Environmental Standards (GSES)

.1 Standard GS-36- 00 , Commercial Adhesives.

.3 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168- A2005 , Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for washroom fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Indicate fixtures and trim:

.1 Dimensions, construction details, roughing-in dimensions.

.2 Factory-set water consumption per flush at recommended pressure.

.3 For water closets, urinals: minimum pressure required for flushing.

1.3 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for washroom fixtures, for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.

.2 Details of operation, servicing, maintenance.

.3 List of recommended spare parts.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.3.

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: as indicated.

.5 Fixtures in any one location to be product of one manufacturer and of same type.

.6 Trim in any one location to be product of one manufacturer and of same type.

.7 Water closets:

.1 WC-1 : wall-mounted, exposed flush valve, top spud ultra-low flush, maximum 6 litres/flush.

.1 Bowl: vitreous china, syphon jet, elongated rim. Fully glazed trapway.

.2 MaP score: 1000g of miso @ 1.6 gpf

.3 Equivalent to American Standard Afwall 1.6gpm

.2 WC-2 : As above and barrier free

.8 Electronic Water Closet Flush Valves:

.1 Barrier free, stainless steel, electronic, sensor proximity type, activated by infra-red.

.2 Sensor: waterproof, with impact-resistant, anti scratch coated plastic lens, sensitivity adjustable from 100 mm to 450 mm.

.3 Water conservation: 30 second maximum run time.

.4 Controls: interchangeable receptacles for stainless steel sheathed sensor and modular plug-type solenoid connections, single 6 VDC, slow-closing commercial solenoid for 860 kPa, 85 degrees C.

.5 Transformer: 120VAC/6 VDC , Class 2, UL and CSA listed, hardwire type, sized for up to 8 solenoids.

.6 Equipped with manual override button.

.9 Water Closet Seats.

.1 Seat: white, elongated, open front, moulded solid plastic, less cover, stainless steel check hinges, stainless steel insert post.

.10 Urinals:

.1 U-1 : ~~wall~~ **floor** mounted, ultra-low flush, exposed flush valve, top spud.

.1 Urinal: vitreous china, washout type, integral flushing rim, extended shields, integral trap, removable stainless steel strainer, back outlet, full height equivalent to American Standard Stallbrook.

.11 Urinal Electronic Flush Valves:

.1 Surface mounted, controlled by infra-red occupancy detector.

.1 Complete with removable filter, 9 second time delay, flush time adjustable from 0-8 seconds, factory set at 4.5 seconds, 4.5 L flush/cycle maximum.

.2 Sensor adjustable from 50-1220 mm, factory set to 860 mm.

.3 Solenoid valve: 6 VDC slow-closing type for 60 kPa (minimum), 1000 kPa (maximum), 85 degrees C with manual over-ride, adjustable flow control.

.4 Transformer: 120/ VAC Class 2, 6 VDC UL and CSA listed, hardwire type.

.5 Manual mechanical override.

.12 Washroom Lavatories:

.1 L-1 : counter-top:

.1 Porcelain-on-steel, self-rimming, with front overflow, soap depressions, gasket, swivel clamps, semi-oval or rectangular bowl, supply openings on 200 mm centres. Sizes: 475 x 400 mm outside, 400 x 250 mm nominal inside.

.2 L-2: wall-hung, for handicapped.

.1 Vitreous china, low shelf, with integral back, contoured front, shallow front basin, front overflow, soap depressions, supply openings on 299 mm centres, concealed supports. Sizes: 686 x 508 mm.

.13 Washroom Lavatory Electronic Trim:

.1 Barrier-free electronic faucet:

.1 Infra-red motion sensor activated by hand motion in lavatory.

.2 Sensor: waterproof, incorporated in body of unit, with impact-resistant plastic lens and anti-scratch coating, inside spout, sensitivity adjustable from 100 mm to 450 mm.

.3 Water conservation: 30 second maximum run time.

.4 Controls: vandal-proof, interchangeable receptacles for stainless steel sheathed sensor and modular plug-type solenoid connections, single 12 VDC slow-closing commercial solenoid for 860 kPa, 85 degrees C.

.5 Transformer: 120/12 VDC Class 2, UL and CSA listed, hard wire type, sized for up to 8 solenoids.

.6 Spout: Chrome plated, with integral flow control aerator rated at 8.35 l/minute at 413 kPa maximum.

.7 Under-counter temperatures mixing controls.

.14 Exam Room Sinks

.1 SK-2 Shampoo Sink

.1 **Willoughby 1911 SHAMPOO Sink,** Right Hand Hole, 19" x 18-3/4" x 9-1/4" (483mm x 476mm x 235mm) deep, cut into a counter-top, solid surfaced bowl, with wide front neck cut out and wall hanger, C.P. crumb

cup strainer, (standard colour as selected). **American Standard #4137.100.002 'CULINAIRE' Combi Pull-Out Spray Faucet,** C.P., 8" (203mm), C.C., lead-free cast brass waterways body, ceramic disc valve cartridge, 7-7/8" (200mm) long swing spout with 8.3 LPM (2.2 GPM) max. flow aerator outlet, cast brass swing spout with deluxe pull-out spray, removable deck plate for single hole applicaton, single control metal lever handle and flexible copper supplies. **PPP #TCP-2 'TEMPRA VALVE,'** C.P. pressure balancing located under sink to serve faucet, specific for Shampoo Sink. Allow 7" (178mm) below interceptor for removal of basket. **McGuire #H165N5-LR Supplies,** C.P. Polished Brass Sink Supplies, rigid horizontal nipples 3/8" (10mm) x 5" (127mm) long, I.P.S. heavy all brass angle stops with wheel handle stops and escutcheons, less flexible copper risers. **Jay R. Smith #8750 Hair Interceptor,** C.P. cast iron, with removable basket 1-1/2" (38mm) inlet and outlet, escutcheon. Interceptor is also used as a sink 'p' trap (check local codes). All exposed piping to be chrome plated

.15 Fixture piping:

.1 Hot and cold water supplies to fixtures:

.1 flexible supply pipes with screwdriver stop, reducers, escutcheon.

.2 Waste:

.1 Brass P trap with clean out on fixtures not having integral trap.

.2 Chrome plated in exposed places.

.16 Chair carriers:

.1 Factory manufactured floor-mounted carrier systems for wall-mounted fixtures.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Mounting heights:

.1 Standard: to manufacturer's recommendations, measured from finished floor.

.2 Barrier free: to most stringent of NBCC and CAN/CSA B651.

3.3 ADJUSTING

.1 Conform to water conservation requirements specified this section.

.2 Adjustments:

.1 Adjust water flow rate to design flow rates.

.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Adjust flush valves to suit actual site conditions.

.4 Adjust urinal flush timing mechanisms.

.5 Set controls of automatic flush valves for WCs and urinals to prevent unnecessary flush cycles.

.3 Checks:

.1 Water closets, urinals: flushing action.

.2 Aerators: operation, cleanliness.

.3 Vacuum breakers, backflow preventers: operation under all conditions.

.4 Thermostatic controls:

.1 Verify temperature settings, operation of control, limit and safety controls.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-B45 Series- 02(R2008) , Plumbing Fixtures.

.2 CAN/CSA-B125.3- 05 , Plumbing Fittings.

.3 CAN/CSA-B651- 04 , Accessible Design for the Built Environment.

.2 Green Seal Environmental Standards (GSES)

.1 Standard GS-36- 00 , Commercial Adhesives.

.3 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168- A2005 , Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for washroom fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Indicate fixtures and trim:

.1 Dimensions, construction details, roughing-in dimensions.

.2 Factory-set water consumption per flush at recommended pressure.

.3 For water closets, urinals: minimum pressure required for flushing.

1.3 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for washroom fixtures, for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.

.2 Details of operation, servicing, maintenance.

.3 List of recommended spare parts.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.3.

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: as indicated.

.5 Fixtures in any one location to be product of one manufacturer and of same type.

.6 Trim in any one location to be product of one manufacturer and of same type.

.7 Water closets:

.1 WC-1 : wall-mounted, exposed flush valve, top spud ultra-low flush, maximum 6 litres/flush.

.1 Bowl: vitreous china, syphon jet, elongated rim. Fully glazed trapway.

.2 MaP score: 1000g of miso @ 1.6 gpf

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.2 Sensor: waterproof, with impact-resistant, anti scratch coated plastic lens, sensitivity adjustable from 100 mm to 450 mm.

.3 Water conservation: 30 second maximum run time.

.4 Controls: interchangeable receptacles for stainless steel sheathed sensor and modular plug-type solenoid connections, single 6 VDC, slow-closing commercial solenoid for 860 kPa, 85 degrees C.

.5 Transformer: 120VAC/6 VDC , Class 2, UL and CSA listed, hardwire type, sized for up to 8 solenoids.

.6 Equipped with manual override button.

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.1 Seat: white, elongated, open front, moulded solid plastic, less cover, stainless steel check hinges, stainless steel insert post.

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Part 3 Execution

3.1 APPLICATION

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.1 Mounting heights:

.1 Standard: to manufacturer's recommendations, measured from finished floor.

.2 Barrier free: to most stringent of NBCC and CAN/CSA B651.

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.1 Conform to water conservation requirements specified this section.

.2 Adjustments:

.1 Adjust water flow rate to design flow rates.

.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Adjust flush valves to suit actual site conditions.

.4 Adjust urinal flush timing mechanisms.

.5 Set controls of automatic flush valves for WCs and urinals to prevent unnecessary flush cycles.

.3 Checks:

.1 Water closets, urinals: flushing action.

.2 Aerators: operation, cleanliness.

.3 Vacuum breakers, backflow preventers: operation under all conditions.

.4 Thermostatic controls:

.1 Verify temperature settings, operation of control, limit and safety controls.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

.1 Common Work Results - Electrical Section 26 05 00

1.2 DESCRIPTION

.1 This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

.2 The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. All VFDs installed on this project shall be from the same manufacturer.

1.3 QUALITY ASSURANCE

.1 Referenced Standards:

.1 Institute of Electrical and Electronic Engineers (IEEE)

.1 Standard 519-1992, IEEE Guide for Harmonic Content and Control.

.2 Underwriters laboratories

.1 UL508C

.3 National Electrical Manufacturer's Association (NEMA)

.1 ICS 7.0, AC Adjustable Speed Drives

.4 IEC 16800 Parts 1 and 2

.5 CSA 22.2

.2 Qualifications:

.1 VFDs and options shall be UL listed and CSA approved as a complete assembly. VFDs that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fusing.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 00 10 00.

.2 Include schematic, wiring, interconnection diagrams.

.3 Indicate:

.1 Outline dimensions, conduit entry locations and weight.

.2 Customer connection and power wiring diagrams.

.3 Complete technical product description include a complete list of options provided. Any portions of the specifications not complied with must be clearly indicated or the supplier and contractor shall be liable to provide all components required to meet the specification.

.4 Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

.1 The VFD manufacturer shall provide calculations; specific to the installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with the IEEE electrical system standard 519. All VFDs shall include a minimum of 5% equivalent impedance reactors, no exceptions.

.4 Motors specified and supplied with mechanical equipment. Refer to Division 23.

1.5 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 00 10 00.

.2 Include operation and maintenance data for each type and style of starter.

.3 On completion of the installation, the supplier shall provide the following:

.1 Full commissioning report documenting all programmable settings, AC input voltage, DC Bus voltage, current draw at maximum speed, and a description of ambient conditions.

.2 One operator’s manual for each VFD installed.

.3 One 8.5" x 11" wiring diagram for each VFD installed.

1.6 GENERAL DESIGN CHARACTERISTICS

.1 The VFD shall be of the Pulse Width Modulated (PWM) type.

.2 The VFD shall be rated for variable torque applications, with an overload rating of 110% for 60 seconds.

.3 All VFD’s shall be factory UL/cUL Listed.

.4 All packaged drive systems shall be CSA Listed.

.5 The VFD shall have the capability of operating multiple motors. The minimum VFD continuous current rating shall be the sum of the full load current ratings of the connected motors.

.6 The VFD shall have a minimum displacement power factor of 0.96 or higher at all output frequencies.

.7 The VFD manufacturer shall have a minimum of ten years experience in the Canadian Market.

Part 2 Products

2.1 VARIABLE FREQUENCY DRIVES

.1 The VFD package as specified herein shall be enclosed in a NEMA rated type 1 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

.1 Environmental operating conditions: $0 – 40^0$ C continuous. Altitude 0 to 3300 feet above sea level, up to 95% humidity, non-condensing. All circuit boards shall have conformal coating.

.2 The VFD shall operate within the following rated values.

.1 Output Frequency Range: 0.1 to 400 Hz.

.2 Overload Rating: VT – 110% for 60 seconds

.3 Input Voltage: 3 phase + ground , 600V +10% / -20%

.4 Input Frequency: 48-62 Hz

.3 The VFD shall be designed to include the following protective functions and display for maintainability:

.1 Instantaneous Over Current Protection: The VFD output shall be turned off if the operating current exceeds the specified level.

.2 Motor Overload Protection: cUL/CSA approved electronic thermal overload protection.

.3 External Trip Input: Programmable for either N/O or N/C operation.

.4 Over Voltage Protection: The VFD output shall turned off if the DC Bus voltage exceeds the specified level.

.5 Ground Fault Protection: The VFD output shall turned off in the event of a ground fault.

.6 Line or Load Phase Loss Protection: Programmable for enable - disable

.7 Software Lock: The VFD shall include a software function that prevents changes to the user-defined settings.

.8 CPU or EEPROM Error: The VFD output shall turned off in the event of an error in the CPU or EEPROM.

.2 All VFDs shall have the following features:

.1 All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

.2 The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.

.3 There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial

power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings. Capacitor backup is not acceptable.

.4 The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

.5 The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

.6 The VFD shall have 5% equivalent impedance internal reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% equivalent impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFDs with only one DC reactor shall add an AC line reactor.

.7 The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% equivalent impedance internal reactors.

.8 The VFD shall provide a programmable proof of flow Form-C relay output (broken belt / broken coupling). The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

.3 All VFDs to have the following adjustments:

.1 Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

.2 Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network.

.3 Two (2) programmable analog inputs shall accept current or voltage signals.

.4 Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

.5 Six (6) programmable digital inputs.

.6 Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.

.7 Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.

.8 Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

.9 The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

.10 The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.

.11 The VFD shall include password protection against parameter changes.

.4 The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (LED and alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words.

.5 All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

.1 Output Frequency

.2 Motor Speed (RPM, %, or Engineering units)

.3 Motor Current

.4 Drive Temperature

.5 DC Bus Voltage

.6 Output Voltage

.6 The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlock, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

.7 Serial Communications

.1 The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, BACnet, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.

.2 The BACnet connection shall be an RS485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

.1 Data Sharing – Read Property – B.

.2 Data Sharing – Write Property – B.

.3 Device Management – Dynamic Device Binding (Who-Is; I-AM).

.4 Device Management – Dynamic Object Binding (Who-Has; I-Have).

.5 Device Management – Communication Control – B.

.3 Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

.8 EMI / RFI filters. All VFDs shall include EMI/RFI filters. The VFD shall comply with standard EN 61800-3 for the First Environment, restricted level with up to 100' of motor cables. No Exceptions. Certified test lab test reports shall be provided with the submittals.

.9 All VFDs through 60HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not be damaged by this condition.

.10 Additional Features – Additional features to be furnished and mounted by the drive manufacturer. All Additional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label. The bypass enclosure door and VFD enclosure must be interlocked such that input power is turned off before either enclosure can be opened. The VFD and Bypass as a package shall have a UL listed short circuit rating of 100,000 amps and shall be indicated on the data label.

.1 A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses

are required. Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted

.2 Door interlocked padlockable disconnect switch that will disconnect all input power from the drive and all internally mounted options.

.11 The following operators shall be provided:

.1 Bypass Hand-Off-Auto

.2 Drive mode selector and light

.3 Bypass mode selector and light

.4 Bypass fault reset

.5 Bypass LDC display, 2 lines, for programming and status / fault / warning indications

.6 Motor protection from single phase power conditions - The Bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in Bypass mode are not acceptable.

.7 The systems (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.

.8 The Bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair / replacement.

.9 Serial communications – the bypass and VFD shall be capable of being monitored and or controlled via serial communications. Provide communications protocols for ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1) and BACnet in the bypass controller.

.10 BACnet Serial communication bypass capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, bypass current (in amps), bypass kilowatt hours (resettable), bypass operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relays output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional bypass status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running under load in both VFD and bypass (proof of flow) in the VFD mode over serial communications or Form-C relay output. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.

.11 Run permissive circuit - there shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, time-clock control, or serial communications) the VFD and bypass shall provide a dry contact closure that will signal the damper to open (VFD motor does not

operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD system input and allows motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.

.12 The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor operation shall be indicated on the Bypass LCD display as well as over the serial communications protocol.

.13 The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

.14 The bypass control shall be programmable for manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass.

.15 There shall be an adjustable motor current sensing circuit for the bypass and VFD mode to provide proof of flow indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and on a relay output contact closure.

.16 The bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs.

.17 The relay outputs from the bypass shall be programmable for any of the following indications.

.1 System started
.2 System running
.3 Bypass override enabled
.4 Drive fault
.5 Bypass fault
.6 Bypass H-O-A position
.7 Motor proof of flow (broken belt)
.8 Overload
.9 Bypass selected
.10 Bypass run
.11 System started (damper opening)
.12 Bypass alarm
.13 Over temperature

.18 The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.

.19 Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All

external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

.20 The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Firestat”, “Freezestat”, “Over pressure” and “Low pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

.21 Class 10, 20, or 30 (selectable) electronic motor overload protection shall be included.

.22 Standard of acceptance:

.1 ABB ACH-VDR-52A1-6+f267 Series or equivalent approved by NRC departmental representative. Approval does not relieve supplier of specification requirements.

2.2 SURGE SUPPRESSOR

.1 3-phase surge protection module rated for 600V.

.2 Standard of acceptance: MTE M-1775 or equivalent approved by NRC departmental representative.

Part 3 Execution

3.1 INSTALLATION

.1 Installation shall be the responsibility of the electrical contractor. The contractor shall install the drive in accordance with the requirements of the VFD manufacturer’s installation manual.

.2 The contractor is to verify that the jobsite conditions for installation meet the factory recommendations and code required conditions for the VFD installation prior to installation. These shall include as a minimum:

.1 Clearance spacing.

.2 Compliance with environmental ratings of the VFD system.

.3 Separate conduit installation of the input wiring, the motor wiring, and control wiring. At no time does any of this wiring run in parallel with each other.

.4 All power and control wiring is complete.

.3 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD system shall not be operated while the unit is covered.

3.2 ON-SITE STARTUP

.1 The manufacturer shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced

in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer site. Sales personnel and other agents who are not factory certified technicians for drive repair shall not be acceptable as commissioning agents.

.2 Start-up services shall include checking for verification of proper operation and installation of the VFD, its options and its interface wiring to the building automation system. Included in this service shall be as a minimum:

.1 Verification of contractor wire terminations and conduit runs to and from the VFD.

.2 Up to four hours of customer operator training on the operation and service diagnostics at the time of commissioning. On-site training is to be provided by the same factory trained application engineering and service personnel to demonstrate full programming and operating features and procedures. Date and time for this training is to be coordinated with the NRC Departmental Representative.

.3 Measurement for verification of proper operation of the following:

.1 Motor voltage and frequency. Verification of proper motor operation.

.2 Control input for proper building automation system interface and control calibration.

.3 Calibration check for the following set-points:

.1 minimum speed

.2 maximum speed

.3 acceleration and deceleration rates.

.3 Commissioning agent to verify the programming of the VFD and to provide a written copy of the settings to the engineer.

.4 Commissioning agent to lock out critical frequencies throughout the operating curve of the equipment as identified and required by the engineer. The agent shall record amperages at six (minimum) different frequencies from minimum to maximum speed.

3.3 PRODUCT SUPPORT

.1 Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

.2 A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.4 WARRANTY

.1 Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses

END OF SECTION

Part 1 General

1.1 RELATED WORK SPECIFIED ELSEWHERE

.1 Common Work Results - Electrical Section 26 05 00

1.2 DESCRIPTION

.1 This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.

.2 The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. All VFDs installed on this project shall be from the same manufacturer.

1.3 QUALITY ASSURANCE

.1 Referenced Standards:

.1 Institute of Electrical and Electronic Engineers (IEEE)

.1 Standard 519-1992, IEEE Guide for Harmonic Content and Control.

.2 Underwriters laboratories

.1 UL508C

.3 National Electrical Manufacturer's Association (NEMA)

.1 ICS 7.0, AC Adjustable Speed Drives

.4 IEC 16800 Parts 1 and 2

.5 CSA 22.2

.2 Qualifications:

.1 VFDs and options shall be UL listed and CSA approved as a complete assembly. VFDs that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fusing.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 00 10 00.

.2 Include schematic, wiring, interconnection diagrams.

.3 Indicate:

.1 Outline dimensions, conduit entry locations and weight.

.2 Customer connection and power wiring diagrams.

.3 Complete technical product description include a complete list of options provided. Any portions of the specifications not complied with must be clearly indicated or the supplier and contractor shall be liable to provide all components required to meet the specification.

.4 Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).

.1 The VFD manufacturer shall provide calculations; specific to the installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with the IEEE electrical system standard 519. All VFDs shall include a minimum of 5% equivalent impedance reactors, no exceptions.

.4 Motors specified and supplied with mechanical equipment. Refer to Division 23.

1.5 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 00 10 00.

.2 Include operation and maintenance data for each type and style of starter.

.3 On completion of the installation, the supplier shall provide the following:

.1 Full commissioning report documenting all programmable settings, AC input voltage, DC Bus voltage, current draw at maximum speed, and a description of ambient conditions.

.2 One operator’s manual for each VFD installed.

.3 One 8.5" x 11" wiring diagram for each VFD installed.

1.6 GENERAL DESIGN CHARACTERISTICS

.1 The VFD shall be of the Pulse Width Modulated (PWM) type.

.2 The VFD shall be rated for variable torque applications, with an overload rating of 110% for 60 seconds.

.3 All VFD’s shall be factory UL/cUL Listed.

.4 All packaged drive systems shall be CSA Listed.

.5 The VFD shall have the capability of operating multiple motors. The minimum VFD continuous current rating shall be the sum of the full load current ratings of the connected motors.

.6 The VFD shall have a minimum displacement power factor of 0.96 or higher at all output frequencies.

.7 The VFD manufacturer shall have a minimum of ten years experience in the Canadian Market.

Part 2 Products

2.1 VARIABLE FREQUENCY DRIVES

.1 The VFD package as specified herein shall be enclosed in a NEMA rated type 1 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

.1 Environmental operating conditions: $0 – 40^0$ C continuous. Altitude 0 to 3300 feet above sea level, up to 95% humidity, non-condensing. All circuit boards shall have conformal coating.

.2 The VFD shall operate within the following rated values.

.1 Output Frequency Range: 0.1 to 400 Hz.

.2 Overload Rating: VT – 110% for 60 seconds

.3 Input Voltage: 3 phase + ground , 600V +10% / -20%

.4 Input Frequency: 48-62 Hz

.3 The VFD shall be designed to include the following protective functions and display for maintainability:

.1 Instantaneous Over Current Protection: The VFD output shall be turned off if the operating current exceeds the specified level.

.2 Motor Overload Protection: cUL/CSA approved electronic thermal overload protection.

.3 External Trip Input: Programmable for either N/O or N/C operation.

.4 Over Voltage Protection: The VFD output shall turned off if the DC Bus voltage exceeds the specified level.

.5 Ground Fault Protection: The VFD output shall turned off in the event of a ground fault.

.6 Line or Load Phase Loss Protection: Programmable for enable - disable

.7 Software Lock: The VFD shall include a software function that prevents changes to the user-defined settings.

.8 CPU or EEPROM Error: The VFD output shall turned off in the event of an error in the CPU or EEPROM.

.2 All VFDs shall have the following features:

.1 All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

.2 The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.

.3 There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial

power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings. Capacitor backup is not acceptable.

.4 The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).

.5 The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.

.6 The VFD shall have 5% equivalent impedance internal reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% equivalent impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFDs with only one DC reactor shall add an AC line reactor.

.7 The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% equivalent impedance internal reactors.

.8 The VFD shall provide a programmable proof of flow Form-C relay output (broken belt / broken coupling). The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.

.3 All VFDs to have the following adjustments:

.1 Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.

.2 Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network.

.3 Two (2) programmable analog inputs shall accept current or voltage signals.

.4 Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.

.5 Six (6) programmable digital inputs.

.6 Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.

.7 Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close.

.8 Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

.9 The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

.10 The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating the VFD or operating at high carrier frequency only at low speeds.

.11 The VFD shall include password protection against parameter changes.

.4 The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (LED and alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words.

.5 All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

.1 Output Frequency

.2 Motor Speed (RPM, %, or Engineering units)

.3 Motor Current

.4 Drive Temperature

.5 DC Bus Voltage

.6 Output Voltage

.6 The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlock, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

.7 Serial Communications

.1 The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus, BACnet, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.

.2 The BACnet connection shall be an RS485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:

.1 Data Sharing – Read Property – B.

.2 Data Sharing – Write Property – B.

.3 Device Management – Dynamic Device Binding (Who-Is; I-AM).

.4 Device Management – Dynamic Object Binding (Who-Has; I-Have).

.5 Device Management – Communication Control – B.

.3 Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.

.8 EMI / RFI filters. All VFDs shall include EMI/RFI filters. The VFD shall comply with standard EN 61800-3 for the First Environment, restricted level with up to 100' of motor cables. No Exceptions. Certified test lab test reports shall be provided with the submittals.

.9 All VFDs through 60HP shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not be damaged by this condition.

.10 Additional Features – Additional features to be furnished and mounted by the drive manufacturer. All Additional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label. The bypass enclosure door and VFD enclosure must be interlocked such that input power is turned off before either enclosure can be opened. The VFD and Bypass as a package shall have a UL listed short circuit rating of 100,000 amps and shall be indicated on the data label.

.1 A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses

are required. Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted

.2 Door interlocked padlockable disconnect switch that will disconnect all input power from the drive and all internally mounted options.

.11 The following operators shall be provided:

.1 Bypass Hand-Off-Auto

.2 Drive mode selector and light

.3 Bypass mode selector and light

.4 Bypass fault reset

.5 Bypass LDC display, 2 lines, for programming and status / fault / warning indications

.6 Motor protection from single phase power conditions - The Bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in Bypass mode are not acceptable.

.7 The systems (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage as a minimum. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain “sealed in” over this voltage tolerance at a minimum.

.8 The Bypass system shall NOT depend on the VFD for bypass operation. The bypass shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the enclosure for repair / replacement.

.9 Serial communications – the bypass and VFD shall be capable of being monitored and or controlled via serial communications. Provide communications protocols for ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1) and BACnet in the bypass controller.

.10 BACnet Serial communication bypass capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, bypass current (in amps), bypass kilowatt hours (resettable), bypass operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relays output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional bypass status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, and bypass selected. The DDC system shall also be able to monitor if the motor is running under load in both VFD and bypass (proof of flow) in the VFD mode over serial communications or Form-C relay output. A minimum of 40 field parameters shall be capable of being monitored in the bypass mode.

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.13 The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

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.7 Motor proof of flow (broken belt)
.8 Overload
.9 Bypass selected
.10 Bypass run
.11 System started (damper opening)
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.18 The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.

.19 Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All

external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

.20 The user shall be able to select the text to be displayed on the keypad when the safety opens. Example text display indications include “Firestat”, “Freezestat”, “Over pressure” and “Low pressure”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.

.21 Class 10, 20, or 30 (selectable) electronic motor overload protection shall be included.

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2.2 SURGE SUPPRESSOR

.1 3-phase surge protection module rated for 600V.

.2 Standard of acceptance: MTE M-1775 or equivalent approved by NRC departmental representative.

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3.1 INSTALLATION

.1 Installation shall be the responsibility of the electrical contractor. The contractor shall install the drive in accordance with the requirements of the VFD manufacturer’s installation manual.

.2 The contractor is to verify that the jobsite conditions for installation meet the factory recommendations and code required conditions for the VFD installation prior to installation. These shall include as a minimum:

.1 Clearance spacing.

.2 Compliance with environmental ratings of the VFD system.

.3 Separate conduit installation of the input wiring, the motor wiring, and control wiring. At no time does any of this wiring run in parallel with each other.

.4 All power and control wiring is complete.

.3 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD system shall not be operated while the unit is covered.

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.1 The manufacturer shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced

in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer site. Sales personnel and other agents who are not factory certified technicians for drive repair shall not be acceptable as commissioning agents.

.2 Start-up services shall include checking for verification of proper operation and installation of the VFD, its options and its interface wiring to the building automation system. Included in this service shall be as a minimum:

.1 Verification of contractor wire terminations and conduit runs to and from the VFD.

.2 Up to four hours of customer operator training on the operation and service diagnostics at the time of commissioning. On-site training is to be provided by the same factory trained application engineering and service personnel to demonstrate full programming and operating features and procedures. Date and time for this training is to be coordinated with the NRC Departmental Representative.

.3 Measurement for verification of proper operation of the following:

.1 Motor voltage and frequency. Verification of proper motor operation.

.2 Control input for proper building automation system interface and control calibration.

.3 Calibration check for the following set-points:

.1 minimum speed

.2 maximum speed

.3 acceleration and deceleration rates.

.3 Commissioning agent to verify the programming of the VFD and to provide a written copy of the settings to the engineer.

.4 Commissioning agent to lock out critical frequencies throughout the operating curve of the equipment as identified and required by the engineer. The agent shall record amperages at six (minimum) different frequencies from minimum to maximum speed.

3.3 PRODUCT SUPPORT

.1 Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

.2 A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.4 WARRANTY

.1 Warranty shall be 24 months from the date of certified start-up. The warranty shall include all parts, labor, travel time and expenses

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

1.2 REFERENCES

.1 The most recent version of the following codes are to be followed

.2 Canadian Gas Association (CGA)

.1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3, Identification of Piping Systems.

.4 National Fire Protection Association (NFPA)

.1 NFPA 13, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures .

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures .

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures .

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements .

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements .

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .

.2 Dispose of unused paint coating material at official hazardous material collections site approved by NRC Departmental Representative .

.3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic , matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5 .

.2 Equipment in Mechanical Rooms: use size # 9 .

.5 Identification for PWGSC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Before starting work, obtain written approval of identification system from NRC Departmental Representative .

2.4 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from NRC Departmental Representative .

.2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	~~CH. WTR.~~ **BUILDING COOLING SYSTEM** SUPPLY
Chilled water return	Green	~~CH. WTR.~~ **BUILDING COOLING SYSTEM** RETURN
Chilled water supply	**Green**	**PROCESS COOLING SYSTEM SUPPLY**
Chilled water return	**Green**	**PROCESS COOLING SYSTEM RETURN**
Hot water heating supply	Yellow	**BUILDING** HEATING **SYSTEM** SUPPLY
Hot water heating return	Yellow	**BUILDING** HEATING **SYSTEM** RETURN
Steam _____ kPa	Yellow	_____ kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Compressed air (	Green	COMP. AIR _____ kPa
Compressed air (700kPa)	Yellow	COMP. AIR _____ kPa
Vacuum	Green	VACUUM
Instrument air	Green	INSTRUMENT AIR

2.5 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

.1 Identification in English and French .

.2 Use one nameplate and label for each language both languages .

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

.1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide CSA registration plates as required by respective agency.

.3 Identify systems, equipment to conform to PWGSC PMSS.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by NRC Departmental Representative . Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

1.2 REFERENCES

.1 The most recent version of the following codes are to be followed

.2 Canadian Gas Association (CGA)

.1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3, Identification of Piping Systems.

.4 National Fire Protection Association (NFPA)

.1 NFPA 13, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures .

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures .

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures .

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements .

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements .

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .

.2 Dispose of unused paint coating material at official hazardous material collections site approved by NRC Departmental Representative .

.3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic , matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
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8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5 .

.2 Equipment in Mechanical Rooms: use size # 9 .

.5 Identification for PWGSC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Before starting work, obtain written approval of identification system from NRC Departmental Representative .

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.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from NRC Departmental Representative .

.2 Colours for legends, arrows: to following table:

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Chilled water return	Green	~~CH. WTR.~~ **BUILDING COOLING SYSTEM** RETURN
Chilled water supply	**Green**	**PROCESS COOLING SYSTEM SUPPLY**
Chilled water return	**Green**	**PROCESS COOLING SYSTEM RETURN**
Hot water heating supply	Yellow	**BUILDING** HEATING **SYSTEM** SUPPLY
Hot water heating return	Yellow	**BUILDING** HEATING **SYSTEM** RETURN
Steam _____ kPa	Yellow	_____ kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Compressed air (	Green	COMP. AIR _____ kPa
Compressed air (700kPa)	Yellow	COMP. AIR _____ kPa
Vacuum	Green	VACUUM
Instrument air	Green	INSTRUMENT AIR

2.5 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

.1 Identification in English and French .

.2 Use one nameplate and label for each language both languages .

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

.1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide CSA registration plates as required by respective agency.

.3 Identify systems, equipment to conform to PWGSC PMSS.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by NRC Departmental Representative . Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE 90.1- 04 -SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM C335- 05ae1 , Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.2 ASTM C449/C449M- 07 , Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C533- 07 , Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.4 ASTM C547- 07 , Standard Specification for Mineral Fiber Pipe Insulation.

.5 ASTM C553- 02 , Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.6 ASTM C612- 04e1 , Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.7 ASTM C795- 03 , Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921- 03a , Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168- A2005 , Adhesive and Sealant Applications.

.5 Thermal Insulation Association of Canada (TIAC)

.1 National Insulation Standards 2005 .

.6 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102- 07 , Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures .

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.

.3 Manufacturer's Instructions:

.1 Include procedures to be used and installation standards to be achieved.

.4 Qualifications:

.1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements .

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25 .

.2 Maximum smoke developed rating: 50 .

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Maximum "k" factor: ASTM C547.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C547.

.5 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: ASTM C553.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C553.

.6 TIAC Code A.6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket .

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor.

.4 Certified by manufacturer free of potential stress corrosion cracking corrodents.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: ASTM C533.

.2 Maximum "k" factor: ASTM C533.

.3 Design to permit periodic removal and re-installation.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C449/C449M.

.2 Hydraulic setting Air drying on mineral wool, to ASTM C449.

2.4 JACKETS

.1 Canvas:

.1 ~~120~~ **220** gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

~~.2 Lagging adhesive: compatible with insulation.~~

.2 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: smooth .

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, reinforced , 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on on one face of insulation with expanded metal lath on other face of insulation .

.7 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Hot equipment: To TIAC code 1503-H.

.2 Cold equipment: to TIAC code 1503-C.

.2 Elastomeric Insulation:to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints , valves , primary flow measuring elements flanges and unions at equipment .

.2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 ~~FIRE SUPPRESSION~~ EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Hot Equipment:

.1 TIAC code A-1 with mechanical fastenings wire bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC code C-2 unfaced with wire bands and 13 mm cement precede by one layer of reinforcing mesh.

.3 Thicknesses:

Domestic hot water storage tanks 25 mm **(TIAC Code A-2)**
Heat exchangers 50 mm **(TIAC Code A-2)**
Steam condensate receivers 50 mm **(TIAC Code A-2)**
Deaerator-feedwater heaters 50 mm **(TIAC Code A-2)**

.3 Steam relief vents:

.1 TIAC code A-2 with 25 mm air gap, mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh.

.4 Cold equipment:

.1 TIAC A-3 with mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC C-2 faced with vapour retardant jacket and with wire bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 Thicknesses: chillers (except factory insulated) 50 mm.

.5 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with canvas jacket.

.2 Equipment elsewhere: TIAC code CEF/2 with canvas jacket.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning .

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

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.8 ASTM C921- 03a , Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168- A2005 , Adhesive and Sealant Applications.

.5 Thermal Insulation Association of Canada (TIAC)

.1 National Insulation Standards 2005 .

.6 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102- 07 , Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures .

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.

.3 Manufacturer's Instructions:

.1 Include procedures to be used and installation standards to be achieved.

.4 Qualifications:

.1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements .

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25 .

.2 Maximum smoke developed rating: 50 .

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Maximum "k" factor: ASTM C547.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C547.

.5 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: ASTM C553.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C553.

.6 TIAC Code A.6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket .

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor.

.4 Certified by manufacturer free of potential stress corrosion cracking corrodents.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: ASTM C533.

.2 Maximum "k" factor: ASTM C533.

.3 Design to permit periodic removal and re-installation.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C449/C449M.

.2 Hydraulic setting Air drying on mineral wool, to ASTM C449.

2.4 JACKETS

.1 Canvas:

.1 ~~120~~ **220** gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

~~.2 Lagging adhesive: compatible with insulation.~~

.2 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: smooth .

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, reinforced , 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on on one face of insulation with expanded metal lath on other face of insulation .

.7 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Hot equipment: To TIAC code 1503-H.

.2 Cold equipment: to TIAC code 1503-C.

.2 Elastomeric Insulation:to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints , valves , primary flow measuring elements flanges and unions at equipment .

.2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 ~~FIRE SUPPRESSION~~ EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Hot Equipment:

.1 TIAC code A-1 with mechanical fastenings wire bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC code C-2 unfaced with wire bands and 13 mm cement precede by one layer of reinforcing mesh.

.3 Thicknesses:

Domestic hot water storage tanks 25 mm **(TIAC Code A-2)**
Heat exchangers 50 mm **(TIAC Code A-2)**
Steam condensate receivers 50 mm **(TIAC Code A-2)**
Deaerator-feedwater heaters 50 mm **(TIAC Code A-2)**

.3 Steam relief vents:

.1 TIAC code A-2 with 25 mm air gap, mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh.

.4 Cold equipment:

.1 TIAC A-3 with mechanical fastenings and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC C-2 faced with vapour retardant jacket and with wire bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 Thicknesses: chillers (except factory insulated) 50 mm.

.5 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with canvas jacket.

.2 Equipment elsewhere: TIAC code CEF/2 with canvas jacket.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning .

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE Standard 90.1-[01], Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM B209M-[04], Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate [Metric].

.2 ASTM C335-[04], Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-[04], Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-[00], Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533-[2004], Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547-[2003], Mineral Fiber Pipe Insulation.

.7 ASTM C795-[03], Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-[03a], Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-[89], Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53-[95], Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-[03], Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-[01], Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702-[1997], Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2-[03], Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.2 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 NRC Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

.3 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility approved by NRC Departmental Representative.

.4 Dispose of unused adhesive material at official hazardous material collections site approved by NRC Departmental Representative.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM E 84.

.2 TIAC Code A-1: rigid moulded inorganic glass fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S102-M88.

.2 Maximum "k" factor: to CAN/ULC-S102-M88.

.3 Equivalent to Knauf 1000°

.3 TIAC Code A-3: rigid moulded inorganic glass fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S102-M88.

.2 Maximum "k" factor: to CAN/ULC-S102-M88.

.3 Equivalent to Knauf 1000°

.4 TIAC Code C-2: rigid moulded inorganic glass fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S102-M88.

.2 Maximum "k" factor: to CAN/ULC-S102-M88.

.3 Equivalent to Knauf 1000°

.5 TIAC Code A-6: flexible closed cell fiber-free tubular elastomeric foam.

.1 Insulation: shall conform to minimum requirements in ASTM C534

.2 Maximum "k" factor: 0.04 W/mK., to ASTM C 177 or C518

.3 All locations, PVC jacketing.

.4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.5 Equivalent to AP Armaflex or nOMACO Flex Therm

.6 Produce application to conform to: “NOMACO THERMAL INSULATION SPECIFICATION GUIDE FOR REFRIGERATION SYSTEMS”

.6 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Maximum "k" factor: 0.059 W/mK to ASTM C 177.

.3 Design to permit periodic removal and re-installation.

.4 Equivalent to Industrial Insulation Group Thermo 12 Gold

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: NRC Departmental Representative.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.2 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

.3 Canvas

.1 ULC listed plain weave cotton fabric

.2 Weight: 220 gm/m^2

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Type 6 Flex Cell insulation to be operationally tested and inspected prior to installing jacketing.

.3 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.

.2 Design: to permit movement of expansion joint to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

.1 Continuous formed (not Self-Seal)

.2 Seals: lap seal adhesive, lagging adhesive.

.5 TIAC Code: C-2 with vapour retarder jacket.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 and over
Steam, Saturated and Super heated	Upto 175 over 175	[A-1] [A-1]	38 38	50 65	65 65	75 75	90 90	90 90
Condensate Return	60 - 94	[A-1]	25	38	38	38	38	38

Pumped Condensate return	up to 94	[A-1]	25	38	38	38	38	38
Boiler Feed Water		[A-1]	25	25	25	25	25	25
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38	38
Glycol Heating	60 - 94	[A-1]	25	38	38	38	38	38
Glycol Heating	up to 59	[A-1]	25	25	25	25	38	38
Domestic HWS		[A-1]	25	25	25	38	38	38
Chilled Water	4 - 13	[A-3]	25	25	25	25	25	25
Chilled Water or Glycol	below 4	[A-6]	38	38	38	38	38	38
Chilled Water Pump Casing		[A-3]	25	25	25	25	25	25
Condenser Water Outdoors		[A-3]	25	25	25	25	25	25
Condenser Water Indoors		[A-3]	25	25	25	25	25	25
Refrigerated Drinking Water		[A-3]	25	25	25	25	25	25
Domestic CWS		[A-3]	25	25	25	25	25	25
Domestic CWS with vapour retarder		[C-2]	25	25	25	25	25	25
Refrigerant[hot gas] [liquid] [suction]	4 - 13	[A-6]	25	25	25	25	25	25
Refrigerant[hot gas] [liquid] [suction]	below 4	[A-6]	25	25	38	38	38	38
RWL and RWP		[C-2]	25	25	25	25	25	25

Cooling Coil cond. drain		[C-2]	25	25	25	25	25	25

.8 Finishes:

.1 Exposed indoors: ~~PVC~~ **Canvas** jacket.

.2 Exposed in mechanical rooms: ~~PVC~~ **Canvas** jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum jacket.

.6 Finish attachments: SS bands, at 150 mm on centre. Seals: wing.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE Standard 90.1-[01], Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM B209M-[04], Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate [Metric].

.2 ASTM C335-[04], Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-[04], Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-[00], Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533-[2004], Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547-[2003], Mineral Fiber Pipe Insulation.

.7 ASTM C795-[03], Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-[03a], Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-[89], Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53-[95], Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-[03], Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-[01], Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702-[1997], Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2-[03], Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.2 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 NRC Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

.3 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility approved by NRC Departmental Representative.

.4 Dispose of unused adhesive material at official hazardous material collections site approved by NRC Departmental Representative.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM E 84.

.2 TIAC Code A-1: rigid moulded inorganic glass fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S102-M88.

.2 Maximum "k" factor: to CAN/ULC-S102-M88.

.3 Equivalent to Knauf 1000°

.3 TIAC Code A-3: rigid moulded inorganic glass fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S102-M88.

.2 Maximum "k" factor: to CAN/ULC-S102-M88.

.3 Equivalent to Knauf 1000°

.4 TIAC Code C-2: rigid moulded inorganic glass fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S102-M88.

.2 Maximum "k" factor: to CAN/ULC-S102-M88.

.3 Equivalent to Knauf 1000°

.5 TIAC Code A-6: flexible closed cell fiber-free tubular elastomeric foam.

.1 Insulation: shall conform to minimum requirements in ASTM C534

.2 Maximum "k" factor: 0.04 W/mK., to ASTM C 177 or C518

.3 All locations, PVC jacketing.

.4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.5 Equivalent to AP Armaflex or nOMACO Flex Therm

.6 Produce application to conform to: “NOMACO THERMAL INSULATION SPECIFICATION GUIDE FOR REFRIGERATION SYSTEMS”

.6 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Maximum "k" factor: 0.059 W/mK to ASTM C 177.

.3 Design to permit periodic removal and re-installation.

.4 Equivalent to Industrial Insulation Group Thermo 12 Gold

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

.1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type [and sheet] to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: NRC Departmental Representative.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.2 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

.3 Canvas

.1 ULC listed plain weave cotton fabric

.2 Weight: 220 gm/m^2

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Type 6 Flex Cell insulation to be operationally tested and inspected prior to installing jacketing.

.3 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.

.2 Design: to permit movement of expansion joint to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

.1 Continuous formed (not Self-Seal)

.2 Seals: lap seal adhesive, lagging adhesive.

.5 TIAC Code: C-2 with vapour retarder jacket.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 and over
Steam, Saturated and Super heated	Upto 175 over 175	[A-1] [A-1]	38 38	50 65	65 65	75 75	90 90	90 90
Condensate Return	60 - 94	[A-1]	25	38	38	38	38	38

Pumped Condensate return	up to 94	[A-1]	25	38	38	38	38	38
Boiler Feed Water		[A-1]	25	25	25	25	25	25
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38	38
Glycol Heating	60 - 94	[A-1]	25	38	38	38	38	38
Glycol Heating	up to 59	[A-1]	25	25	25	25	38	38
Domestic HWS		[A-1]	25	25	25	38	38	38
Chilled Water	4 - 13	[A-3]	25	25	25	25	25	25
Chilled Water or Glycol	below 4	[A-6]	38	38	38	38	38	38
Chilled Water Pump Casing		[A-3]	25	25	25	25	25	25
Condenser Water Outdoors		[A-3]	25	25	25	25	25	25
Condenser Water Indoors		[A-3]	25	25	25	25	25	25
Refrigerated Drinking Water		[A-3]	25	25	25	25	25	25
Domestic CWS		[A-3]	25	25	25	25	25	25
Domestic CWS with vapour retarder		[C-2]	25	25	25	25	25	25
Refrigerant[hot gas] [liquid] [suction]	4 - 13	[A-6]	25	25	25	25	25	25
Refrigerant[hot gas] [liquid] [suction]	below 4	[A-6]	25	25	38	38	38	38
RWL and RWP		[C-2]	25	25	25	25	25	25

Cooling Coil cond. drain		[C-2]	25	25	25	25	25	25

.8 Finishes:

.1 Exposed indoors: ~~PVC~~ **Canvas** jacket.

.2 Exposed in mechanical rooms: ~~PVC~~ **Canvas** jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum jacket.

.6 Finish attachments: SS bands, at 150 mm on centre. Seals: wing.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 The most current version of the following codes are to be followed.

.2 American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

.1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings: Class 25, 125, 250 and 800.

.2 ASME B16.25, Buttwelding Ends.

.3 ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.

.4 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS through 24.

.5 ANSI/ASME B16.9, Factory-Made Wrought Steel Buttwelding Fittings.

.6 ANSI B18.2.1, Square and Hex Bolts and Screws (Inch Series).

.7 ANSI/ASME B18.2.2, Square and Hex Nuts (Inch Series).

.3 American National Standards Institute (ANSI) / American Water Works Association (AWWA)

.1 ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 ASTM International Inc.

.1 ASTM A47/A47M , Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M , Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM A126- , Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.5 Canadian Standards Association (CSA International)

.1 CSA W48- , Filler Metals and Allied Materials for Metal Arc Welding.

.6 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

.1 MSS-SP-70- , Cast Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS-SP-71- , Gray Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS-SP-80- , Bronze Gate, Globe, Angle and Check Valves.

.4 MSS-SP-85- , Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures .

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for valves and pipes and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:

.1 Special servicing requirements .

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements .

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .

1.5 EXTRA MATERIALS

.1 Extra Stock Materials:

.1 Provide spare parts as follows:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every ten flanges.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B , as follows:

.1 Steam;

.1 Schedule 40 seamless to ASTM A 106/A106M.

.2 Condensate:

.1 Schedule 80 ASTM A 53/A53M

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings with lead-free dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48 .

.3 Flanges: plain or raised face. Flange gaskets to ANSI/AWWA C111/A21.11 .

.4 Pipe thread: taper.

.5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1 .

.6 Buttwelding ends: to ANSI/ASME B16.28 .

2.3 FITTINGS-STEAM

.1 Screwed fittings: malleable iron to ASME B16.3, Class 150 .

.2 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.

.3 Buttwelding fittings: steel to ANSI/ASME B16.9.

.4 Unions: malleable iron, to ASME B16.3 .

2.4 FITTINGS-CONDENSATE

.1 Screwed fittings: 2000#, 3000# ASME B16.11/ASTM A105.

.2 Socket weld: 3000#, 6000# ASME B16.11/ASTM A105.

.3 Buttwelding fittings: Schedule 80 ASME B16.9/ASTM A234

2.5 VALVES

.1 Connections:

.1 NPS 2 and smaller: screwed ends.

.2 NPS 2 1/2 and larger:

.1 Equipment: Flanged ends.

.2 Elsewhere: Flanged ends.

.2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines .

.1 NPS 2 and under:

.1 Class 125 , rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves-Bronze .

.2 NPS 2 1/2 -8:

.1 Class 150 , rising stem, split wedge disc, cast iron, bronze trim, as specified Section ~~23 05 23.02 - Valves - Cast Iron~~ **23 05 23.03 Valves – Cast steel**.

.3 Globe valves: Application: Steam service, throttling, flow control, emergency bypass .

.1 NPS 2 and under:

.1 with PFTE disc as specified Section 23 05 23.01 - Valves - Bronze .

.2 NPS 2 1/2 and over:

.1 With composition bronze disc, cast iron with bronze trim, to Section ~~23 05 23.02 - Valves - Cast Iron~~ **23 05 23.03 Valves – Cast steel**.

.4 Gate valves: Application: pumped gravity condensate return service, steam drip point assemblies .

.1 NPS 2 and under:

.1 To BS 5154A: Class 125 , rising stem, plug valve, as specified Section 23 05 23.01 - Valves-Bronze .

.2 Elsewhere : Class 125 , non- rising stem, solid wedge disc, Bronze body/stainless steel/seat.

.3 Spirax Sarco HV3 stop valve or equivalent

.5 Drain valves: Gate, Class 125 , non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze .

.6 Bypass valves around large size control valves to be line size class 150 ANSI 150 stainless steel seat.

.1 Spirax Sarco BSA3T bellows sealed stop valve or equivalent.

.7 Lift check valves:

.1 NPS 2 and under: Class 125 , lift, with composition disc.

.1 Bronze Spirax Sarco LCV1 or equivalent.

.2 NPS 2 1/2 and over: ANSI 150 Stainless steel Spirax Sarco DCV4 wafer check valve or equivalent.

2.6 VALVE OPERATORS

.1 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms Mechanical Equipment rooms .

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PIPING

.1 Install pipework in accordance with Section 23 05 05 - Installation of Pipework , supplemented as specified below .

.2 Connect branch lines into top of mains.

.3 Install piping in direction of flow with slopes as follows, unless indicated:

.1 Steam: 1:240 .

.2 Condensate return: 1:70 .

.4 Make provision for thermal expansion as indicated and in accordance with manufacturer’s recommendations.

.5 Drip pocket: line size.

3.3 VALVES

.1 Bypass lines and valves: line size.

3.4 TESTING

.1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical .

.2 Test pressure: 1-1/2 times maximum system operating pressure or 860 kPa whichever is greater.

3.5 SYSTEM START-UP

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems .

3.6 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems supplemented as specified herein.

.2 Timing, only after:

.1 Pressure tests successfully completed.

.2 Flushing as specified has been completed.

.3 Water treatment system has been commissioned.

.3 PV Procedures:

.1 Verify complete drainage of condensate from steam coils.

.2 Verify proper operation of system components, including, but not limited to:

.1 Steam traps - verify no blow-by.

.2 Flash tanks.

.3 Thermostatic vents.

.4 Vacuum breakers

.3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.

.1 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly , shut down system, add pipe guides as required, re-align, repeat start-up procedures.

.4 Condensate pumping units: for commissioning procedures, refer to Section 01 91 13 - General Commissioning (Cx) Requirements .

3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning .

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 The most current version of the following codes are to be followed.

.2 American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

.1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings: Class 25, 125, 250 and 800.

.2 ASME B16.25, Buttwelding Ends.

.3 ASME B16.3, Malleable Iron Threaded Fittings: Classes 150 and 300.

.4 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS through 24.

.5 ANSI/ASME B16.9, Factory-Made Wrought Steel Buttwelding Fittings.

.6 ANSI B18.2.1, Square and Hex Bolts and Screws (Inch Series).

.7 ANSI/ASME B18.2.2, Square and Hex Nuts (Inch Series).

.3 American National Standards Institute (ANSI) / American Water Works Association (AWWA)

.1 ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 ASTM International Inc.

.1 ASTM A47/A47M , Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M , Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM A126- , Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.5 Canadian Standards Association (CSA International)

.1 CSA W48- , Filler Metals and Allied Materials for Metal Arc Welding.

.6 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

.1 MSS-SP-70- , Cast Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS-SP-71- , Gray Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS-SP-80- , Bronze Gate, Globe, Angle and Check Valves.

.4 MSS-SP-85- , Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures .

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for valves and pipes and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.3 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:

.1 Special servicing requirements .

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements .

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal .

1.5 EXTRA MATERIALS

.1 Extra Stock Materials:

.1 Provide spare parts as follows:

.1 Valve seats: one for every ten valves, each size. Minimum one.

.2 Discs: one for every ten valves, each size. Minimum one.

.3 Stem packing: one for every ten valves, each size. Minimum one.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every ten flanges.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B , as follows:

.1 Steam;

.1 Schedule 40 seamless to ASTM A 106/A106M.

.2 Condensate:

.1 Schedule 80 ASTM A 53/A53M

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings with lead-free dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48 .

.3 Flanges: plain or raised face. Flange gaskets to ANSI/AWWA C111/A21.11 .

.4 Pipe thread: taper.

.5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1 .

.6 Buttwelding ends: to ANSI/ASME B16.28 .

2.3 FITTINGS-STEAM

.1 Screwed fittings: malleable iron to ASME B16.3, Class 150 .

.2 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.

.3 Buttwelding fittings: steel to ANSI/ASME B16.9.

.4 Unions: malleable iron, to ASME B16.3 .

2.4 FITTINGS-CONDENSATE

.1 Screwed fittings: 2000#, 3000# ASME B16.11/ASTM A105.

.2 Socket weld: 3000#, 6000# ASME B16.11/ASTM A105.

.3 Buttwelding fittings: Schedule 80 ASME B16.9/ASTM A234

2.5 VALVES

.1 Connections:

.1 NPS 2 and smaller: screwed ends.

.2 NPS 2 1/2 and larger:

.1 Equipment: Flanged ends.

.2 Elsewhere: Flanged ends.

.2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines .

.1 NPS 2 and under:

.1 Class 125 , rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves-Bronze .

.2 NPS 2 1/2 -8:

.1 Class 150 , rising stem, split wedge disc, cast iron, bronze trim, as specified Section ~~23 05 23.02 - Valves - Cast Iron~~ **23 05 23.03 Valves – Cast steel**.

.3 Globe valves: Application: Steam service, throttling, flow control, emergency bypass .

.1 NPS 2 and under:

.1 with PFTE disc as specified Section 23 05 23.01 - Valves - Bronze .

.2 NPS 2 1/2 and over:

.1 With composition bronze disc, cast iron with bronze trim, to Section ~~23 05 23.02 - Valves - Cast Iron~~ **23 05 23.03 Valves – Cast steel**.

.4 Gate valves: Application: pumped gravity condensate return service, steam drip point assemblies .

.1 NPS 2 and under:

.1 To BS 5154A: Class 125 , rising stem, plug valve, as specified Section 23 05 23.01 - Valves-Bronze .

.2 Elsewhere : Class 125 , non- rising stem, solid wedge disc, Bronze body/stainless steel/seat.

.3 Spirax Sarco HV3 stop valve or equivalent

.5 Drain valves: Gate, Class 125 , non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze .

.6 Bypass valves around large size control valves to be line size class 150 ANSI 150 stainless steel seat.

.1 Spirax Sarco BSA3T bellows sealed stop valve or equivalent.

.7 Lift check valves:

.1 NPS 2 and under: Class 125 , lift, with composition disc.

.1 Bronze Spirax Sarco LCV1 or equivalent.

.2 NPS 2 1/2 and over: ANSI 150 Stainless steel Spirax Sarco DCV4 wafer check valve or equivalent.

2.6 VALVE OPERATORS

.1 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms Mechanical Equipment rooms .

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PIPING

.1 Install pipework in accordance with Section 23 05 05 - Installation of Pipework , supplemented as specified below .

.2 Connect branch lines into top of mains.

.3 Install piping in direction of flow with slopes as follows, unless indicated:

.1 Steam: 1:240 .

.2 Condensate return: 1:70 .

.4 Make provision for thermal expansion as indicated and in accordance with manufacturer’s recommendations.

.5 Drip pocket: line size.

3.3 VALVES

.1 Bypass lines and valves: line size.

3.4 TESTING

.1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical .

.2 Test pressure: 1-1/2 times maximum system operating pressure or 860 kPa whichever is greater.

3.5 SYSTEM START-UP

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems .

3.6 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems supplemented as specified herein.

.2 Timing, only after:

.1 Pressure tests successfully completed.

.2 Flushing as specified has been completed.

.3 Water treatment system has been commissioned.

.3 PV Procedures:

.1 Verify complete drainage of condensate from steam coils.

.2 Verify proper operation of system components, including, but not limited to:

.1 Steam traps - verify no blow-by.

.2 Flash tanks.

.3 Thermostatic vents.

.4 Vacuum breakers

.3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.

.1 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly , shut down system, add pipe guides as required, re-align, repeat start-up procedures.

.4 Condensate pumping units: for commissioning procedures, refer to Section 01 91 13 - General Commissioning (Cx) Requirements .

3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning .

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 The most current versions of the following codes are to be followed.

.2 American Society for Mechanical Engineers (ASME International)

.3 ASTM International Inc.

.1 ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

.3 ASTM A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.

.4 ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.5 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.

.6 ASTM A278/A278M, Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).

.7 ASTM A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

.8 ASTM A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

.9 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature Canadian Registration Number (CRN), and datasheets for steam traps, vacuum breakers, pressure reducing valves, air vents, safety relief valves, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:

.1 Special servicing requirements.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Cast steel: to ASTM A216/A216M.

.2 Cast iron: to ASTM A278, Class 300.

.3 Bronze: to ASTM B62.

.4 Stainless steel: to ASTM A351/A351M.

2.2 FLOAT AND THERMOSTATIC STEAM TRAPS 0-206 KPA

.1 Application: for modulating steam service on heating coils, heat exchangers, unit heaters, steam mains to 206 kPa.

.2 Materials: body - cast iron; valve - stainless steel thermostatic type with stainless steel seat; float and mechanisms - stainless steel; air vent – stainless steel.

.3 Spirax sarco FT14 or equivalent.

2.3 INVERTED BUCKET STEAM TRAPS 0-1724 KPA

.1 Application: distribution main drip points.

.2 Material: ASTM A48 Cast Iron

.3 The trap shall employ a simple free floating stainless steel valve mechanism with no fixed pivots and no valve or bucket guides.

.4 The discharge valve shall be attached to the valve lever to be free to rotate for even wear distribution, and the valve and seat of the trap shall be lapped together as a matched as a matched set to insure tight shutoff.

.5 The piping configuration for the trap shall be side inlet/side outlet.

2.4 BALANCED PRESSURE THERMOSTATIC STEAM TRAPS 0-700 KPA

.1 Application: for modulating steam services on radiators as listed:

.2 Materials: body, union and cap – brass, valve, head and renewable seat - stainless steel; inlet with heavy brass union.

.3 Spirax Sarco BPT13

2.5 VACUUM BREAKERS 0.85-68 KPA

.1 Application: on inlets to steam coils, heat exchangers and as indicated.

.2 Materials: body and cap – brass; valve - stainless steel; valve seat - stainless steel; gasket-stainless steel.

.3 Spirax Sarco VB14.

2.6 PRESSURE REDUCING VALVE -PNEUMATICALLY OPERATED

.1 Location: as indicated.

.2 Pneumatic positioner operated, single seat, spring and diaphragm operated, with filter and internal relief.

.3 Connections:

.1 Under NPS 2: screwed ends.

.2 NPS 2-1/2 and over: flanged ends.

.4 Main valve:

.1 Body: WCC steel.

.2 Diaphragm: NBR

.3 Seat rings: stainless steel to S41600.

.4 Valve plug: stainless steel to S41600.

.5 Stem: stainless steel to S31600SST.

.6 Spring: carbon steel.

.7 Bolting: carbon steel.

.5 690 to 345kPa Service: NPS 1 Fischer EZ 657 Size 30 358255 or equivalent

.6 345 to 1033 kPa service: NPS 1.5 Fischer EZ Size 30 3582 or equivalent.

2.7 SAFETY AND RELIEF VALVES

.1 Spring loaded with open bonnet and easing lever and ASME code.

.2 Material: body -cast iron to ANSI 250. Flanged inlet, 250 psig max pressure 446 ^{o}F max temperature.

.3 Spirax Sarco SV73.

2.8 DRIP PAN ELBOWS

.1 Application: on discharge of steam safety relief valves and as indicated.

.2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.9 PIPE LINE STRAINERS UP TO NPS 2

.1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.

.2 Working pressure: 860 kPa.

.3 Body: cast iron.

.4 Connections: screwed.

.5 Screen: stainless steel with 0.8 mm perforations.

.6 Spirax Sarco CT.

2.10 PIPE LINE STRAINERS NPS 2-1/2 AND OVER

.1 Application: ahead of condensate pumps, steam traps, control valves and as indicated.

.2 Working pressure: 860 kPa.

.3 Body: cast iron. Baffle type

.4 Connections: flanged.

.5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.

.6 Screen: stainless steel with 3.2 mm perforations.

.7 Spirax Sarco IT, CI-250, F-250.

~~**2.11 FLASH TANKS**~~

~~.1 Locations: as indicated.~~

~~.2 Tanks: vertical type with flanged drop tube connections.~~

~~.3 Construction: to ASME code.~~

~~.4 Maximum working pressure: 860 kPa.~~

~~.5 Connections: NPS 2 and under, screwed; NPS 2 1/2 and over, flanged.~~

~~.6 Finish: prime coated.~~

~~.7 Supports: vertical legs for vertical tank; saddles for horizontal tank.~~

~~2.12~~2.11 CONDENSATE RECEIVERS

.1 Packaged factory assembled and wired unit.

.2 Two-pole level controls with stainless steel float and float rod, doublebreak silver-to-silver contacts, drip proof case.

.3 Receiver: cast iron, 15 gallon

.4 Volute: Cast iron

.5 Seal plate: cast iron

.6 Impeller: non-ferrous material

.7 Mechanical seal: JohnCrane type 6 or equal, ceramic and phenolic bonded carbon graphite seal faces

.8 Casing gasket: cellulose fibre chloroprene

.9 Close coupled motor: cast iron, 1/3 hp, 115V ODP, 12 gpm, permanently grease lubricated shielded ball bearings, threaded stainless steel shaft. Capacitor start, induction run, built-in thermal overload protection with automatic reset.

.10 Armstrong FHC series

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

.1 Install as indicated.

.2 Ensure clearance for removal of basket.

.3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

.1 Pipe to atmosphere independent of other vents and in accordance with applicable code.

.2 Support discharge pipe against reaction forces and to take up thermal movement.

.3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

.1 Install unions on inlet and outlet.

3.5 PRESSURE REDUCING VALVES

.1 Install on 3-valve bypass with strainer on inlet.

.2 Pipe as indicated. Follow manufacturer's installation instructions.

~~**3.6 FLASH TANKS**~~

~~.1 Pipe arrangement as indicated.~~

~~3.7~~3.6 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

~~3.8~~3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 The most current versions of the following codes are to be followed.

.2 American Society for Mechanical Engineers (ASME International)

.3 ASTM International Inc.

.1 ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

.3 ASTM A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.

.4 ASTM A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

.5 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.

.6 ASTM A278/A278M, Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).

.7 ASTM A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

.8 ASTM A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

.9 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature Canadian Registration Number (CRN), and datasheets for steam traps, vacuum breakers, pressure reducing valves, air vents, safety relief valves, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:

.1 Special servicing requirements.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Cast steel: to ASTM A216/A216M.

.2 Cast iron: to ASTM A278, Class 300.

.3 Bronze: to ASTM B62.

.4 Stainless steel: to ASTM A351/A351M.

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.1 Application: for modulating steam service on heating coils, heat exchangers, unit heaters, steam mains to 206 kPa.

.2 Materials: body - cast iron; valve - stainless steel thermostatic type with stainless steel seat; float and mechanisms - stainless steel; air vent – stainless steel.

.3 Spirax sarco FT14 or equivalent.

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.1 Application: distribution main drip points.

.2 Material: ASTM A48 Cast Iron

.3 The trap shall employ a simple free floating stainless steel valve mechanism with no fixed pivots and no valve or bucket guides.

.4 The discharge valve shall be attached to the valve lever to be free to rotate for even wear distribution, and the valve and seat of the trap shall be lapped together as a matched as a matched set to insure tight shutoff.

.5 The piping configuration for the trap shall be side inlet/side outlet.

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.1 Application: for modulating steam services on radiators as listed:

.2 Materials: body, union and cap – brass, valve, head and renewable seat - stainless steel; inlet with heavy brass union.

.3 Spirax Sarco BPT13

2.5 VACUUM BREAKERS 0.85-68 KPA

.1 Application: on inlets to steam coils, heat exchangers and as indicated.

.2 Materials: body and cap – brass; valve - stainless steel; valve seat - stainless steel; gasket-stainless steel.

.3 Spirax Sarco VB14.

2.6 PRESSURE REDUCING VALVE -PNEUMATICALLY OPERATED

.1 Location: as indicated.

.2 Pneumatic positioner operated, single seat, spring and diaphragm operated, with filter and internal relief.

.3 Connections:

.1 Under NPS 2: screwed ends.

.2 NPS 2-1/2 and over: flanged ends.

.4 Main valve:

.1 Body: WCC steel.

.2 Diaphragm: NBR

.3 Seat rings: stainless steel to S41600.

.4 Valve plug: stainless steel to S41600.

.5 Stem: stainless steel to S31600SST.

.6 Spring: carbon steel.

.7 Bolting: carbon steel.

.5 690 to 345kPa Service: NPS 1 Fischer EZ 657 Size 30 358255 or equivalent

.6 345 to 1033 kPa service: NPS 1.5 Fischer EZ Size 30 3582 or equivalent.

2.7 SAFETY AND RELIEF VALVES

.1 Spring loaded with open bonnet and easing lever and ASME code.

.2 Material: body -cast iron to ANSI 250. Flanged inlet, 250 psig max pressure 446 ^{o}F max temperature.

.3 Spirax Sarco SV73.

2.8 DRIP PAN ELBOWS

.1 Application: on discharge of steam safety relief valves and as indicated.

.2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.9 PIPE LINE STRAINERS UP TO NPS 2

.1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.

.2 Working pressure: 860 kPa.

.3 Body: cast iron.

.4 Connections: screwed.

.5 Screen: stainless steel with 0.8 mm perforations.

.6 Spirax Sarco CT.

2.10 PIPE LINE STRAINERS NPS 2-1/2 AND OVER

.1 Application: ahead of condensate pumps, steam traps, control valves and as indicated.

.2 Working pressure: 860 kPa.

.3 Body: cast iron. Baffle type

.4 Connections: flanged.

.5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.

.6 Screen: stainless steel with 3.2 mm perforations.

.7 Spirax Sarco IT, CI-250, F-250.

~~**2.11 FLASH TANKS**~~

~~.1 Locations: as indicated.~~

~~.2 Tanks: vertical type with flanged drop tube connections.~~

~~.3 Construction: to ASME code.~~

~~.4 Maximum working pressure: 860 kPa.~~

~~.5 Connections: NPS 2 and under, screwed; NPS 2 1/2 and over, flanged.~~

~~.6 Finish: prime coated.~~

~~.7 Supports: vertical legs for vertical tank; saddles for horizontal tank.~~

~~2.12~~2.11 CONDENSATE RECEIVERS

.1 Packaged factory assembled and wired unit.

.2 Two-pole level controls with stainless steel float and float rod, doublebreak silver-to-silver contacts, drip proof case.

.3 Receiver: cast iron, 15 gallon

.4 Volute: Cast iron

.5 Seal plate: cast iron

.6 Impeller: non-ferrous material

.7 Mechanical seal: JohnCrane type 6 or equal, ceramic and phenolic bonded carbon graphite seal faces

.8 Casing gasket: cellulose fibre chloroprene

.9 Close coupled motor: cast iron, 1/3 hp, 115V ODP, 12 gpm, permanently grease lubricated shielded ball bearings, threaded stainless steel shaft. Capacitor start, induction run, built-in thermal overload protection with automatic reset.

.10 Armstrong FHC series

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

.1 Install as indicated.

.2 Ensure clearance for removal of basket.

.3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

.1 Pipe to atmosphere independent of other vents and in accordance with applicable code.

.2 Support discharge pipe against reaction forces and to take up thermal movement.

.3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

.1 Install unions on inlet and outlet.

3.5 PRESSURE REDUCING VALVES

.1 Install on 3-valve bypass with strainer on inlet.

.2 Pipe as indicated. Follow manufacturer's installation instructions.

~~**3.6 FLASH TANKS**~~

~~.1 Pipe arrangement as indicated.~~

~~3.7~~3.6 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

~~3.8~~3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International

.1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

.3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Green Seal Environmental Standards (GS)

.1 GS-36-11, Standard for Adhesives for Commercial Use.

.4 National Fire Protection Association (NFPA)

.1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

.3 IAQ Guideline for Occupied Buildings Under Construction 2007.

.6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.4 Test and Evaluation Reports:

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metal ducts from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section.

.5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed
Zero Leakage Ductwork (round 304 SS)	All welded joints / airtight flanged equipment connections

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

.3 Class C: transverse joints and connections made air tight with gaskets sealant or combination thereof. Longitudinal seams unsealed.

.4 Unsealed seams and joints.

.5 All laboratory ductwork shall be in accordance with SMACNA Seal Class 'A'.

2.2 SEALANT

.1 Sustainability Characteristics:

.1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.

.2 Adhesives and sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.2 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: centreline radius: 1.5 times width of duct.

.2 Round: smooth radius, centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm: with single double thickness turning vanes.

.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full radiused elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to ASHRAE SMACNA. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 STAINLESS STEEL

.1 To ASTM A480/A480M, Type 304.

.2 Finish: number 4.

.3 Thickness, fabrication and reinforcement: to SMACNA as indicated.

.4 Joints: to SMACNA be continuous inert gas welded.

.5 Gasket and flanged equipment connections

2.9 ALUMINUM

.1 To ASHRAE SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA as indicated.

.3 Joints: to ASHRAE SMACNA be continuous weld.

2.10 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with black galvanized steel rods to SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp steel plate washer.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 GENERAL

.1 Do work in accordance with SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA as indicated.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500

3.4 ZERO LEAKAGE

.1 Provide zero leakage all welded stainless steel ductwork and flanged equipment connections for supply and return ducting serving 22-AHU-05 and 22-AHU-06 between bubble tight dampers CD01, 04, 11, 12, 16,17 and air flow stations capped connections within the Flight simulator Lab and the Flexible Cabin Lab.

3.5 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Minimum 3000 mm from duct mounted humidifier in all directions.

.3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and trap primer and discharging to open funnel drain.

3.6 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA.

.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.7 LEAKAGE TESTS

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Do leakage tests in sections.

.4 Zero leakage ductwork testing shall be entire duct segment between bubble tight dampers with all flanged equipment in place and blind flanges at end of runs.

.5 Make trial leakage tests as instructed to demonstrate workmanship.

.6 Do not install additional ductwork until trial test has been passed.

.7 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.8 Complete test before performance insulation or concealment Work.

3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International

.1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

.3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Green Seal Environmental Standards (GS)

.1 GS-36-11, Standard for Adhesives for Commercial Use.

.4 National Fire Protection Association (NFPA)

.1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.

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.3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

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.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.

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.3 IAQ Guideline for Occupied Buildings Under Construction 2007.

.6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.4 Test and Evaluation Reports:

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metal ducts from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section.

.5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed
Zero Leakage Ductwork (round 304 SS)	All welded joints / airtight flanged equipment connections

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

.3 Class C: transverse joints and connections made air tight with gaskets sealant or combination thereof. Longitudinal seams unsealed.

.4 Unsealed seams and joints.

.5 All laboratory ductwork shall be in accordance with SMACNA Seal Class 'A'.

2.2 SEALANT

.1 Sustainability Characteristics:

.1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.

.2 Adhesives and sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.2 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: centreline radius: 1.5 times width of duct.

.2 Round: smooth radius, centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm: with single double thickness turning vanes.

.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full radiused elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.

.2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to ASHRAE SMACNA. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 STAINLESS STEEL

.1 To ASTM A480/A480M, Type 304.

.2 Finish: number 4.

.3 Thickness, fabrication and reinforcement: to SMACNA as indicated.

.4 Joints: to SMACNA be continuous inert gas welded.

.5 Gasket and flanged equipment connections

2.9 ALUMINUM

.1 To ASHRAE SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA as indicated.

.3 Joints: to ASHRAE SMACNA be continuous weld.

2.10 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with black galvanized steel rods to SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp steel plate washer.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 GENERAL

.1 Do work in accordance with SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA as indicated.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500

3.4 ZERO LEAKAGE

.1 Provide zero leakage all welded stainless steel ductwork and flanged equipment connections for supply and return ducting serving 22-AHU-05 and 22-AHU-06 between bubble tight dampers CD01, 04, 11, 12, 16,17 and air flow stations capped connections within the Flight simulator Lab and the Flexible Cabin Lab.

3.5 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Minimum 3000 mm from duct mounted humidifier in all directions.

.3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and trap primer and discharging to open funnel drain.

3.6 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA.

.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.7 LEAKAGE TESTS

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Do leakage tests in sections.

.4 Zero leakage ductwork testing shall be entire duct segment between bubble tight dampers with all flanged equipment in place and blind flanges at end of runs.

.5 Make trial leakage tests as instructed to demonstrate workmanship.

.6 Do not install additional ductwork until trial test has been passed.

.7 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.8 Complete test before performance insulation or concealment Work.

3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

.2 ASTM International

.1 ASTM A653/A653M-09b, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. (Metric).

.3 Canada Green Building Council (CaGBC)

.1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum 2007).

.2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.

.3 LEED Canada 2009 for Design and Construction-2010, LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide.

.4 LEED Canada for Existing Buildings, Operations and Maintenance-2009, LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.

.4 Green Seal Environmental Standards (GS)

.1 GS-36-11, Standard for Adhesives for Commercial Use.

.5 Sheet Metal Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2005.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

.3 SMACNA IAQ Guideline for Occupied Buildings Under Construction, 2007.

.6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.4 Test and Evaluation Reports:

.1 Certification of Ratings:

.1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metal ducts from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DUCTWORK

.1 Material:

.1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.

.2 Thickness: to SMACNA.

.2 Construction: round.

.1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.

.2 Transverse joints up to 900 mm: slip type with tape and sealants.

.3 Transverse joints over 900 mm: Vanstone.

.4 Fittings:

.1 Elbows: smooth radius 5 piece (for 90 degrees) 3 piece (for 45 degrees). Centreline radius: 1.5 x diameter.

.2 Branches: conical transition with conical branch at 45 degrees and 45 degrees elbow.

.3 Construction: rectangular:

.1 Ducts: to SMACNA.

.2 Transverse joints: welded, SMACNA seal Class A and B.

.3 Fittings:

.1 Elbows: smooth radius; centreline radius 1.5 x width of duct. No vanes.

.2 Branches: with conical branch at 45 degrees and 45 degrees elbow.

.4 Fire stopping:

.1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.

.2 Fire stopping material must not distort duct.

2.2 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
2500	A
1500	A
1000	A
750	B

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with gaskets, sealant, tape, or combination thereof.

.3 All laboratory ductwork shall be in accordance with SMACNA Seal Class A.

2.3 SEALANT

.1 Sustainability Characteristics:

.1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.

.2 Adhesives and sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.

.2 Oil resistant, polymer type flame resistant high velocity duct sealing compound.

.1 Temperature range of minus 30 degrees C to plus 93 degrees C.

2.4 TAPE

.1 Tape: polyvinyl treated, open weave fibre glass, 50 mm wide.

2.5 HANGERS AND SUPPORTS

.1 Hangers and supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping Equipment.

.1 Band hangers: use on round and oval ducts up to 500 mm diameter, of same material as duct but next sheet metal thickness heavier than duct.

.2 Trapeze hangers: ducts over 500 mm diameter or longest side, to SMACNA.

.3 Hangers: black steel angle with black steel rods to SMACNA following table.

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp or steel plate washer.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal duct installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 GENERAL

.1 Do work in accordance with SMACNA as indicated.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate band hangers 100 mm beyond insulated duct.

.2 Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA as indicated.

.4 Install breakaway joints in ductwork on sides of fire separation.

3.3 HANGERS

.1 Band hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000

1501 and over	2500

3.4 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.5 LEAKAGE TESTS

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Perform leakage tests in sections.

.4 Perform trial leakage tests, as instructed to demonstrate quality of work.

.5 Do not install additional ductwork until trial tests have been achieved.

.6 Test section minimum of 30 m long with not less than 3 branch takeoffs and two 90 degrees elbows except for zero leakage ductwork.

.7 Complete tests before performing insulation or concealment Work.

.8 Zero leakage ductwork testing shall be entire duct segment between bubble tight dampers with all flanged equipment in place and blind flanges at end of runs.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Air-Conditioning, Heating and Refrigeration Institute (AHRI)

.1 AHRI-550/590-03, Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle.

.2 CSA International

.1 CSA B52-05 SMART, Mechanical Refrigeration Code.

.3 Environment Canada, (EC)/Environmental Protection Services (EPS)

.1 EPS 1/RA/2-1996, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for chillers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate:

.1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.

.2 Wiring as assembled and schematics.

.3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.

.4 Type of refrigerant used.

.4 Sustainable Design Submittals:

.1 Construction Waste Management:

.1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for chillers for incorporation into manual.

.3 Data to include:

.1 Description of equipment giving manufacturers name, model type and year, capacity and serial numbers.

.2 Provide part load performance curves.

.3 Details on operation, servicing and maintenance.

.4 Recommended spare parts list.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect chillers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section.

.5 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan.

Part 2 Products

2.1 GENERAL

.1 Provide complete chiller package including: compressor; evaporator; condenser, motor and motor starter; controls; control centre; piping; wiring; refrigeration and oil change; ready for connection to chilled water circuit and condenser water circuit interlocks, and electric power source, installed in welded steel frame panels and access doors finished to manufacturers standard.

2.2 BUILDING CHILLER 22-CCH-04

.1 Certified ratings based on AHRI 550/590:

.2 UNIT DESCRIPTION

.1 Provide and install as shown on the plans factory-assembled, factory-charged air-cooled scroll compressor packaged chiller. Each chiller shall consist of hermetic tandem scroll compressor sets (total four compressors), brazed plate evaporator, air-cooled condenser section, microprocessor-based control system and all components necessary for controlled unit operation.

.2 Each chiller shall be factory run-tested to verify operation. Operating controls and refrigerant charge shall be checked for proper operation and optimum performance.

.3 DESIGN REQUIREMENTS

.1 Flow Range: The chiller shall have the ability to support variable flow range down to 40% of nominal design (based on AHRI conditions).

.2 Operating Range: The chiller shall have the ability to control leaving chilled fluid temperature from 15F to 65F

.3 General: Provide a complete scroll compressor packaged chiller as specified herein and as shown on the drawings. The unit shall be in accordance with the standards referenced in section 1.02 and any local codes in effect.

.4 Performance: Refer to the schedule of performance on the drawings. The chiller shall be capable of stable operation to a minimum percentage of full load (without hot gas bypass) of 25%. Performance shall be in accordance with AHRI Standard 550/590.

.5 Acoustics: Sound pressure levels for the unit shall not exceed the following specified levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.

.1 63Hz Band: 65dB

.2 125 Hz Band: 64 dB

.3 250 Hz Band: 61 dB

.4 500 Hz Band: 60 dB

.5 1000 Hz Band: 56 dB

.6 2000 Hz Band: 51 dB

.7 4000 Hz Band: 46 dB

.8 8000 Hz Band: 41 dB

.9 Overall dBA: 61dBA

.4 CHILLER COMPONENTS

.1 Compressor

.1 The compressors shall be sealed hermetic, scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on vibration isolator pads. The compressors shall be equipped with an internal module providing compressor protection and communication capability.

.2 Evaporator

.1 The evaporator shall be a compact, high efficiency, dual circuit, brazed plate-to-plate type heat exchanger consisting of parallel stainless steel plates

.2 The evaporator shall be protected with an electric resistance heater (heat trace tape) and insulated with 3/4" (19mm) thick closed-cell polyurethane insulation. This combination shall provide freeze protection down to -20°F (-29°C) ambient air temperature.

.3 The water-side working pressure shall be a minimum of 653 psig (4502 kPa). Vent and drain connections shall be provided in the inlet and outlet chilled water piping by the installing contractor. Evaporators shall be designed and constructed according to, and listed by, Underwriters Laboratories (UL).

.3 Condenser

.1 Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct-drive fan motors. The fans shall be equipped with a heavy-gauge vinyl-coated fan guard. Fan motors shall be TEAO type with permanently lubricated ball bearings, inherent overload protection, three-phase, direct-drive, 1140 rpm. Each fan section shall be partitioned to avoid cross circulation.

.2 Coil shall be all aluminum alloy microchannel design and shall have a series of flat tubes containing multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils shall withstand 1000+ hour acidified synthetic sea water fog (SWAAT) test (ASTM G85-02) at 120°F (49°C) with 0% fin loss and develop no leaks.

.4 Refrigerant Circuit

.1 R410A. Each of the two refrigerant circuits shall include a refrigerant filter-drier, sight glass with moisture indicator, liquid line solenoid valve (no exceptions), expansion valve, and insulated suction line.

.5 Construction

.1 Unit casing and all structural members and rails shall be fabricated of pre-painted or galvanized steel to meet ASTM B117, 500-hour salt spray test.

.6 Control System

.1 A centrally located weatherproof control panel shall contain the field power connection points, control interlock terminals, and control system. Power and starting components shall include factory circuit breaker for fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and two power blocks (one per circuit) for connection to remote, contractor supplied disconnect switches. Hinged access doors shall be lockable. Barrier panels or separate enclosures are required to protect against accidental contact with line voltage when accessing the control system.

.2 Shall include optional single-point connection to a non-fused disconnect switch with through-the-door handle and compressor circuit breakers.

.7 Unit Controller

.1 An advanced DDC microprocessor unit controller with a 5-line by 22-character liquid crystal display provides the operating and protection functions. The controller shall take preemptive limiting action in case of high discharge pressure or low evaporator pressure. The controller shall contain the following features as a minimum:

.2 The unit shall be protected in two ways: (1) by alarms that shut the unit down and require manual reset to restore unit operation and (2) by limit alarms that reduce unit operation in response to some out-of-limit condition. Shut down alarms shall activate an alarm signal.

.8 Shutdown Alarms
- .1 No evaporator water flow (auto-restart)
- .2 Sensor failures
- .3 Low evaporator pressure
- .4 Evaporator freeze protection
- .5 High condenser pressure
- .6 Outside ambient temperature (auto-restart)
- .7 Motor protection system
- .8 Phase voltage protection (Optional)

.9 Limit Alarms
- .1 Condenser pressure stage down, unloads unit at high discharge pressures.
- .2 Low ambient lockout, shuts off unit at low ambient temperatures.
- .3 Low evaporator pressure hold, holds stage #1 until pressure rises.
- .4 Low evaporator pressure unload, shuts off one compressor.

.10 Unit Enable Section
- .1 Enables unit operation from either local keypad, digital input, or BAS

.11 Unit Mode Selection
- .1 Selects standard cooling, ice, glycol, or test operation mode

.12 Analog Inputs:
- .1 Reset of leaving water temperature, 4-20 mA\
- .2 Current Limit

.13 Digital Inputs
- .1 Unit off switch
- .2 Remote start/stop
- .3 Flow switch
- .4 Ice mode switch, converts operation and setpoints for ice production
- .5 Motor protection

.14 Digital Outputs
- .1 Shutdown alarm; field wired, activates on an alarm condition, off when alarm is cleared
- .2 Evaporator pump; field wired, starts pump when unit is set to start

.15 Condenser fan control - The unit controller shall provide control of condenser fans based on compressor discharge pressure.

.16 Building Automation System (BAS) Interface
- .1 Factory mounted DDC controller(s) shall support operation on a BACnet®, Modbus® or LONMARK ® network via one of the data link / physical layers listed below as specified by the successful Building Automation System (BAS) supplier.
- .2 BACnet MS/TP master (Clause 9)
- .3 BACnet IP, (Annex J)
- .4 BACnet ISO 8802-3, (Ethernet)

.5 LONMARK FTT-10A. The unit controller shall be LONMARK® certified.

.6 The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list.

.7 For chillers communicating over a LONMARK network, the corresponding LONMARK eXternal Interface File (XIF) shall be provided with the chiller submittal data.

.8 All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2001). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

.5 OPTIONS AND ACCESSORIES

.1 The following options are to be included:

.1 Hot Gas Bypass: allows unit operation to 10 percent of full load. Includes factory-mounted hot gas bypass valve, solenoid valve, and manual shutoff valve for each circuit. Shall be ready for field piping according to manufacturer instructions.

.2 Ground Fault Protection: Factory installed circuit breaker to protect equipment from damage from line-to-ground fault currents less than those required for conductor protection.

.3 Phase loss with under/over voltage protection and with LED indication of the fault type to guard against compressor motor burnout.

.4 BAS interface module to provide interface with the BACnet MSTP protocol.

.5 The following accessories, if selected, are to be included:

.1 Spring vibration isolators for field installation

.2 Rubber-in-shear vibration isolators for field installation

.3 Factory-mounted thermal dispersion type flow switch

.4 Field-mounted, paddle type, chilled water flow switch field wired to the control panel

.5 Evaporator inlet strainer, 40-mesh with extension pipe and Victaulic couplings (factory mounted or field installed)

.6 115V GFI convenience outlet

2.3 LABS CHILLER 22-CCH-05

.1 Composition

.1 The machine is set-up to manage both hydraulic circuits (evaporator and condenser), allowing operation in cooling and heat pump modes, via cycle reverse on the hydraulic side.

~~.2 Acoustics:~~

~~.1 Sound pressure levels for the unit shall not exceed the following specified levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.~~

~~.1 63Hz Band: 65dB~~

~~.2 125 Hz Band: 64 dB~~

~~.3 250 Hz Band: 61 dB~~

~~.4 500 Hz Band: 60 dB~~

~~.5 1000 Hz Band: 56 dB~~

~~.6 2000 Hz Band: 51 dB~~

~~.7 4000 Hz Band: 46 dB~~

~~.8 8000 Hz Band: 41 dB~~

~~.9 Overall dBA: 61dBA~~

~~.3~~**.2** Refrigerant

.1 Chillers in the NXW range use R410A refrigerant.

~~.4~~**.3** Cooling Circuit

.1 Two cooling circuits, with four high-efficiency scroll type hermetic compressors. Both circuits are served by two compressors in tandem and are independent, thus guaranteeing greater operating safety. At partial loads, every operating compressor works in maximum yield conditions, thus allowing to maximize the efficiency of the entire machine. The unit is dual-circuit on the chiller side and single-circuit on the hydraulic side.

~~.5~~**.4** Description of the cooling circuit

.1 Both circuits are made using copper pipes with welded joints in silver alloy including the following components:

.1 braze welded plate type evaporator and condenser (AISI 316);

.2 thermostatic valve;

.3 dehydrator filter;

.4 liquid indicator;

.5 liquid and pressing line taps;

.6 solenoid valve.

.2 The unit also has a liquid separator placed on the compressor intake for protection against any return of liquid.

.3 Version without condenser. Machines are delivered after being pre-charged.

~~.6~~**.5** Partial Capacity Steps

.1 Four partial capacity steps.

~~.7~~**.6** Thermostatic Valve:

.1 Mechanical thermostatic valve with external equalizer positioned at the exit of the evaporator and bulb sensitive to the intake temperature. Depending on the heat load it modulates the flow of gas, always maintaining the correct heating

level of the intake gas to the compressor. This allows working with minimum temperature of the water produced from 17.6 °F to 39 °F.

~~.8~~**.7** Version

.1 Silenced. Version with acoustic protection covering made with a galvanised sheet steel panel casing covered internally using sound-absorbent material, able to isolate the noise produced by the compressors. This leads to a noise reduction of 6 db(A).

~~.9~~**.8** Support frame

.1 Made in hot galvanized sheet steel with suitable thickness and painted with polyester powders able to resist atmospheric agents through time.

~~.10~~**.9** Compressors

.1 The scroll-type hermetic compressors mounted on the NXW are optimized to work with R410A refrigerant and are distinguished by high efficiency and low power absorption. They are supplied with an electric resistance on the oil sump as standard. The resistance is powered automatically when the unit stops as long as the unit is live. The scroll compressors are moved by 2-pole electric motors cooled by intake gas and are supported by rubber anti-vibration mounts placed at the base. Started depending on plant load requirements, the use of several scroll compressors allows an efficient "step" adjustment of the power distributed by the unit, thus obtaining much more efficient operation at partial loads with greater efficiency with respect to traditional partial load methods. All of this means noteworthy seasonal energy efficiency ratios ESEER, calculated according to Eurovent specifications.

~~.11~~**.10** Thermostatic valve

.1 Standard mechanical thermostatic valve with external equalizer placed at the exit of the evaporator and bulb sensitive to the intake temperature. Depending on the heat load, it modulates the flow of gas, always maintaining the correct heating level of the intake gas to the compressor. This allows to work at a minimum temperature of the water produced at 39 °F.

~~.12~~**.11** Heat exchangers

.1 Standard: Plate type Heat exchangers of the machine are optimized for R410A, made of AISI 316 steel and covered by closed cell expanded elastomeric insulating mattress, Victaulic hydraulic connections, with just one hydraulic circuit and two entry cooling circuits. They respect the PED standards.

~~.13~~**.12** Evaporator side hydronic unit

.1 Heat exchanger has the function of evaporator in summer mode.

~~.14~~**.13** Condenser side hydronic unit

.1 Heat exchanger has the function of condenser in summer mode.

~~.15~~**.14** Protection and safety devices

.1 The following devices are present in the chiller:

.1 High pressure gauge with IP54 protection rate: it blocks the unit if the pressure of the refrigerant exceeds the maximum safety value of 580PSI.

.2 Chiller circuit safety valves calibrated at 653PSI: They intervene by discharging the refrigerant in case of anomalous pressures.

.3 High pressure transducer (one per circuit): allows to view the value of the compressor flow pressure on the microprocessor board display, also causing pre-alarms in case of anomalous work values; it is located in the high pressure side of the chiller circuit.

.4 Low pressure transducer.

.5 Water temperature probes on inlet and outlet to the evaporator and the condenser.

.6 Electric control board access door interlock system.

.7 Compressor magnet circuit-breaker protection.

.8 Power supply voltage check.

.2 Electric Control Board

.1 Contains the power section and the management of controls and safety devices. It is in compliance with the IEC 60204-1 Standard and the Directives regarding electromagnetic compatibility EMC 2004/108/EC and to the LVD (Low Voltage Directive) 2006/95/EC. It is always equipped with a door-lock isolating switch: the electric control board can be accessed by removing the voltage. Act on the opening lever of the control board itself. This lever can be locked using one or more padlocks during maintenance interventions to prevent the machine being powered up accidentally. The control keyboard is located on the door of the control board, which allows the complete control of the appliance.

.3 Power Supply

.1 Three-phase power supply, 575V, 60Hz with magnet circuit breakers.

.4 Electronic adjustment

.1 The electronic adjustment is consists of a control board and a control panel with display. Transducers, loads and alarms are connected to each board. The set program and parameters are memorized permanently on FLASH memory, allowing their storage even in case of lack of power supply. The microprocessor has the following functions:

.1 remote ON/OFF with external contact without voltage;

.2 phases sequence control;

.3 amperometric transformer;

.4 separate control of the individual compressors;

.5 the distributed power adjustment depends on the outlet water temperature (proportional+integral control), complete with “Switching Hysteresis” self-adapting work differential to always ensure the correct work schedule, even with low water flow rate (stand-by between peaks, stand-by between switch off and switch on, minimum operation time etc.);

.6 rotation of the compressors depending on working hours;

.7 PDC “Pull Down Control” system to prevent the activation of power steps when the temperature of the water quickly approaches the set-point; it optimizes machine operation when

working normally and in the presence of load variations, ensuring the best efficiency in all conditions;

.8 "Always Working" function to prevent machine stopping in certain critical conditions, by means of a self-adjustment system;

.9 management of any anomalies by:

.1 alarms display;

.2 historical alarms;

.3 cumulative faults block signal;

.10 differential pressure switch and/or flow meter management;

.11 display of all main sizes regarding the operation of the machine;

.12 the main operation parameters can be changed;

.13 remote control by:

.1 remote panel with the main functions (PGD1 accessory);

.2 RS485 range and compatible Modbus protocol (AER 485P1 accessory);

.14 double set-point, both summer and winter, for the temperature of the water produced, pre-set at the menu;

.15 automatic compensation of the set points on the basis of an analogue input 4 ÷ 20 mA;

.16 pump management and rotation;

.17 programmable timer function;

.18 daily/weekly programming;

.19 inlet/outlet temperature display;

.20 multi-language display of the parameters.

.5 Acoustics: Sound pressure levels for the unit shall not exceed the following specified levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.

~~.1 63Hz Band: 65dB~~

~~.2 125 Hz Band: 64 dB~~

~~.3 250 Hz Band: 61 dB~~

~~.4 500 Hz Band: 60 dB~~

~~.5 1000 Hz Band: 56 dB~~

~~.6 2000 Hz Band: 51 dB~~

~~.7 4000 Hz Band: 46 dB~~

~~.8 8000 Hz Band: 41 dB~~

~~.9 Overall dBA: 61dBA~~

NXW (L/HL)	Power (dB) (A)	Pressure (dB) (A)		Sound power by Central Band Frequency (dB)(A)						
		32.8 ft	3.3 ft	125	250	500	1000	2000	4000	8000
0900L	85	53	68	61.9	66.8	80.2	82.9	72.6	67.5	51.2

2.4 FUSELAGE CHILLER 22-CCH-06

.1 GENERAL

.1 Semi-Hermetic compressor chiller shall be manufactured by Refplus. Unit(s) shall be CSA approved and UL listed.

.2 Unit shall meet the performance detailed in the schedule. Construction shall be in accordance with latest, ANSI/ASHRAE 15, CSA-B52 and ASME Code.

.3 The unit shall be completely factory assembled on a rugged steel base and shall be shipped with a full operating charge of R404A refrigerant.

.4 water-cooled chiller unit bases and electrical boxes are heavy-gauge galvanized steel (G90) with plated or stainless steel hardware for corrosion-free assembly.

.5 As standard, chiller components shall be housed in an acoustically treated enclosure designed specifically to reduce radiated noise transmission by a minimum of 6 db(A). Enclosure panels shall be G90 galvanized steel.

.6 Compressors shall have Spring vibration isolators shall be factory installed

.2 COMPRESSORS

.1 Compressors are air or suction cooled, refrigeration duty, accessible semi-hermetic. They are supplied with suction and discharge valves, suction strainer, oil filter, oil pump on model 3HP and larger, solid state or line break thermal protection, crankcase heater, Polyol Ester oil with HFC refrigerant..

.3 EVAPORATOR AND CONDENSER

.1 Evaporator and condensers shall be direct expansion type with stainless steel plates brazed together. Evaporator shall be insulated with closed cell polyurethane insulation.

.2 Flow switches shall be supplied loose for field installation by others. Provide a flow switch for both the evaporator and condenser water lines. Installing contractor shall wire flow switch back to main unit control panel.

.4 REFRIGERANT CIRCUIT

.1 All units shall feature a minimum of two independent refrigerant circuits coupled to a common hydraulic circuit for increased reliability. Unit shall be capable of operating at reduced load with one refrigerant circuit shut down.

.2 Each refrigerant circuit shall include a liquid line shutoff valve, replaceable core or sealed filter-drier, sight glass with moisture indicator, liquid line solenoid valve, thermal expansion valve, and insulated suction line.

.3 Receivers (6” dia. and smaller) are UL/CSA certified and are supplied with a fusible plug. Receivers (6 5/8” dia. and larger) are CRN or ASME “U” stamped and are supplied with relief valves. All receivers have inlet and outlet back-seated Rotalock valves**.**

.5 CONTROLS

.1 Control Panels are complete with terminal blocks, control transformer, control circuit fuses, compressor contactors, fan interlock, fix high and adjustable low pressure control, oil failure switch (for compressors with positive pressure oil pump), and a pump-down switch. The wires are numbered and color-coded, conveniently routed in wiring ducts. All terminal blocks are identified to match

the wiring diagram.The control system shall stage the compressors based on the leaving water temperature.

.2 Equipment protection devices include motor protection, high pressure, loss of refrigerant, loss of water flow, and low refrigerant pressure. Controls shall include auto/stop switch, chilled water set point adjustment, anti-recycle timer, and with water temperature and set point, operating temperatures and pressures, and diagnostic messages.

.3 Control system shall monitor all system temperatures, pressures and safeties, and shall automatically shut down a refrigerant circuit or entire unit should a fault occur.

.6 ELECTRICAL

.1 Field power connection, control interlock terminals and unit control system shall be centrally located. Panel access door shall key lock to prevent unauthorized access. Dead front panel shall protect service personnel against accidental contact with line voltage components.

.2 Chiller shall be supplied with factory installed non fused disconnect.

.7 STARTUP SERVICE AND WARRANTY

.1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit. The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

.8 ACOUSTICS

.1 Sound pressure levels for the unit shall not exceed the following specified levels. All manufacturers shall provide the necessary sound treatment (parts and labor) to meet these levels if required. Sound data shall be provided with the quotation. Test shall be in accordance with AHRI Standard 370.

~~.1 63Hz Band: 65dB~~

~~.2 125 Hz Band: 64 dB~~

~~.3 250 Hz Band: 61 dB~~

~~.4 500 Hz Band: 60 dB~~

~~.5 1000 Hz Band: 56 dB~~

~~.6 2000 Hz Band: 51 dB~~

~~.7 4000 Hz Band: 46 dB~~

~~.8 8000 Hz Band: 41 dB~~

~~.9 Overall dBA: 61dBA~~

Octave Band	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
dB	**20**	**30**	**41**	**39**	**42**	**38**	**30**	**30**

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for rotary-screw water chiller installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform NRC Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Representative.

3.2 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.3 GENERAL

.1 Provide appropriate protection apparatus.

.2 Install a field-supplied or optional manufacturer-supplied strainer in the chilled water return line at the evaporator inlet; 40 mesh on units with brazed plate evaporators.

.3 Install unit as indicated, to manufacturers recommendations, and in accordance with EPS 1/RA/2.

.4 Ensure adequate clearances for servicing and maintenance.

.5 Manufacturer to approve installation, to supervise startup and to instruct operators. Include 3 days per unit.

.6 Install units on a flat surface level within 1/8 inch and of sufficient strength to support concentrated loading.

.7 Provide components furnished as per manufacturer's literature.

.8 Provide all water piping so unit and water circuits are serviceable, without having to dismantle excessive lengths of pipe.multiple supply and return chilled water and condenser water connection required connecting to on the chiller

.9 Provide valves in water piping upstream and downstream of the evaporator and condenser water connections for isolating the shells for maintenance and to balance and trim the system.

.10 Provide pressure relief piping from relief valve to outside in accordance with manufacturer's instructions and CSA-B52.

.11 Provide certified wiring schematics to the electrical division for the chiller, associated equipment and controls.

.12 Provide all necessary control wiring as recommended by the manufacturer.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials for reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by chiller installation.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Labour, products, equipment and services necessary to complete the work of this Section.

.2 Provide labour, installation materials and control equipment to provide a complete and satisfactory building automation system in accordance with the intent and meaning of the Drawings and Specifications. Include:

.1 Wire or pipe remote instrumentation required to operate packaged systems supplied by others. Modulating thermostats for these systems must match the system component characteristics.

.2 Supply, install and connect all control wiring for the systems described.

.3 Control wiring of components for systems listed herein requiring 120V or less. Included are such items as remotely mounted interlocks, sensors, 120V supply to refrigerated air dryers, seven day timers, etc.

.3 Refer to and comply with requirements specified in Basic Mechanical Requirements, Section 23 05 01 and also Division 26, Electrical Work.

.4 Co-ordinate the work of this Division with other Trades to obtain their electrical input for the electrical control schematics.

.5 Advise and co-ordinate this work with all associated trades and balancing technicians.

1.2 CODES, REGULATIONS AND STANDARDS

.1 Comply with Municipal or Provincial Codes, Rules and Regulations and/or Authorities having jurisdiction.

.2 Comply with the National Building Code in areas where Municipal or Provincial Regulations and/or Codes are not mandatory.

.3 Revisions issue: latest version as amended to date.

1.3 MATERIAL APPROVALS

.1 Obtain special inspection and approvals by CSA and/or local authorities, for materials where specified.

.2 Obtain such approval for the particular installation with the co-operation of the material supplier.

1.4 PERMITS AND INSPECTIONS

.1 Obtain permits required for the installation of mechanical trades work including:

.1 Electrical inspection

.2 Arrange for inspections and tests and pay all fees and costs for the permits, inspections and tests. Obtain permits immediately after notification of award of Contract.

.1 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.5 **RELATED WORK**

.1 The following equipment will be supplied and installed under other Sections or Divisions.

.1 Manual balancing dampers, fire dampers and gravity dampers: Division 23.

.2 Automatic control dampers supplied as an integral part of equipment. e.g. mixing box dampers and face and bypass dampers unless otherwise noted: Division 23.

.3 Control and power wiring between components of "packaged" systems: Division 21, 22, 23 and 26.

.4 Direct expansion cooling valves: Division 23.

.5 Refrigerant solenoid valves: Division 23.

.6 Multizone dampers unless otherwise noted: Division 23.

.7 Humidifier control valves complete with operators: Division 23.

.8 Return air fan variable vane linkage: Division 23.

.9 Supply air fan intake variable vanes and linkage: Division 23.

1.6 **ITEMS TO BE SUPPLIED UNDER THIS SECTION AND INSTALLED UNDER OTHER SECTIONS**

.1 Supply the following equipment to the appropriate Mechanical Trades for installation in accordance with instructions from, and under the supervision of, the Automatic Controls Subcontractor:

.1 Motorized dampers.

.2 Automatic control valves.

.3 Temperature control wells for pipe or tank mounted sensors.

.4 Roof mounted relief dampers, with operators and linkage.

.5 Variable volume terminal unit operators. (These operators will be installed on the terminal units by the terminal unit supplier).

1.7 **WORK UNDER OTHER CONTRACTS OR DIVISIONS**

.1 The following equipment will be supplied and installed by other trades or Contractors:

.1 Door limit switches for automatic temperature controls.

.2 Electrical items of work as defined hereinafter.

.3 All line side power wiring.

.4 Combination starters or contactors complete with integral pushbuttons, Hand-Off-Auto switches, etc. unless otherwise specified.

.5 Alternators for pump sequencing.

.6 All controls and wiring for:

.1 Fire alarm control system.

.2 Electric baseboard heaters.

.3 Electric forced flow heaters with integral thermostats.

1.8 **REFERENCE STANDARDS**

.1 Input/Output devices:

.1 To ASCII (American Standard for Communication and Information Exchange) code and standard EIA (Electronic Industry Association) interfaces.

.2 RFI interference: To F.C.C. regulation Part 15 Section 15 governing radio frequency electromagnetic interference and devices so labeled.

.2 Codes and Standards: comply with the following as a minimum:

.1 UL-916-PAZX listed

.2 Electrical Safety Code

.3 ASHRAE/ANSI 135-1995 (BACnet)

1.9 **PRODUCT AVAILABILITY**

.1 Product Development

.1 All products to be new, currently under manufacture, and have been applied in similar installations for a minimum of two (2) years.

.2 This installation shall not be used as a test site for new products unless explicitly approved by the Owner's representative in writing prior to bid date.

.2 Spare Parts

.1 Spare parts to be available for at least five (5) years after completion of this contract.

1.10 **WORKING DRAWINGS AND DOCUMENTS**

.1 Design Drawing Intent

.1 The design Drawings are schematic in arrangement, and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.

.2 The Work is suitably outlined on the Drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram

except where in certain cases the Drawings may include details giving the exact locations and arrangements required.

.3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.

.4 In order to provide clarity to the arrangement of the work, not all details including valves, thermometers, pressure gauges, etc. are shown on the plan drawings. Refer to schematic drawings, standard details and the specification for these requirements.

.5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the drawings, install to these requirements.

.6 Where Standard Details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.

.2 Contractor Coordination Responsibilities

.1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this Division of the Work, as well as providing coordination with other Divisions and/or contracts. This supervisor may be full time or part time on site, as appropriate to the work stage and complexity of the work, at the discretion of the Owner.

.2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.

.3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.

.4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.

.5 Prepare construction / installation / fabrication drawings, coordinated with other trades and contracts, as required. Provide these drawings to other trades for coordination with their Work.

.6 Update these drawings as part of the As-built drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.

.7 The design drawings show the major requirements for the installation of equipment based on one manufacturer's requirements, but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.

.8 The construction / installation / fabrication drawings are not to be submitted as shop drawings. Make them available for viewing at site when requested by the Consultant.

.3 Review before proceeding (HOLD)

.1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract.

.2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.

1.11 **COORDINATION AND EXAMINATION**

.1 Examination

.1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.

.2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.

.2 Coordination

.1 Coordinate Work of this Division such that items will properly interface with Work of other Divisions. Prepare installation drawings of critical locations and submit to Consultant for review.

.2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.

1.12 **PROVISION FOR FUTURE**

.1 Future equipment:

.1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.

1.13 **EQUIPMENT NOT IN CONTRACT**

.1 Supplied By Owner (S.B.O.) equipment:

.1 Owner will receive, check and temporarily store this equipment in Building M19 located on the NRC Montreal Rd. Campus.

.2 Contractor under Division 1 will check for damage, will load and transport from M19 storage building to M22 construction site and be responsible for this equipment.

.3 Contractor under Division 1 will unpack, and assemble this equipment, and locate them in building.

.4 Connect mechanical services to accommodate this equipment.

.5 Owner shall hold equipment warrantee and Contractor shall be responsible for installation warrantee.

1.14 **PRE-PURCHASED EQUIPMENT**

.1 The following equipment has been pre-purchased by the Owner:

.1 Quantity two (2) Sewage Vacuum Tanks; refer to specification 22 42 01 section 2.13.

.2 The purchase value of the equipment is not included as part of the Work.

.3 Include as part of this Work the following:

.1 Scheduling and coordination for removal from storage and delivery of point of installation.

.2 Check, store, rigging, installation and otherwise be responsible for this equipment.

.3 All other provisions of this work including but not limited to Start-up and Performance Testing, manufacturers start-up services, training , Operating and Maintenance materials, coordination of installation, and warranty of installation provisions.

1.15 **SUBMITTALS**

.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 33 00. Partial or incomplete submittals of data and/or drawings will be returned without review.

.2 Commence installation of the controls only after the shop drawings have been reviewed by the Consultant.

.3 Include the following in the shop drawings:

.1 Pneumatic piping and/or electric schematic drawings for the various control systems including component make and model numbers in accordance with the operating sequences on the instrument data sheets.

.2 Description and sequence of operation for each system in accordance with the Drawings. The preferred location for the operating sequence is on the Schematic Drawing.

.3 Drawings for control panels showing control equipment arrangement.

.4 Point address

.5 Manufacturer’s data/specification sheets. Indicate supplied model and options.

.6 Location of local support office

.7 Location of local parts supply

.8 Names of subcontractors, if any

.9 BMS Architecture schematic(s)

.10 System capacity and identified points reserve

.11 Software programs included

.12 Sample of commissioning plan and documentation

.4 Include electric control schematics for all systems in this Section. Schematic format and wire numbering:

.1 In accordance with the typical schematics attached to this Specification and on drawings.

.2 Include electrical components, e.g. control transformers, relays, overloads selector switches, running lights, thermostats, etc. which are necessary to provide a complete schematic.

.5 Use contact identification identical to the contacts shown on the suppliers shop drawings. List the reference shop drawing numbers on each schematic drawing.

.6 Revise the suppliers shop drawings for the systems listed herein to show the appropriate power demand, master clock and fire alarm contacts and the reference drawing numbers.

1.16 **"AS-BUILT" RECORD DRAWINGS**

.1 Reference

.1 Conform to Section 01 77 00 Contract Closeout.

.2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.

1.17 **INSTALLATION AND START-UP INSTRUCTIONS**

.1 Reference

.1 Conform to Section 01 77 00 Contract Closeout.

.2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.

1.18 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**

.1 Reference

.1 Conform to Section 01 77 00 Contract Closeout.

.2 In addition, include the following in the manuals:

.1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.

.2 Operating instructions, including start-up and shut-down procedure.

.3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.

.4 List of spare parts.

.3 All the above applies to component parts of equipment whether they are manufactured by the supplier of the equipment or are supplied as a component part of an item of equipment.

1.19 **TRADE QUALIFICATIONS**

.1 Applicable to the following trades

.1 Electricians

.2 Requirements

.1 Trade workers to have a Certificate of Qualification as Journeyman or Apprentice Registration for the province where the work is performed or an Interprovincial Certificate.

.2 Ratio of journeyman to apprentice: not to exceed the defined ratio in the Apprenticeship Act of Ontario.

.3 Certificates and Registration must be provided to the Consultant on request.

.4 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

1.20 **PRODUCT DELIVERY, STORAGE AND HANDLING**

.1 Seal instruments after manufacture and inspection and remain sealed until ready for installation.

.2 Handle instruments and equipment carefully handled and protect from weather, dust and construction materials.

PART - 2 PRODUCTS

2.1 **MATERIALS AND EQUIPMENT**

.1 Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.

.2 Of Canadian manufacture wherever possible.

.3 Labelled or listed as required Code and/or inspection authorities.

2.2 **B.M.S. GENERAL SYSTEM PERFORMANCE REQUIREMENTS**

.1 General

.1 Distributed, microprocessor based, direct digital control system, capable of performing binary and PID control loop operations independent of communications with external controllers.

.2 Design Intent: the design documentation is schematic in nature. Provide hardware, software, and system architecture design to implement the functions, performance and control sequences shown.

.3 Any items required to complete the work and not specifically mentioned herein shall be supplied to the same quality standards as the specified items.

.2 Performance Standards: BMS system to conform to the following:

.1 Graphic Display: display a graphic with a minimum of 20 dynamic points. All current data displayed within 20 seconds of the request.

.2 Graphic Refresh: update all dynamic points with current data within 30 seconds.

.3 Object Command: maximum time between the command of a binary object by the operator and the reaction by the device not to exceed 10 seconds. Analog object to begin adjusting within 10 seconds of command input.

.4 Object Scan: all changes of state and change of analog values to be transmitted over the high-speed network and displayed at a controller or Workstation with 60 seconds of change.

.5 Alarm Response Time: maximum 45 seconds between alarm condition and annunciation at the work station.

.6 Program Execution Frequency: custom and standard application executions run a minimum of once every 5 seconds. Contractor to select execution times consistent with the mechanical process under control.

.7 Control Loop Performance: execute PID control loops at a selectable frequency, at least once every 5 seconds. Scan and update the process value and output generated by this calculation at the same frequency.

.8 Multiple Alarm Annunciation: all work stations on the network to receive alarms within 5 seconds of each other.

.3 Network Communications General Requirements:

.1 Communications designed such that each control system is capable of operating under stand-alone control during network communication failure.

.2 Network communication: high-speed peer based network.

.3 Building Management System LAN : BACnet TCP/IP protocol (10baseT Ethernet).

.4 Fault Tolerance:

.1 All system components are to be designed, built, and installed to be fault tolerant as follows:

.1 Satisfactory operation without damage at 110% above and 85% below rated voltage and at +3 hertz variation in line frequency.

.2 Static, transient, and short circuit protection on all inputs and outputs.

.3 Communications lines protected against incorrect wiring, static transients and induced magnetic interference.

.4 All real time clocks and data file RAM shall be battery backed for a minimum of 72 hours.

.5 Bus connected devices to be a.c. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

.5 Building Services NRC Network Systems Reporting Accuracy:

Space Temperature	±0.5°C	±1°F
Ducted Air	±0.5°C	±1°F
Outside Air	±1.0°C	±2°F
Water Temperature	±0.5°C	±1°F
Delta-T	±0.15°C	±0.25°F
Relative Humidity	±1% RH	
Water Flow	±5% full scale reading	
Air flow (terminal unit)	±10% full scale reading	
Air flow (measuring station)	±5% full scale reading	
Air pressure (ducts)	±25 Pa	±0.1 in.wc.
Air pressure (space)	±3 Pa	±0.01 in.wc.
Water pressure	±2% full scale reading	
Non-utility electrical metering	5% of reading	
Carbon Monoxide (CO)	±50 ppm	
Carbon Dioxide (CO2)	±5 ppm	

.6 Process BAS Systems Reporting Accuracy:

Space Temperature	±0.5°C	±1°F
Ducted Air	±0.5°C	±1°F
Outside Air	±1.0°C	±2°F
Water Temperature	±0.5°C	±1°F
Delta-T	±0.15°C	±0.25°F
Relative Humidity	±1% RH	
Water Flow	±5% full scale reading	
Air flow (terminal unit)	±10% full scale reading	
Air flow (measuring station)	±5% full scale reading	
Air pressure (ducts)	±25 Pa	±0.1 in.wc.
Air pressure (space)	±3 Pa	±0.01 in.wc.
Water pressure	±2% full scale reading	

Non-utility electrical metering	5% of reading
Carbon Monoxide (CO)	±50 ppm
Carbon Dioxide (CO2)	±5 ppm

.7 Suppliers/Installers:

.1 Supplied and installed by a Control Subcontractor specializing in such work. As far as practical, all control equipment to be the products of a single manufacturer.

.2 Bids by Wholesalers, Contractors, Franchised Dealers or any firm whose principal business is not that of manufacturing and installing automatic temperature control systems shall not be acceptable.

.3 Single source responsibility of supplier shall be the complete installation and proper operation of the BMS and control system, including commissioning and proper calibration of each component in the entire system.

.4 An in-place support facility within 50 kilometers of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

.5 Standard of Acceptance:

.1 Airtron **(Contact Info: Aaron Dobson-613-247-7938**

2.3 LOCAL CONTROL PANELS

.1 Type: wall or floor mounted

.1 EEMAC 12: sheet metal cubicles for indoor use.

.2 EEMAC 4: sheet metal cubicles with hinged and locking front panels, for outdoor use.

.2 Construction:

.1 Suitable knockouts and hinged, lockable doors all keyed alike.

.2 Factory piped, wired, assembled and ready for field installation.

.3 Door mounted temperature gauges, filter gauges, pneumatic selector switches, etc.

.4 Interior compartment mounted DDC Controllers, controllers, air solenoid valves, relays, air gauges, etc.

.5 Nameplates for components mounted in and on local control panels in accordance with the Nameplate Article of this Section.

.6 Where one panel serves more than one system in a Mechanical Room, clearly separate the system components on the front of the panel.

.3 Panel Wiring:

.1 Wire electrical components mounted in local control panels.

.2 Terminate wire at terminal blocks located near the top or bottom of the panel to suit incoming conduit.

.1 Terminal blocks: Electrovert WK Series.

.3 Number and identify each terminal block point to tie in with the control drawings.

.4 Wire panel neatly and conform to all applicable codes.

.5 Identify control wires terminating at terminal strips.

.1 Markers: Electrovert Type Z

2.4 WIRING

.1 Wiring Standards

.1 To Section 25 05 00 requirements and the Electrical Safety Code as amended to date.

.2 Conduit:

.1 Wiring in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury: thin wall up to 32 mm.

.2 Wiring in poured concrete, where exposed and for conduit 40 mm: rigid galvanized.

.3 Wiring used as part of a smoke control/venting system, all locations: 40 mm: rigid galvanized.

.3 Power Wiring:

.1 Colour coded No. 14 gauge for control

.2 All conduits used for base building controls shall be orange in colour.

2.5 IDENTIFICATION

.1 Lamacoid Nameplates:

.1 75 x 50 mm, 10 mm high black lettering on white background. Include the following information:

.1 Component name/ID

.2 Data Cards:

.1 100 x 150 mm (nominal) pre-printed data card, mounted in a hard plastic case, secured to device with nylon tie-wraps. Include the following information:

.1 Device Tag Identification

.2 Device Name

.3 BCU or ECU address

.4 Power Requirements

.3 Brass Valve Tags:

.1 25 mm dia. circular brass tag, fastened to valve body with keychain. Include the following information:

.1 Valve Tag ID (to correspond with manual valve tags under Section 23 05 53)

2.6 EQUIPMENT SUPPORTS

.1 Support Frames: galvanized modular framing system: Unistrut.

.2 Backboards: 20 mm fire rated plywood.

PART - 3 EXECUTION

3.1 EXAMINATION

.1 Thoroughly examine the design documentation for control devices and equipment, Notify the consultant of any discrepancies, conflicts or omissions prior to commencement of rough-in work.

3.2 INSTALLATION

.1 The BAS system is to be divided into two separate architectures, one with and one without a local front end.

.1 Those systems designated for general Building Services HVAC system applications and that support laboratory / research functional programs will NOT require a local work station but rather be interconnected with the NRC campus wide network. These shall include Zones “Terminal Units”, Mics Equipment, 20, 27 and 28.

.2 Those systems that are dedicated to process and laboratory / research functional programs will require a local front end that will be housed in the Flight Simulator Observation Room 26. These shall include all remaining Zones.

.3 Refer to the Points list tabulated in Section 25 95 00_01 for details.

.2 Execute work in accordance with requirements specified in the various Sections of Division 25, and where referenced to other Divisions.

.3 Lay out the work so that it does not interfere with work under other Divisions of Specifications.

.4 Make good any damage to Owner’s property or other trade’s work caused by improperly locating or carrying out of work.

.5 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided alteration is made before installation.

3.3 **PROTECTION**

.1 Protect work and materials before, during and after erection from weather and other hazards and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

3.4 **PAINTING**

.1 With the exception of prime painting of miscellaneous steel or any other specific requirements as specified under the respective Sections of this Work, or equipment otherwise factory painted, all painting will be provided under Division 09 (under a Separate Contract).

.2 Field prime painting:

.1 Mechanical rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses: paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% alkyd base enamel.

.2 Clean rust and oil from exposed iron and steel work provided under this Division, whether or not it has been factory prime painted. Paint this equipment with one coat of chrome oxide phenolic base primer and one coat of 100% alkyd base enamel in an approved colour.

3.5 **CONSTRUCTION REVIEW**

.1 The construction review will include milestone and periodic reviews.

.2 Milestone Reviews

.1 Specific milestone reviews will be performed by the Consultant for compliance with the Ontario Building Code, including any or all of the following:

.1 Equipment Demonstration and Training

.2 Substantial Performance and Deficiency Review

.3 Total Performance

.2 Some or all of these reviews are of portions of the work which may be concealed. If work is enclosed before the Consultant can review the installation, the Consultant may direct the Contractor to expose the Work for it to be examined, at no additional cost to the project including rework affecting other Trades.

.3 If deficiencies are noted during any review where work will be enclosed, correct noted deficiencies and have them reviewed by the Consultant prior to the Work being enclosed.

.4 Provide a minimum of seven (7) calendar days written notice to the Consultant when requesting each review date.

.5 The Consultant will provide a check-list to the Contractor of required milestone reviews which must be completed. Maintain this list on site along with identified test reports, and make available for Consultants review when requested. When completed, include this checklist form with the Test Reports forms specified in this Division.

.3 Periodic Reviews

.1 The Consultant will conduct periodic reviews, as required for the project. These reviews are for the benefit of the Owner to describe the progress and workmanship of the Work, and are not intended as any form of quality assurance for the Contractor.

.2 Deficiencies will generally not be reported as part of this review, as the work has not been reported by the Contractor as being complete. However, deficiencies may be reported where it may not be possible to correct the work at a later date, or at great expense.

.3 The Contractor shall not relay on these Periodic Reviews to identify deficiencies during the progress of the Work.

.4 Deficiency Review

.1 The Consultant will conduct a deficiency review only after the Contractor submits an application for Substantial Performance. As part of this application, the Contractor shall submit their own comprehensive deficiency list of incomplete or incorrect work. Failure by the contractor to list any deficiency does not relieve the Contractor from correcting or completing the Work.

.2 The Consultant shall review the work and any deficiencies noted will be classified as Major or Minor.

.1 Major deficiencies are required to be corrected as part of obtaining Substantial Performance.

.2 Minor deficiencies may be corrected before or after Substantial Performance.

.5 Final Review

.1 The Consultant will conduct a final review only after the Contractor submits a declaration that all of the following has been completed:

.1 Noted deficiencies have been corrected

.2 Final As-built drawings have been submitted to the Owner

.3 Final Operating and Maintenance manuals have been submitted to the Owner

.4 Final Test reports, including Alternate season tests have been submitted to the Owner.

.6 The Consultant will only review the deficiency list to confirm these deficiencies have been corrected.

.7 Tubing and Conduit

.1 Tubing and conduit: follow horizontal and perpendicular building lines to fit into the layout of the area. Properly support and install in a neat and workmanlike manner throughout.

.2 Install panels in readily accessible locations. Unless other wise shown, mount control panels at a height of 1800 mm from the floor to the top of the cabinet for units without operator input devices (LCD screens, keypads, etc). For units with operator input devices, mount unit so that the horizontal centerline of the LCD display is located 1650 mm above the floor.

.3 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

3.6 LOCAL CONTROL PANELS

.1 Install BCU and ECU controllers in separate EEMAC 4 or 12 panels, to suit location. Install operator LCD screen, where specified, on the front panel door to allow operator access without opening door.

.2 Install BCU and ECU controllers, complete with OEM factory installed EEMAC 1 enclosures, directly to walls or support stands as described below. On systems requiring pneumatic control elements including pressure gauges, selector switches, etc., mount controller and pneumatic devices in an EEMAC 1 sheet metal enclosure. Install operator LCD screen, where specified, on the front panel door to allow operator access without opening door.

.3 Support local control panels from fixed masonry or concrete walls. Do not support from drywall partition walls. Provide free standing support frames in other locations.

3.7 VIBRATION ISOLATION

.1 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

.2 Sensing elements in ductwork: substantially supported and protected from vibration.

.3 Vibration sensitive controllers: isolate either by location or by mounting device.

.4 Tubing and conduit: install to preserve vibration isolation of equipment and ducting.

3.8 WIRING COORDINATION

.1 Provide wiring and conduit under this Section of the work as follows:

.1 Between ceiling mounted junction boxes and terminal unit controllers.

.2 Between MCC mounted receptacle panels in mechanical rooms and controllers and control devices within the same area.

.3 Provide circuit breakers in "RP" and "ERP" panels; provide breaker locks to prevent unauthorized use of the breaker.

.2 Power wiring provided under Division 26 as follows:

.1 120 VAC power and conduit to a junction box located in the ceiling adjacent to each terminal unit.

.2 120 VAC normal power panels labeled "RP" with spaces available for use.

.3 120 VAC emergency power panels labeled "ERP" with spaces available for use.

.3 Termination at Packaged Equipment and Systems:

.1 Terminate wiring at packaged equipment and system controllers provided under Mechanical Division.

.2 For equipment or systems panels provided under other Divisions of the Work, pull wire into control panel as per OEM manufacturers instructions. Final termination at equipment or panel will be by the trade Contractor providing/installing the equipment.

3.9 WIRING

.1 Maximum control voltage : 120 V.

.2 Supply, install and connect power transformers as required for each system.

.3 Sizing of conduit and selection of size and type of wire is by the Contractor under this Section of the Work.

.4 Flexible metal and liquid tight conduit:

.1 Maximum 1000 mm length

.2 Minimum size: 20 mm

.3 Supported at each end

.5 Control and Status Relays:

.1 Provide relays in designated enclosures only. Relays may be installed within packaged equipment control panels.

.2 Do not install relays within motor starter enclosures. Install relays in spare MCC sections, or provide a NEMA 1 enclosure mounted adjacent to the MCC or starter.

.6 Control and interlock wiring: comply with Ontario Electrical Safety Code and Division 26, and as specified herein.

.7 Wire:

.1 All cables ULC listed for application.

.2 Exposed cable in ceiling plenums: FT6 plenum rated.

.8 Conduit:

.1 Wiring in ceiling plenum spaces to be in conduit or be FT6 plenum rated cable.

.2 Wiring in all other areas to be in conduit.

.3 Wiring for rated smoke venting/control system to be FT6 plenum rated cable and be installed conduit.

.9 Sleeves:

.1 Provide wall sleeves for plenum rated cable passing through walls.

.2 Maintain fire rating at all penetrations.

3.10 FIBRE OPTIC CABLE SYSTEM

.1 Install cable to maintain the minimum cable and unjacketed fiber bend radii as specified by the manufacturer.

.2 Do not exceed maximum pulling tensions as specified by the manufacturer. Do not exceed manufacturer's ratings for post installation residual cable tension.

.3 Install fiber optic cabinets, hardware, and cable entering the cabinet as per manufacturer's instructions.

3.11 ARCHITECTURE

.1 Refer to drawings for system architecture schematic. The system architecture shown provides a general summary of the design intent, and does not show all control devices.

.1 Obtain a CAD design file form the consultant and complete the development of the system architecture drawing. In the absence of a design architecture, provide an architecture drawing as required.

.2 Include on the architecture drawing the following:

.1 Operator work stations

.2 Building LAN network

.3 Field LAN network

.4 BCU units, with identification label, and room location

.5 ECU units, with identification label, and room location

.6 LAN system repeaters

.2 Controllers:

.1 Provide a separate ECU for each piece of major equipment.

.2 Provide a separate ECU for each major system, including hydronic system water pumps.

.3 A universal programmable style ECU may be used to terminate miscellaneous I/O including system instrumentation, freestanding fans and pumps, etc. which may not form part of a more complex system.

.4 Select ECU's to provide a minimum of 15% spare capacity for each point type at each controller, but in no case less than 1 spare point.

3.12 PROGRAMMING

.1 General

.1 Point Naming: modular description without written point index.

.1 Use naming convention as indicated in contract documents.

.2 Provide programming for the system as specified and control sequence requirements. Include for additional programming necessary for the operation of the system but not specifically identified herein.

.3 Imbed sufficient comments in programming logic to clearly describe each section of the program. Comment statements to reflect language used in the sequences of operation.

.4 Enter all computer programs and data files into the related computers including English descriptors, control programs, approved parameters, and settings.

.2 Graphics

.1 Provide graphics for each major piece of equipment/system and for each floor plan in the building. Design CAD files will be provided to the controls Contractor for this purpose. Equipment to include:

.1 Chillers

.2 Cooling Towers

.3 Air Compressors

.4 Boilers

.5 Air Handling units

.6 Terminal box units

.7 Fan coils, unit heaters, etc

.8 Any integrated system including fire alarm, lighting control, security, etc.

.3 Reporting Information

.1 Implement samples of the following features:

.1 Bar chart (four different bars on one chart)

.2 Curve plot (five curves on one plot)

.3 Trend log

.4 Alarm message (action taking message)

.5 Run time maintenance message

.6 Trouble action message

3.13 NAMEPLATES

.1 Provide Nameplates:

.1 Lamacoid type:

.1 On each BMS control device, indicating device number.

.2 On the panel front to identify each system being controlled and to identify each front mounted component.

.2 Laminated Data Card:

.1 Field devices

.2 Damper actuators

.3 DDC terminal unit box controllers

.4 Automatic control valve actuators

.3 Brass Valve Tags:

.1 Pipe mounted valves, etc., supplied under this section.

.2 Control valves supplied under other Sections of the Specifications but controlled under this Section. Radiator valves do not require valve tags.

.2 Warning Labels:

.1 Provide plastic adhesive-backed labels, black lettering on yellow background, on each starter and equipment automatically controlled through the BMS system, as follows:

CAUTION
This equipment is operating under automatic control and may start at any time without warning.

ATTENTION
Cet équipement fonctionne sous contrôle automatique et peut commencer à tout moment et sans avertissement .

.3 Securely fasten Lamacoid nameplates to the equipment or adjacent to the equipment, with round-head cadmium plated steel self-tapping screws.

3.14 OPERATING INSTRUCTIONS

.1 Provide the services of a competent technician qualified to instruct the operating personnel in maintenance and operating procedures, after commissioning, for a period of not less than 1 day. Training to include:

.1 Overall operational program

.2 Equipment functions

.3 Commands

.4 Graphics generation

.5 Appropriate operator intervention following system's operation.

.2 Provide Operating instructions for the control system in accordance with Section 23 05 01, and include a description of the sequence of operation, and reproducible drawings of the "as-built" system schematics.

.3 Maintain CD-R copies of all data file and application software for reload use in the event of a system crash or memory failure. Deliver one copy to the owner during training sessions, and archive one copy in the control manufacturer's local software vault.

.4 "As-built" system schematics:

.1 Changes made during construction.

.2 Component final set points.

.3 Controller sensitivity and authority settings.

.5 Include maintenance instructions for control components supplied under this Section.

3.15 ADJUSTMENT AND DEMONSTRATION OF SYSTEMS

.1 After completion of the installation, regulate and adjust all sensors, motors and other equipment provided under this contract and place them in complete operating condition. Coordinate this work with the Mechanical Contractor and system balancing technicians.

.2 During the balancing and adjustment of the heating and ventilating systems, assist the Mechanical Contractor and system balancing technicians in the complete balancing of the systems.

.3 After this work is completed, advise the Consultant in writing that the installation is complete and ready for inspection.

3.16 TESTING AND REPORTING

.1 Conduct complete performance tests to demonstrate to the Consultant the correct operation of each individual control system and each item of control equipment. Repeat performance tests as necessary until all systems are proven satisfactory.

.2 Report Format

.1 Prepare test forms in MS Excel, Word, Access or other Database format.

.2 Include the following header information for each test report:

.1 Owner Name

.2 Project Name

.3 Contractor Name

.4 Consultant Name

.5 Name of Test Report

.3 Include the following on the front sheet of the consolidated report:

.1 Contractor Company Name

.2 Name and signature of the person submitting the report

.3 Date of report

.4 The following statement: “The undersigned certifies that the test results recorded in this report are correct, and that results have been witnessed by the trade responsible for the test”.

.4 Submit the above tests in a hardcopy form, separately bound from the Operations and Maintenance manuals, and in Adobe Acrobat PDF format, in accordance with Section 01 33 00.

.3 Controls Report:

.1 Provide a test report in spreadsheet format which summarizes the following data for each piece of controls operation.

.1 Equipment ID and name

.2 Device Location

.3 ECU reference

.4 BCU reference

.5 I/O reference

.2 Record the following tests for each device as applicable:

.1 Communications Loop Integrity Test

.2 Sensor Range Test

.3 Actuator Stroke Test

.4 Controls logic function test – single loop.

.5 Controls logic function test – equipment or system test.

.3 Communications Loop integrity test

.1 Check communications between DDC controller and remote I/O device

.4 Sensor Range Calibration Test

.1 Provide data for minimum and maximum sensor values, setpoint value, and current value at time of test.

.5 Actuator Stroke Test

.1 Provide data on actuator stroke from 0-100% full stroke.

.2 Indicate output value vs. actuator position (i.e. 20 mA = 100% open)

.6 Controls Logic Function Test – Single Loop

.1 Two position actuators: use manual control function from operators workstation to change current state of controller output.

.2 Modulating valves: vary Setpoint of control variable to modulate valve from 0-100% opening, at nominal 25% increments.

.7 Controls Logic Function Test – Equipment or System Test

.1 Create a point form checklist of the Sequence of Operation for each system.

.2 Operate system through each control sequence element specified.

.3 Operate each system through an actual power outage, and restart on power resumption.

.4 Operate each applicable system for automatic restart on emergency power.

.5 Operate each system through scheduled operation.

.8 Trend Logs

.1 Provide a copy of each trend log specified or requested.

3.17 COMMISSIONING ASSISTANCE

.1 Provide (fifteen) (15) days of 8 hours each (net of travel time) after Substantial Performance for on-site programming in conjunction with the Owner's commissioning agent.

.2 (Perform commissioning of the controls system in accordance with Section 23 08 23).

3.18 SERVICE AND GUARANTEE

.1 The controls systems herein specified shall be free from defects in workmanship and material under normal use and service after commissioning and acceptance of the complete control system.

.2 After acceptance of the systems by the Consultant, provide any service required for the proper performance of the control systems for a period of one (1) year or one complete heating and cooling cycle.

.3 This service shall include readjustment of the controls for proper balance of the systems under the direction of the Testing and Balancing firm six months after the initial adjustment. The controls shall be adjusted and set for optimum performance under the changed operating conditions during this system rebalancing.

.4 Include replacement parts for defective components and any labour to remove and replace such parts at no cost to the Owner.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 35 29.06 - Health and Safety Requirements.

.3 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

.4 Section 09 91 23 - Interior Painting.

.5 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.6 Section 25 05 54 - EMCS: Identification.

.7 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

.8 Section 260521 - Wires and Cables (0-1000 V)

.9 Section 260534 - Conduits, Conduit Fastenings and Conduit Fittings

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).

.1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

.1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).

.1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).

.1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.7 Electrical and Electronic Manufacturers Association (EEMAC).

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.9 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level.
.2 AI - Analog Input.
.3 AIT - Agreement on International Trade.
.4 AO - Analog Output.
.5 BACnet - Building Automation and Control Network.
.6 BC(s) - Building Controller(s).
.7 BECC - Building Environmental Control Center.
.8 CAD - Computer Aided Design.
.9 CDL - Control Description Logic.
.10 CDS - Control Design Schematic.
.11 COSV - Change of State or Value.
.12 CPU - Central Processing Unit.
.13 DI - Digital Input.
.14 DO - Digital Output.
.15 DP - Differential Pressure.
.16 ECU - Equipment Control Unit.
.17 EMCS - Energy Monitoring and Control System.
.18 HVAC - Heating, Ventilation, Air Conditioning.
.19 IDE - Interface Device Equipment.
.20 I/O - Input/Output.
.21 ISA - Industry Standard Architecture.
.22 LAN - Local Area Network.
.23 LCU - Local Control Unit.
.24 MCU - Master Control Unit.
.25 NAFTA - North American Free Trade Agreement.
.26 NC - Normally Closed.
.27 NO - Normally Open.
.28 OS - Operating System.
.29 O&M - Operation and Maintenance.
.30 OWS - Operator Work Station.
.31 PC - Personal Computer.
.32 PCI - Peripheral Control Interface.
.33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
.34 PID - Proportional, Integral and Derivative.
.35 RAM - Random Access Memory.

.36 SP - Static Pressure.

.37 ROM - Read Only Memory.

.38 TCU - Terminal Control Unit.

.39 USB - Universal Serial Bus.

.40 UPS - Uninterruptible Power Supply.

.41 VAV - Variable Air Volume.

1.4 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: The Andover™ system utilizes an **[Area/System/Point]** naming convention. To maximize the potential of the Continuum software it is essential to maintain a standard point naming convention.

.1 Master Control Unit Names **[Area]**: Naming the **Area** is the first name to consider. This name should be simple and reflective of the area in which this MCU shall be controlling.

Example:	M50MAST/xxx/xxx	(Montreal Road Campus Building M50 Master)
	M36BCX1/xxx/xxx	(Montreal Road Campus Building M36 BACnet Master/Router)

.2 LCU's, ECU's,TCU's, IOU Modules Names **[System]**: Naming the **System** controller is the second name to consider. This name should reflect the building in which it is located and the primary equipment this controller is controlling. As much as is possible, the NRC Equipment name is to be embedded into the code via the point naming convention.

Example:	XXX/AHU02/xxx	(Air Handling Unit 02)
	XXX/BLR01/xxx	(Boiler 01)
	XXX/MISC3/xxx	(Miscellaneous 3)
	XXX/Rm103/xxx	(Room 103)
	XXX/IOU1/xxx	(Input Output Module 1)

In the event that there are multiple pieces of equipment being controlled i.e.: 2 air handling units, the controller name shall follow the following standard.

Example:	XXX/AHU01_02/xxx	(Air Handling Units 01 and 02)

.3 Point Inputs/Outputs Names **[Point]**: The **Point** name is an abbreviation of the input/output function. Each type of equipment (chilled water system controllers, terminal unit controllers, etc.) has a standard list of input and output

abbreviations (see attached list). Again, as much as is possible, the NRC Equipment name is to be embedded into the code via the point naming convention.

E*xample:*	XXX/xxx/SFA	(Supply Fan Amperage)
	XXX/xxx/CCV	(Cooling Coil Valve)
	XXX/xxx/RMT	(Room Temperature)
	XXX/xxx/WTM01	(Water Meter)
	XXX/xxx/CHWST	(Chilled Water Supply Temperature)

In the event that there are multiple end devices on the same controller with the same function these would be first identified by the type of input/output followed by an underscore and an abbreviation of the location/description of the multiple type input.

Example:	XXX/xxx/RMT_102	(Room 102 Room Temperature)
	XXX/xxx/DCP01	(Domestic Circulating Pump 01)
	XXX/xxx/HCV2	(Heating Coil Valve Secondary)
	XXX/xxx/RM02_FLOOD	(Room 02 Flood Alarm)

.4 Numeric (virtual points) Names: The numeric should take on a similar naming standard as the point names. The numeric is a virtual point whose value is calculated by programs within the operator work station. The name for these virtual points should refer first to the point it is directly effecting followed by its function.

Example:	XXX/xxx/DATSp	(Discharge Air Temperature Setpoint)
	XXX/xxx/ RFS	(Return Fan Status)
	XXX/xxx/SFm	(Supply Fan Mode)

Other numeric's that do not involve points directly but programs shall be named for the function they server.

Example:	XXX/xxx/WINTER	(Winter Flag)
	XXX/xxx/SiteOAT	(Site Outside Air Temperature)
	XXX/xxx/CTL	(Pseudo System Control Value)

.5 Control Program Names:

Program names should be names in the same convention as Point and Numeric Names. The program name should first start with a description of its function followed by the point that the program controls.

Example:	XXX/xxx/CtlCCV	(Cooling Coil Valve Control)
	XXX/xxx/CtlMode	(Mode Control)
	XXX/xxx/VARCALC	(Variable Calculations)

.3 Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide [32] [___] character field for each point expansion.

.4 Point Object Type: points fall into following object types:

.1 AI (analog input).

.2 AO (analog output).

.3 DI (digital input).

.4 DO (digital output).

.5 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer also to Section 25 05 54- EMCS: Identification.

1.5 CONTRACTOR'S QUALIFICATIONS

.1 The EMCS controls systems contractor shall:

.1 Be an authorized distributor of the product lines listed in these specifications and on the drawings.

.2 Have at least five (5) years experience in the installation and maintenance of DDC control systems.

.3 Have in-house qualified technicians and tradesmen for the installation, maintenance and repair of systems.

.4 Have an office within 20 km of the project site and shall be able to offer emergency service 24 hrs/day, 365 days/year.

1.6 SYSTEM DESCRIPTION

.1 Refer to control schematics for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.

.2 Control devices as listed in I/O point summary tables.

.3 OWS(s).

.4 Data communications equipment necessary to effect EMCS data transmission system.

.5 Field control devices.

.6 Software/Hardware complete with full documentation.

.7 Complete operating and maintenance manuals.

.8 Training of personnel.

.9 Acceptance tests, technical support during commissioning, full documentation.

.10 Electrical 120 volt power distribution and low voltage power wiring as required for controllers and devices.

.11 Wiring interface co-ordination of equipment supplied by others.

.12 Control air piping and tubing as required for controllers and devices.

.13 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:

.1 Design and provide conduit and wiring linking elements of system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.

.3 Location of controllers as reviewed by Departmental Representative prior to installation.

.4 Provide utility power to EMCS as indicated.

.5 Imperial references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements:

.1 Provide English operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.

.3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.

.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.5 Include, in English:

.1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.7 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Submit for review:

.1 Equipment list and systems manufacturers within 10 days after award of contract.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative

.8 Existing devices intended for re-use: submit test report.

1.8 QUALITY ASSURANCE

.1 Have local office within 20km of project, staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,

.2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

.3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.

.4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.5 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.

.5 Ensure emptied containers are sealed and stored safely.

1.10 EXISTING CONDITIONS - CONTROL COMPONENTS

.1 Utilize existing control wiring and piping as indicated.

.2 Re-use field control devices that are usable in their original configuration provided that they conform to applicable codes, standards specifications.

.1 Do not modify original design of existing devices without written permission from Departmental Representative.

.2 Provide for new, properly designed device where re-usability of components is uncertain.

.3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.

.1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Departmental Representative.

.2 Failure to produce test report will constitute acceptance of existing devices by contractor.

.4 Non-functioning items:

.1 Provide with report specification sheets or written functional requirements to support findings.

.2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.

.5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.

.6 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.

.1 Be responsible for items repaired or replaced by Departmental Representative.

.2 Be responsible for repair costs due to negligence or abuse of equipment.

.3 Responsibility for existing devices terminates upon final acceptance of EMCS applicable portions of EMCS as approved by Departmental Representative.

.7 Remove existing controls, conduit, wiring and pneumatic tubing (poly or copper) not re-used or not required. Place in approved storage for disposition as directed.

Part 2 Products

~~**2.1 SUSTAINABLE REQUIREMENTS**~~

~~.1 [___].~~

~~2.2~~2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 or ASHRAE STD 135.

.2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 ELECTRICAL POWER AND CONTROL WIRING

.1 Provide 120 volt electrical power and low voltage control wiring to controllers and devices in accordance with specification sections 260521 and 260534, and coordinate work with the main electrical contractor.

3.3 CONTROL AIR PIPING AND TUBING

.1 Use type “L” air copper pipe with silver brazed joints in the following locations:

.1 In mechanical rooms.

.2 -Areas of ambient temperature above 80C.

.3 In fire rated walls and ceilings.

.4 Areas where piping may be subject to damage.

.5 In other locations polyethylene plastic tubing with barbed type fittings is acceptable.

3.4 PAINTING

.1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components to match existing building standards.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's. Labour, products, equipment and services necessary to complete the work of this Section.

.2 The BAS system is to be divided into two separate architectures, one with and one without a local front end.

.1 Those systems designated for general Building Services HVAC system applications and that support laboratory / research functional programs will NOT require a local work station end but rather be interconnected with the NRC campus wide network. These shall include Zones 20, 27 and 28.

.2 Those systems that are dedicated to process and laboratory / research functional programs will require a local front end that will be housed in the Flight Simulator Observation Room 26. These shall include all remaining Zones.

.3 Refer to the Points list tabulated in Section 25 95 00_01 for details.

.3 Related Sections:

.1 Section 25 05 00 – Common Work For Building Automation

.2 Section 25 05 01 - EMCS: General Requirements.

.3 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.4 Section 25 05 03 - EMCS: Project Record Documents.

.5 Section 25 30 01 - EMCS: Building Controllers.

.6 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.7 Section 25 95 00 - Bldg Automation Control Sequences

1.2 DEFINITIONS

.1 BCU: Building Controller Unit

.2 ECU: Equipment Controller Unit

.3 PWS: Portable Work Station

.4 PC: commercially available Personal Computer

.5 OWS: Operator Work Station

PART - 2 PRODUCTS

2.1 OWS

.1 General

.1 Real time, ULC listed digital personnel computer.

.2 Acceptable Manufacturers

.1 Dell

.2 Hewlett Packard

.3 IBM

.2 PC Hardware

Chassis	3.6 GHz, XEON/533 Mini Tower
Connections	PS/2 – keyboard
	USB – mouse
	USB x 4 Rear
	USB x 1 Front
	8 x RS422
	2 x RS232
Processor	3.60 GHz 4th generation Intel® Core™ i7-4790
Hard Drive	1.0 TB, IDE (ATA_100), 1 inch, 7200 RPM, Precision
Memory	8 GB, Double Data Rate SDRAM, ECC, 2x512
Video	ATI, Fire GL Z1, 128 MB, 1-2 VGA/DVI, Graphics Card
CD Rom	16X DVD-ROM and 48X CDRW with Roxio and DVD Decode
Base Service	Next Business Day, On-Site Parts and Labour Service, 3 Years
Operating System	Windows 7, NTFS with Media
Accessories	700 VA Intelligent Line Inter
Monitor	19 Inch SVGA (17.90 inch Viewable Image Size), Energy Star compliant
Keyboard	Entry Level, PS/2, No Hot Keys
Mouse	Logitech, 2-button, with scroll, USB, Optical

.1 Laser Printer

.1 Black and White laser printer

.2 Printing of reports, graphics and trend logs

.3 600x300 dpi black text resolution on plain paper

.4 Replaceable print cartridges

.5 True type scalable fonts

.3 OWS Furniture

.1 Provide the following commercial grade computer desk furniture.

.1 Commercial grade computer furniture.

.2 Desk: suitably sized to hold the monitor, 1 printer beneath desk, underdesk support for CPU (CPU not to sit on the floor).

.3 Pull out keyboard tray with side space for mouse and mouse pad.

.4 Five roller leg office chair, padded seat and back support, adjustable height arm rests.

2.2 OPERATOR WORKSTATION - SOFTWARE

.1 General

.1 Data base

.1 Manages all data on an integrated, non-redundant basis.

.2 Allows additions and deletions to the data base without any detriment to existing data.

.3 Provides cross linkages such that no data that is required by a software program may be deleted by the operator.

.2 Error reporting

.1 Report execution and operating system errors to the dedicated programmer's terminal via an error message.

.2 Display error messages on the programmer's terminal and stored in a disk file.

.3 Store operator error acknowledgement in a disk file.

.4 Print the error file on demand based on date range, at any printer designated by the programmer.

.5 Error messages: full readable English and French.

.3 Error restart

.1 Automatic restart after an error occurs that halts operation, unless otherwise specified in the Sequence of Operation.

.2 During the restart procedure, store the contents of RAM memory in a disk file.

.3 Make this data available to be printed and analyzed to determine cause of failure.

.4 The OWS will return to full operation after restart.

.2 System Access

.1 Sign-on procedure:

.1 Masked system password

.2 Operator initials

.3 A unique 8 character (maximum), masked operator password.

.2 Sign-on action:

.1 Display a "signed-on" message containing the initials of the operator on pre-determined terminals.

.2 Print a "signed-on" message containing the initials of the operator on pre-determined printers.

.3 Store the operator's initials and sign-on time in the event driven database.

.3 Unsuccessful sign-on attempts:

.1 Alarm and record unsuccessful sign-on attempts.

.2 Record the details of the sign-on attempt in the event driven database.

.3 Record the failed attempt after the third incorrect sign-on attempt.

.4 Provide a software mechanism to control operator access to various commands and to control access to specific points within commands.

.3 Automatic Sign-off

.1 Automatically sign-off colour graphic or monochromatic terminals on the BMS after a field-programmable period of no keyboard activity.

.1 Adjustable sign-off period from one minute to one day in one minute increments.

.2 Sign-off action:

.1 Display a "signed-off" message containing the initials of the operator on pre-determined terminals.

.2 Print a "signed-off" message containing the initials of the operator on pre-determined printers.

.3 Store the operator's initials and sign-off time in the event driven database.

.4 Operators Interface (OIS)

.1 Functions:

.1 Interactive operator interface

.2 Colour graphics

.3 Bar charts and curve plots

.4 Summary reports

.5 User definable reports and system security.

.2 OIS operates under human machine interface software control to provide self-prompting "top down" means of system penetration.

.1 Pop-up or pull-down menu driven at all levels initiates next step instructions.

.2 Functional grouping of system access menus:

.1 System

.2 Equipment

.3 Building

.4 Floor

.3 On-line Data Base Generator:

.1 Accomplish data file entry, application program modifications, group and point assignments, graphics generation and device assignments.

.2 Able to change programs or application package parameters, or modify points without interfering with HVAC control functions being performed by the BMS.

.3 Process and annunciate alarms, and execute control programs during all keyboard program modes.

.4 Command Functions:

.1 System security

.1 Sign on a terminal

.2 Sign off a terminal

.3 Reconfigure terminal to background console or operator console

.4 Set system and operator security parameters

.5 Set command security parameters

.6 Set point security parameters

.2 Point Information

.1 Point create/modify/read

.2 Point engineering unit read/modify

.3 System menu penetration create/modify

.4 Point display/command

.3 Historical Logging

.1 Historical capture parameters definition

.2 Historical report generation on captured data

.4 Report Initiation

.1 Alarm report

.2 All point report

.3 Status and Summary Report

.4 Trend Report

.5 Operator table report

.6 Event driven data base report

.5 Colour Graphics

.1 Graphic create/modify/delete

.2 Graphic for last Change of State (COS) point

.3 Graphic on for point

.4 Graphic index

.5 Graphic off

.6 Graphic on

.6 Change of State Message Text

.1 Alarm and trouble display/modify/create

.7 Historical Report (Curve Plot/Bar Chart)

.1 Historical report assignments

.2 Curve plot/bar chart display

.8 Report Scheduling

.1 Time scheduler (based on frequency and time)

.9 Peripheral Devices

.1 Segregation/name/descriptor of devices in system

.10 Help Command

.1 Summarize available operator command functions

.11 Time Synchronize

.1 Set OWS and field panel time, and synchronize their operation

.12 Communications

.1 Status/enable/disable communications from OWS to field panels.

.13 Time & Event

.1 Initiator create/modify/read/initiated programs delete

.2 Time/event program create/modify/read/delete

.5 Error/Problem Messages

.1 Inform operators of all types of errors and problems with comprehensive error messages:

.1 Operator input error messages

.2 Data transmission error messages

.3 Device failure messages

.4 Software failure messages

.6 Point Access

.1 Limit each operator access to specific points (see Access Control Section).

.2 Operator override (subject to access control):

.1 Command digital output and pseudo points.

.2 Manually command point normally under BCU/ECU software control, and to subsequently return to software control.

.3 Command analog output and pseudo points.

.4 Manually command analog point normally under DCU/ECU software control, and to subsequently return the point to software control.

.5 Command analog or digital output point on a graphic while viewing the graphic.

.1 Dynamically update the point's status on the graphic.

.2 Able to command points that are not displayed on the graphic that is being viewed.

.3 Operator to access points by using:

.1 Keyname of up to l2 characters.

.2 A numerical system point address.

.3 By using menu penetration.

.4 Logical Groups and Menu Penetration

.1 Generate software groupings of all system points.

.2 The logical grouping will allow points in different field panels to appear in logs and CRT displays.

.3 Points able to appear in a minimum of four logical software groups.

.4 Each logical group: minimum of 30 points.

.5 Create or modify any point keyname, logical group, or the menu penetration scheme, through any workstation.

.7 Access Control

.1 Provide software to control operator access to various commands and to control access to specific points within commands.

.2 Command Access Groups:

.1 Minimum of fifteen possible command access groups.

.2 Operator to easily assign any command to any, all or none of these groups.

.3 Operator to easily assign any operator to any, all or none of these groups.

.3 Operator Command Access:

.1 Only if there is at least one match between the command access groups of an operator and the command access groups of a command.

.2 Make visible only the commands to which an operator has access.

.4 Point Access Groups:

.1 Minimum of sixteen possible point access groups.

.2 Operator to easily assign any point to any, all or none of these groups.

.3 Operator to easily assign any operator to any, all or none of these groups.

.5 Operator Point Access:

.1 Only if there is at least one match between the point access groups of an operator and the respective point access groups of a point.

.2 Make visible only the system points to which the operator has access.

.8 Change of State Alarm (COS) Handling

.1 Queue COS conditions at the OWS and processed in a predetermined priority basis.

.1 Present COS conditions in the form of formatted COS messages.

.2 COS Reporting:

.1 Highest Priority: Point COS messages due to a device transmission failure.

.2 Point COS priority levels:

.1 Alarm

.2 Trouble

.3 No response

.4 Command failed

.5 Return to normal

.3 COS Reporting Levels:

.1 Minimum of 8 levels.

.2 Level 0 does not report a COS alarm; level 7 has highest priority

.4 COS Message Displays and History Storage:

.1 A dedicated area on OWS monitor allocated for change of state displays.

.2 COS message contents:

.1 Point name

.2 Point descriptor

.3 Engineering unit and value

.4 Time of change of state occurrence

.5 System descriptor

.6 Graphic number associated with the point

.7 Alarm or trouble message

.3 COS system capacity: 999

.4 COS message length: 236 characters (3 lines)

.5 Display the most recent highest priority unacknowledged COS message.

.6 Only retain the latest data received from a point that produces multiple alarms in the prioritized queue for display.

.7 Print all alarms as they occur.

.8 Do not acknowledge an alarm from a terminal that is not signed on by an operator

.5 Print to file COS Conditions including as follows:

.1 Alarm conditions for all types of points.

.2 Return-to-normal condition for all alarms

.3 Trouble conditions to fire points

.4 Acknowledgement of alarm and trouble conditions

.5 No responses, including power failure of field panels

.6 Uniquely identify COS alarm printouts.

.7 Acknowledgement and return-to-normal printouts:

.1 Time of restoration or acknowledgement

.2 The condition of the point

.3 Initials of operator acknowledging the condition

.8 Store data in the event driven database for recall by the operator.

.9 Separate message facility for fire trouble conditions.

.1 Allow for the same point to have two independent action taking instructions, one each for fire alarm and fire trouble conditions.

.10 Generate an audible alarm as well as visual annunciation.

.1 Definable audible type.

.9 Segregation

.1 Twelve unique segregation groups in the system.

.1 Any point in the system can belong to any, all or none of these groups.

.2 Any specific COS message can also belong to any, all, or none of these groups.

.3 Monitor any subset of the twelve segregation groups from any operators terminal.

.2 COS

.1 Display the point only at those terminals which have at least one segregation group assignment in common with the point and the type of COS.

.10 Databases

.1 Time Driven Database

.1 Able to sample analog physical and analog pseudo points.

.2 Sampling interval: adjustable between l minute and 60 minutes.

.3 Analog point sample time span: adjustable.

.4 Time spans:

.1 1 to 24 hours

.2 1 to 365 days

.3 1 to 5 years

.5 Continue sampling the analog point values (recycling data) at the end of the time period, or stop sampling the analog point values.

.1 Operator selectable.

.2 Event Drive Database

.1 Store in the event driven database the following items.

.1 Change of state activity including alarms and returns-to-normal.

.2 Operator signs-on and operator signs-off with time, location and operator's initials.

.3 Invalid sign-on attempts.

.4 Manual commands issued by any operator including the point keyname and the initials of the operator.

.5 Acknowledgment of alarms, including point's keyname, time of acknowledgment and initials of the operator.

.6 Definable number of transactions stored in the event driven database. Provide a counter which shall indicate the current number of transactions stored in the event driven database. Up to 999,999 transactions may be stored online.

.11 Data Archiving

.1 Archive events stored in the event driven database onto a secondary storage device such as a floppy disk, hard disk and CD Writer unit. Password protected Operator features include:

.1 Ability to schedule the data archiving task in the scheduler.

.2 Initiate a new data archiving task

.3 Suspend current data archiving

.4 Resume current data archiving

.5 Terminate current data archiving

.2 When the data archiving process is activated and the data archiving volume is not mounted, generate a COS message.

.1 COS message requests the operator to mount the volume.

.3 If during a data archiving session, the current data archiving volume becomes full, then automatically terminate the session and generate a COS message.

.1 COS message informs the operator that the volume is full.

.12 Dynamic Colour Graphics

.1 Provided as interactive icon based software to permit operator to create, modify, delete, file and recall graphics.

.1 System colour graphics easily developed via the mouse and keyboard using a number of interactive construction programs

.2 Library of standard symbols representing devices such as coils, smoke detectors, temperature sensors, thermals, contacts, speakers, watch tour stations, pumps, fans, dampers, motors, relays among others.

.3 Graphic construct program places the desired line drawings or symbols in the appropriate place on the screen, assign point type, colours, and text.

.4 Diagnostic dynamic testing of diagrams for accuracy and validity.

.2 Create graphics to describe systems as outlined in Operating Sequences and shown in I/O summary.

.3 Colour graphics: dynamic updating of dispersed real-time data.

.4 General:

.1 Minimum storage: 10,000 graphics, each including up to 200 freely assigned points.

.2 Point information: displayed in point windows.

.3 Graphic point capacity: up to 80 point windows and up to 200 points.

.5 Point window types:

.1 Single point window: constantly display point information for a single point on the graphic.

.2 Common point window: report alarms for up to 80 points. If any point represented in the window goes into alarm, indicate the alarm in the common window.

.3 Blind or hidden point window: display point information for a single point only when the point goes into alarm.

.6 Display graphics by:

.1 Entering the graphic number

.2 Entering the keyname of any point in the graphic

.3 Entering a command that displays the graphic of the point that last underwent a COS.

.7 Select systems/equipment graphics to be displayed by the following means:

Written description list of system names

.1 Operator entered physical label code

.2 Building location, using building floor plan CAD files

.3 Digital photos of mechanical / electrical rooms

.4 Terminal box / occupant data base, based on search by occupant name or room number.

.8 Operator commandable points on the graphic while viewing the graphic.

.9 Operator commandable points which are not displayed on the graphic that is being viewed.

.13 Curve Plot/Bar Chart

.1 Capability to display curve plots and bar charts using information stored in the time driven database.

.1 Display these curve plots and bar charts on any workstation.

.2 General

.1 Create up to 90 different curve plots.

.2 Display a minimum of 6 points on the same curve plot or bar chart. Highlight the six curves/bars in different colours.

.3 Display the minimum, maximum, average or actual variable values, over the specified sampling period and time window of the data capture.

.4 Display up to two y-axis on each curve plot/bar chart. Printer controllable y-axis and x-axis scales.

.5 Able to print the curve plot/bar chart to the colour printer

.6 Able to print the numerical values and point keynames of the points used in a curve plot or bar chart to the alarm or log printers.

.3 Three types of curve plots:

.1 Dot pattern

.2 Linear pattern

.3 Step pattern

.14 Dynamic Curve Plots/Bar Charts

.1 Capability to display dynamic trends of analog or digital point values on a curve plot or bar chart.

.1 Display these curve plots and bar charts on any workstation.

.2 General

.1 No limit on the number of plots that can be constructed.

.2 Capable of dynamically trending a minimum of 6 points on the same curve plot or bar chart with a minimum sample interval of 6 seconds.

.3 Operator control over the type of plot that is dynamically constructed.

.1 A linear plot

.2 Step plot

.3 Bar chart

.4 Display up to four reference lines on a curve plot or bar chart. The reference lines could be used for target or reference values.

.5 Capable of displaying either one or two y-axis on a curve plot or bar chart.

.6 Display up to 2 independent dynamic curve plots on one screen.

.7 Selectable different characteristics for each plot/bar chart.

.8 Able to print the curve plot/bar chart to the colour printer.

.15 Reports and Logs

.1 Operator selectable report generator.

.1 Custom formatted reports

.2 Selectable printer designation

.3 User-supplied report identifier (1 to 6 characters) and report title (60 characters minimum).

.2 Initiate report by:

.1 Manual command.

.2 A change of state.

.3 Return to normal.

.4 Alarm.

.5 Alarm return to normal.

.6 Schedule at specified time(s)/date(s).

.7 Schedule at specified time intervals.

.3 Standard reports available:

.1 Event driven data report

.2 Archived data report

.3 Historical report

.4 Summary report

.5 All Point log report

.6 Trend report

.7 Operator report

.8 Command Information report

.4 Operator point access:

.1 Restrict an operator from viewing points in a report unless the operator has the appropriate point access levels. This restriction is on a point by point basis.

.5 Extract data in the form of reports and include:

Report Type	Event Driven Database Report	Archived Data Report	Summary Report	All Point Log Report
User Defined Report Title	√	√	√	√
Event dates and times	√	√		
Point keynames	√	√	√	√
COS descriptors	√	√		
Engineering units	√	√	√	√
Point status			√	√
Point current value			√	√
Point descriptors			√	√

.6 Provide parameter selection filters:

.1 Key names of points

.2 Types of events (e.g. alarm, high alarm, low alarm, no response, etc)

.3 Engineering units such as Celsius, kilowatt, degrees, etc.

.4 Time windows, i.e., start date and time and end date and time.

.7 Historical Report (time driven database)

.1 Produce a list of the numerical values and the point keynames of the points stored in the time driven database.

.8 Summary Report and All Point Log Reports

.1 Alarm summary report: list points that are currently still in alarm.

.2 Operator selectable points that will be checked for alarms using any of the following methods:

.1 By selecting any logical group of points

.2 By selecting any branch of the menu penetration scheme. A branch may contain many logical groups

.3 By manually selecting up to 30 points

.9 Trend Report

.1 Trend the values of one to thirty points.

.2 Operator selects whether to print the values of the points at each trend interval or defer the printing of the report until all the data has been collected.

.1 Able to select up to 30 different points to be trended.

.2 Able to select any trend interval from two minutes to years.

.3 Provide multiple trend reports; trend report able to run concurrently.

.10 Operator Report

.1 Display a report of all operators assigned to the BMS. Include:

.1 Operator's initials

.2 Four-character operator ID

.3 Access level assignments.

.4 Ability to modify any of these parameters on-line.

.2 Assignable level of security so that only authorized personnel may access and run the report.

.11 Command Information Report

.1 Produce an alphabetical summary of all system commands including a brief description.

.2 All the command mnemonics and descriptors: on-line modifiable by any operator with proper authorization.

.3 Only display the commands that the operator is authorized to use.

.12 Comprehensive Report Scheduler

.1 Any report that has been previously formatted must be assignable to the comprehensive report scheduler. Operator selectable output schedule:

.1 Predetermined calendar time

.2 Predetermined time interval

.2 At any time, the operator must be able to view the queue of reports submitted to comprehensive report scheduler to determine:

.1 The current status of a report (i.e. executing or awaiting execution).

.2 Next time of execution of a report.

.3 Remaining number of executions for a report.

.4 The type of scheduling for a report.

.3 Cancel report: operator able to cancel any outstanding scheduled report at any time.

.16 Time and Event Initiated Programs

.1 Initiator (alarms, point transitions, etc.) activates any global or local TEIP (transferring of data, commanding points etc.). Initiators:

.1 A manual command

.2 A time schedule

.3 Point events such as

.1 Alarms

.2 Return to normal

.3 Value exceeding or falling below predefined limits

.4 Transition from any status to any other status.

.2 Each initiator can activate up to 10 TEIP's.

.3 TEIP functions:

.1 Transferring of data between devices

.2 Transferring of data between any two subsystems (e.g., EMC to DCP)

.3 Commanding any digital analog or pseudo point

.4 Initiating the printing or displaying of any report

.5 Initiate another TEIP.

.4 Operator access control to create TEIP's.

.5 Store in the event driven database a trace message describing its success or failure after the execution of each TEIP item.

.17 BCU/ECU/OWS Interface

.1 General

.1 Able to downline load any BCU/ECU application program to any BCU/ECU device from the OWS

.2 Able to up-line load BCU/ECU application programs to the OWS.

.3 Operator access restricted editing rights to BCU/ECU application program and database.

.4 Update and synchronize the real time clock in each BCU/ECU with the CCF's real time clock.

2.3 NETWORK COMMUNICATIONS

.1 General

.1 BACnet TCP/IP, Ethernet 10baseT, bus topology

.2 Fire Alarm and Security system communications:

.1 U.L. 864 listed and approved supervised redundant transmission network.

PART - 3 EXECUTION

3.1 INSTALLATION

.1 Create and install control sequence graphics and review with the Owner. Revise graphics to suit Owners requirements.

.2 Create initial logs as requested by the Owner.

3.2 SYSTEM INTEGRATION

.1 Network Integration

.1 Configure BMS system to integrate with other equipment/systems connected to the BMS system at either the Building LAN or Field LAN levels.

.2 OWS Integration

.1 Configure the OWS, including installation of communication cards and software programming supplied under separate Divisions of the Work.

.3 Provide operator access, graphics, trend logs, etc as if these devices were supplied under this Section of the Work,

3.3 PROGRAM ARCHIVES

.1 Provide two permanent record of all programs on CDROM. Provide one copy to the Owner and retain one copy.

.2 Archive programs after completion of controls verification at a time agreed to with the Owner.

3.4 COMPUTER FURNITURE

.1 Set-up workstation on computer furniture. Provide power bars, etc, to suit power requirements.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Labour, products, equipment and services necessary to complete the work of this Section.

.2 The requirements of this Section can be met by either a standalone server device, or incorporation into a BCU - Section 25 13 00.

1.2 REFERENCE STANDARDS

.1 BACnet

.1 ANSI/ASHRAE Standard 135-1995

1.3 SUBMITTALS

.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 33 00.

.2 Submit Protocol Implementation Conformance Statements (PICS) for all BACnet compliant devices.

PART - 2 PRODUCTS

2.1 INTERNET/INTRANET WEB SERVER

.1 General

.1 Web Server to allow daily operations functions to be accomplished from any network connected web browser, utilizing any commercially available browser such as Google Chrome

.2 No additional software is to be installed or is required on the client PC for normal operation of the system.

.3 Web Server to be located on the owners Intranet or on the Internet.

.4 Automatically obtain an IP (Internet Protocol) address using DHCP, as well as supporting static IP addressing.

.5 Sufficient capacity to store and serve 4000 (minimum) user defined graphics.

.6 Accessibility: unlimited, with a minimum of 30 users accessing this device at the same time.

.7 Web Browser Client supports Sun Microsystems JAVA 2 (JRE 1.4.0 or higher) plug-in.

.2 Communications

.1 BACnet: support the BACnet Interoperable Building Blocks (BIBBS) for Read (Initiate) and Write (Execute) Services, for the following data sharing BIBBS:

9.	DS-RP-A,B
10.	DS-RPM-A
11.	DS-WP-A
12.	DS-WPM-A

.3 Communications Security

.1 128 bit SSL encryption.

.4 Functionality

.1 Operators enter a valid user name and password to enter system. The view (access level) of the system provided will be customized based on user identity.

.2 Operator Security : assign an unique user name and password to each operator.

.3 Operator Access: based on security level – View, View and Edit, Administrator.

.1 Operators with proper security level can override setpoints and equipment operation, revise operating schedules, acknowledge alarms. These changes to be made graphically within the browser.

.4 Graphics Display : same as those generated at the Operators Workstation (OWS).

.1 Includes static information: floor plans, equipment schematics, etc.

.2 Includes dynamic information: space temperature, setpoints, equipment status, etc.

.3 Refresh rate: dynamic information every 10 seconds, without requiring a refresh of the static display.

.4 Display of system schedules.

.5 Alarms and Events: displayed through browser.

.6 Trending: displayed graphically through browser, with proper axis scaling automatically selected.

.5 Hardware

.1 Solid state type server. No moving parts, including but not limited to cooling fans, disk drives, CD-Rom drives, etc.

.2 Wall mounted in EEMAC 1 enclosure.

.3 All user entered information (web pages, security, etc) stored in non-volatile memory.

.4 Back-up system operational information and clock functions by battery or other device for a minimum of 72 hours.

PART - 3 EXECUTION

3.1 INSTALLATION

.1 Wiring

.1 Refer to Sections 25 13 00 and 25 14 00 for selection of communications medium.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 DEFINITIONS

.1 ECU: Equipment Controller Unit

.2 BCU: Building Controller Unit

.3 OWS: Operators Work Station (desktop personnel computer)

.4 EMS: Energy Management System programs

1.3 SUBMITTALS

.1 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00.

PART - 2 PRODUCTS

2.1 BUILDING CONTROLLER UNITS (BCU)

.1 General

.1 BCU used for:

.1 Global energy management control strategies

.2 Communications router/gateway between field bus and building network bus

.3 Storage of field data for Trend and History logs

.4 Capable of providing Direct Digital Control through use of integral or expansion module I/O boards, or I/O ECU units.

2.2 BCU - HARDWARE

.1 General

.1 Microprocessor based Direct Digital Control stand-alone units capable of performing control routines independent of communications with OWS.

.1 16-bit microprocessor with EPROM for operating system (O.S.) and EMS programs

.2 72 hour battery backed RAM for DDC programs and data files

.3 Microprocessor and memory sockets for chip replacement

.4 Power supply

.5 A/D and D/A converters

.6 Memory

.7 Motherboard capacity to accommodate a maximum of 64 input/output (I/O) points

.8 Plug in expansion boards to the maximum 64 points

.9 Minimum two totalizer inputs to accommodate demand meter pulse counts and end of interval signal

.2 Time Clock

.1 A battery backed hardware real time clock to provide time of day, day of week, date, month, and year

.2 An integral one hundred year calendar with automatic leap year compensation

.3 Operating Environment:

.1 Outdoors and/or wet ambient: mounted in NEMA 4 rated enclosures, rated for operation at -40°C to +65°C (-40°F to +150°F)

.2 Indoors : mounted in NEMA 1 rated enclosures, rated for operation at 0°C to +50°C (32° F to 120°F)

.3 Power rating ; 90% to 110% nominal voltage rating, with orderly shut-down below 80% voltage rating.

.2 Input/Output Interface

.1 I/O Protection

.1 I/O from shorting the point to itself, another point, or to ground, and not cause damage to the controller.

.2 Protected from voltage up to 24 V, with no damage to the controller.

.2 I/O General

.1 Inputs: universal type capable of handling current, voltage, resistance or open and closed contacts in any mix

.2 I/O's integral to BCU or mounted on expansion modules

.3 Analogue input devices

.1 4-20 mA

.2 0-1 volt

.3 0-5 volt

.4 0-10 volt

.5 2-10 volts

.4 Digital input types

.1 Normally open contacts

.2 Normally closed contacts

.3 Current/no current

.4 Voltage/no voltage

.5 Analog output types

.1 Proportional current or voltage type with a minimum incremental resolution of 0.5 percent of the full operating range of the valve or damper actuating device

.2 Proportional range: matched to the full operating range of the actuating device

.3 Zero and maximum output voltage or current values: used for shutdown and close off modes

.4 For troubleshooting and load analysis, make available the value of each analog output in the data base for trending and display

.6 Digital output types

.1 Maintained outputs

.2 Pulsed outputs for momentary or magnetic latching circuits

.3 Configurable for 3 mode control (fast-slow-off) and 2 mode control (On-Off)

.7 Sensor linearization

.1 Programmable intermediate ranges and linearization tables for sensors

.2 For RTD type sensors of 1000 ohms or less, individually calibrate each input point via precision decade box to compensate for lead lengths errors

.8 Packaging

.1 Complete installation and check out of field wiring can be done prior to the installation of electronic boards

.2 All board terminations are to be made via plug in connectors to facilitate trouble shooting, repair, and replacement

.3 Factory mounted accessories, wired and housed in enclosure including relays, transducers, power supplies, etc.

.4 Pre-wired connector for insertion of a portable operators terminal (POT) or portable programmers terminal (PPT). Attachment of POT or PPT shall not interrupt or disable normal panel operation or bus communications.

.9 Diagnostic indication

.1 Transmit

.2 Receive

.3 Power Up Test

.4 Power Up Fail

.5 Power Up Test Ok

2.3 BCU - SOFTWARE

.1 General

.1 Store Energy Management application programs and associated data files in non-volatile or 72 hour battery backed RAM memory.

.2 Access individual programs from the central operators terminal or portable operators terminal for enabling/disabling and program parameter modification.

.3 BCU programs written at OWS and downloaded to BCU.

.4 Self test diagnostics to run automatically and allow BCU to report malfunctions to OWS.

.5 DDC control sequences implemented in a high level programming language such as Pascal. Both PID and adaptive control algorithms are to be utilized as appropriate to the sequence of operation paragraphs of this specification.

.2 Programs

.1 Provide the following global programs

.1 Time Programs

.2 Exception day programs

.3 Optimal Start

.4 Distributed Power Demand

.5 Optimum Start

.6 Night Cycle

.7 Night Purge

.8 Duty Cycle

.9 Enthalpy Control

.10 Load Reset

.11 Heavy Equipment Starting

.12 Emergency/Normal Power program

.2 Assignment of points and systems to these programs to be under operator control.

.3 Time Programs

.1 Independent start and stop program time provided for each system identified in the Input/Output summary.

.2 It shall be possible to assign two independent start and stop times per day to any equipment connected to a controller. Outputs from this program are start/stop command signals to air handling, heating or cooling systems, etc.

.3 Downloadable to ECU units.

.4 Exception Day Scheduling

.1 Provided to accommodate Holiday and other planned exceptions to the normal time programs.

.1 Definition of up to 32 exception time spans. Each span to be defined as to calendar start day and calendar stop day.

.2 The exception day program applies to all time scheduled energy management programs like Optimum Start and Stop and Duty Cycle.

.3 Downloadable to ECU units.

.5 Temporary Scheduler

.1 Provided to allow the operator to modify present time program control of equipment.

.2 Minimum feature set required:

.1 Ability to alter time schedule changes as much as six days in advance.

.2 Ability to alter either start time, stop time or both for each day.

.3 Temporary schedule to be in effect for all days specified.

.4 Automatically delete the temporary schedule and restore program to normal schedule after execution.

.5 Ability to alter the stop time for the current day.

.6 Ability to assign schedule changes as permanent as well as temporary.

.3 Downloadable to ECU units.

.6 Distributed Power Demand Program (Load Shedding)

.1 Based on a sliding window instantaneous demand algorithm.

.2 Calculates the demand, forecasts the demand trend, compares it to established demand limits, and initiates load shedding action or reestablishment of loads as required.

.3 Sequential basis load-shedding with least important loads shed first and restored last.

.4 Restoration cycle: adds the most important loads first.

.5 Prioritization tier: four-tier system.

.1 When a tier request is issued to the bus, each ECU controller will shed Tier 4-3-2-1 loads, etc. until the shed requirement is met.

.7 Optimum Start, Night Cycling and Night Purge for Free Cooling

.1 Integrated into a single coordinated software package addressing the unique requirement of the building's Unoccupied Period. Each air handler is to be assigned an independent Unoccupied Period program which may include one or more of the following:

.2 Optimum Start Program

.1 Delay equipment startup based on outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy time.

.2 The program operates in both heating and cooling cycles.

.3 Employ an adaptive algorithm which automatically adjusts according to the previous day's actual start time and whether comfort conditions were reached prior to or after scheduled occupancy time.

.4 The program automatically assigns longer lead times for weekend and holiday shutdowns.

.5 Space temperature input: For those zones that a Thermostat only is specified a single representative sample shall be applied. For those zones that a Thermostat and Space Temperature Sensors are specified, an average of zones served shall be applied.

.6 Assignable occupancy start times on a per air handler unit basis.

.7 Optimum Stop program to utilize stored energy (flywheel effect) to carry the heating or cooling load on a short term basis.

.8 Applicable to any primary or secondary system which supplies heating or cooling medium to the space (air handlers or water systems).

.9 employ an adoptive algorithm to automatically accelerate the stop time as much as one hour based on external load conditions and the rate of temperature change of the occupied space with the energy source off (Drift Rate).

.10 Independent Drift Rate calculations are required for heating and cooling. Calculate drift rate for heating on the basis of the zone having the greatest cooling load.

.11 Multi-zone applications: provide a subroutine that compares several zone temperatures, then selects the lowest or highest for the Drift Rate calculation depending on whether heating or cooling energy is being supplied.

.12 Historical Drift Rates for both heating and cooling are to be stored and adjusted daily for the current heating and cooling load. The lead time for stopping equipment shall not cause space conditions to exceed either the heating or cooling comfort limits.

.3 Night Cycle Program

.1 Applies to both heating and cooling cycle.

.2 Heating cycle: the average space temperature of the zones served determines the "fan on" or "supply heat" command. Assign a low limit of (15.5-18.3°C) as the minimum night temperature. During night cycle operation outdoor air dampers are to remain closed.

.3 Cooling cycle: the highest space temperature of the zones served or the highest relative humidity of the zones served determines the "fan on" or supply cooling command. Assign a high limit of 27.7°C (65% RH) as the upper limit for night cycle operation.

.4 Duty Cycle Program

.1 Periodically cycles lead duty standby pumps.

.2 Assign each load a cycle period, a maximum off time and a minimum off time.

.3 Do not cycle when either pump is in alarm or reports a failure to run status.

.4 The program applies to heating only, cooling only and heating/cooling units.

.5 Enthalpy Program

.1 Automatically selects the air source, outdoor air, or return air, or mix of both, that presents the least total heat load to the cooling coil.

.2 Base the control algorithm decision on measurement of outside air drybulb, outside air dewpoint or RH and return air drybulb, return dewpoint or RH. Make calculations of total heat content for each source and compare to determine if minimum outdoor air is to be used or a mix of outdoor and return air.

.6 Load Reset Program:

.1 Provided to assure that only the minimum amount of heating and cooling energy is supplied to satisfy zone temperature requirements.

.2 Applicable to multi-zone units and the chilled water supply to individual air handlers of all types.

.3 Provide individual programs, each sensing the worst case zone requirements and providing only the minimum temperature source media to satisfy the need.

.7 Heavy Equipment Starting Program:

.1 Prevent simultaneous starting of heavy equipment such as fans, pumps and chillers.

.2 Invoked on return to normal power from a power failure, or on return to normal after fire alarm condition and any other time when more than one piece of heavy equipment could be started at a time.

.8 Emergency/Normal Power Program:

.1 Initiated when normal power is off and diesels are running at proper voltage and frequency and when normal power is restored.

.2 Sense failure of primary power and automatically restore any preselected group of loads to running mode.

.3 Record time at which primary power failed and list loads turned on under emergency power condition.

.4 Turn on loads in an orderly fashion with programmable delay between starts.

.5 Sense restoration of primary power and automatically restore preselected group of loads to running mode.

.6 Record time at which primary power was restored and list loads turned on with the restoration of normal power.

.7 Turn on loads in an orderly fashion with programmable delay between starts.

.8 Alarm if equipment turned on fails to start on either emergency power or power restoration sequence.

2.4 OEM INTEGRATION CONTROLLERS

~~RESERVED~~

.1 Type

.1 Two way data communications/integration between BAS system and Original Equipment Manufacturers (OEM) controller units.

.2 Integration:

.1 Programmable protocol converters at the BMS Building Network Level or the Field LAN level.

.3 OEM manufacturers will provide communications device and application software for communications connections and data transfer:

.4 Applicable systems:

.1 Chillers

.2 22-AHU-03

.3 Variable speed drives

.4 Air compressors

.5 Compressed air dryers

.6 Chemical water treatment

.7 Fire Alarm System

.8 Lighting Control System

.9 Electrical Power Metering System

.10 Security System

.11 Other equipment

2.5 BUILDING LAN COMMUNICATIONS

.1 Type

.1 Manufacturer selectable communication protocol from the following:

.1 BACnet TCP/IP - Ethernet/Internet

.2 Wiring:

.1 Less than 100 m between network nodes without repeaters: Category 5 cable.

.2 Greater than 100 m between network nodes: optical fibre

.3 Between buildings, regardless of distance: optical fibre in 50 mm conduit directly buried in 20 MPa concrete.

PART - 3 EXECUTION

3.1 INSTALLATION

.1 Provide Energy Management Controllers for control and instrumentation strategies as detailed in sequence of operation, and mechanical drawings and specifications.

.2 Building LAN Wiring:

.1 Provide BMS Building LAN Ethernet wiring system in a Bus or Star topology.

.3 Equipment mounting:

.1 Install equipment in accordance with manufacturer's recommendations.

.2 Mount units on channel frames adjacent to equipment being controlled.

.3 Install piping securely anchored to structure or equipment.

.4 Make power connections to controller units and sensors.

.4 Configuration:

.1 Total number of devices on each Building LAN Bus not to exceed 80% of maximum device limitations (with the use of repeater devices).

.5 Labeling:

.1 Provide labeling in accordance with Section 25 05 00.

END OF SECTION

PART - 1 GENERAL

1.1 SUMMARY

.1 Section includes:

.1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 DEFINITIONS

.1 ECU: Equipment Controller Unit

.2 BCU: Building Controller Unit

.3 POT: Portable Operators Terminal

.4 OWS: Operators Work Station (desktop personal computer)

.5 EMS: Energy Management System programs

PART - 2 PRODUCTS

2.1 ECU - GENERAL

.1 Microprocessor based Direct Digital Control stand-alone units capable of performing control routines independent of communications with BCU units.

.2 ECU's divided into two controller classifications:

.1 Programmable: universal type, suitable for custom air handling units and large equipment systems - ECUP

.2 Configurable: pre-programmed units to serve terminal and unitary equipment. - ECUC

.3 I/O capacity: as required for control sequence requirements, plus a minimum of 10% allocation for future point additions without the addition of controllers or I/O expansion modules.

.4 I/O Protection:

.1 I/O from shorting the point to itself, another point, or to ground, and not cause damage to the controller.

.2 Protected from voltage up to 24 V, with no damage to the controller.

2.2 PROGRAMMABLE ECU - HARDWARE

.1 General

.1 Microprocessor based Direct Digital Control stand-alone units capable of performing custom control routines independent of communications with BCU units.

.1 16-bit microprocessor with EPROM for operating system (O.S.) and

EMS programs

.2 72 hour battery backed RAM for DDC programs and data files

.3 Microprocessor and memory sockets for chip replacement

.4 Power supply

.5 A/D and D/A converters

.6 Memory

.7 Motherboard capacity not to exceed 64 input/output (I/O) points, with or without expansion boards

.8 Minimum two totalizer inputs to accommodate demand meter pulse counts and end of interval signal

.2 Time Clock

.1 A battery backed hardware real time clock to provide time of day, day of week, date, month, and year

.2 An integral one hundred year calendar with automatic leap year compensation

.3 Operating Environment:

.1 Outdoors and/or wet ambient: mounted in NEMA 4 rated enclosures, rated for operation at -40°C to +65°C

.2 Indoors : mounted in NEMA 1 rated enclosures, rated for operation at 0°C to +50°C

.3 Power rating ; 90% to 110% nominal voltage rating, with orderly shut-down below 80% voltage rating

.2 Input/Output (I/O) Interface

.1 Inputs: universal type capable of handling current, voltage, resistance or open and closed contacts in any mix.

.2 Analogue input devices

.1 4-20 mA

.2 0-1 volt

.3 0-5 volt

.4 0-10 volt

.5 2-10 volts

.3 Binary input types

.1 Normally open contacts

.2 Normally closed contacts

.3 Current/no current

.4 Voltage/no voltage

.4 Analog output types

.1 Proportional current or voltage type with a minimum incremental resolution of .5 percent of the full operating range of the valve or damper actuating device

.2 Proportional range: matched to the full operating range of the actuating device

.3 Zero and maximum output voltage or current values: used for shutdown and closeoff modes

.4 For troubleshooting and load analysis, make available the value of each analog output in the data base for trending and display

.5 Binary output types

.1 Maintained outputs

.2 Pulsed outputs for momentary or magnetic latching circuits

.3 Configurable for 3 mode control (fast-slow-off) and 2 mode control

.6 Sensor linearization

.1 Programmable intermediate ranges and linearization tables for sensors

.2 For RTD type sensors of 1000 ohms or less, individually calibrate each input point via precision decade box to compensate for lead lengths errors

.7 Packaging

.1 Complete installation and check out of field wiring can be done prior to the installation of electronic boards

.2 All board terminations are to be made via plug in connectors to facilitate trouble shooting, repair, and replacement

.3 Factory mounted accessories, wired and housed in enclosure including relays, transducers, power supplies, etc.

.4 Pre-wired connector for insertion of a portable operators terminal (POT) or portable programmers terminal (PPT). Attachment of POT or PPT shall not interrupt or disable normal panel operation or bus communications

.8 LED Diagnostic indication

.1 Transmit

.2 Receive

.3 Power Up Test

.4 Power Up Fail

.5 Power Up Test Ok

.9 Operator Interface:

.1 LCD display and keypad, with scroll menu options

.2 Multi level security password access

2.3 PROGRAMMABLE ECU - SOFTWARE

.1 General

.1 DDC control sequences are to be ECU resident and implemented in a high level programming language such as Pascal. Both PID and adaptive control algorithms are to be utilized as appropriate to the sequence of operation paragraphs of this specification.

.2 ECU resident EMS programs: adaptive and fully integrated with the DDC programs to avoid control contentions. Specific EMS programs to be provided are as called for in the software section of this specification and the sequences of operation.

.3 Software includes:

.1 Complete operating system (O.S.)

.2 Communications handler

.3 Point processing

.4 Standard control algorithms and specific control sequences (DDC)

.5 An Owner/User custom control and calculation package complete with interpreter. (Reference "Data Communications" for communications network requirements.)

.2 O.S. Software

.1 General:

.1 PROM resident

.2 Operate in real time

.3 Provide prioritized task scheduling

.4 Control time programs

.5 Monitor and manage ECU to ECU and ECU to central computer communications

.6 Scan inputs and outputs

.7 Built-in diagnostics

.3 Input/Output Point Processing Software

.1 General:

.1 Continuous update of input and output values and conditions

.2 All connected points are to be updated at a minimum of one second intervals

.3 Analog to digital conversion

.4 Scaling and offset

.5 Correction of sensor non-linearity

.6 Sensing no response or failed sensors

.7 Conversion of values to 32 bit floating point format

.2 Both the maximum and minimum values sensed for each analog input are to be retained in memory.

.3 Able to input subsets of standard sensor ranges to the A/D converter and assign gains to match the full scale 32 bit conversion to achieve high accuracy readout.

.4 A reasonability check on all analog inputs against the previously read value and discard those values falling outside preprogrammed reasonability limits.

.5 Assignment of proper engineering units and status condition identifiers to all analog and digital input and outputs.

.6 Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input or to assign a set of floating limits (alarm follows a reset schedule or DDC control point) to the input.

.1 Assign a unique differential to prevent a point from oscillating into and out of alarm

.2 Alarm comparisons are to be made each scan cycle

.7 Debounce of binary inputs to prevent nuisance alarms.

.1 Debounce timing: adjustable from two seconds to two minutes in one second increments

.4 Command Control Software

.1 Manages the receipt of commands from the central operators console, portable operators terminal, and from control programs.

.2 Command delay: provided to prevent simultaneous energizing of loads. Delay must be programmable from 0 to 30 seconds.

.3 Assign each command a command and residual priority to manage contentions created by multiple programs having access to the same command point:

.1 Execute only outputs with a higher command priority execute

.2 Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority

.4 Fixed mode" option: supported to allow inputs to, and outputs from, DDC control programs to set to a fixed state or value:

.1 In "fixed mode" inputs and outputs are to be assigned a high

residual command priority to prevent override by application programs.

.5 Maintain a last user record to positively identify which program or manual command is in control of a given point.

.1 Display the last user information along with other point data on the CRT display of logical groups.

.5 Alarm Lockout

.1 Provided to prevent nuisance alarms

.1 On initial startup of air handler and other mechanical equipment assign a "timed lockout" period to analog points to allow them to reach a stable condition before activating alarm comparison logic

.2 Lockout period: programmable on a per point basis from 0 to 90 minutes in one minute increments

.2 Provide a "hard lockout" to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point.

.1 Hard lockout points and lockout initiators: operator programmable.

.6 Run Time

.1 Accumulated Run time based on the status of a digital input point.

.1 Totalize either on time or off time up to 10,000 hours with one minute resolution.

.2 Run time counts reside in non volatile memory and have ECU resident run time limits assignable through the operators terminal.

.7 Transition Counter

.1 Provided to accumulate the number of times a device has been cycled on or off.

.1 Non-volatile and be capable of accumulating 600,000 switching cycles

.2 Assignable limits to counts to provide maintenance alarm printouts

.8 Custom DDC Programs

.1 Provide custom programming to meet the control strategies as called for in the sequence of operation sections.

.2 Memory resident and available to the programs a full library of DDC algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences.

.3 Proportional Control, Proportional plus Integral (PI), Proportional plus Integral plus Derivative (PID), and Adaptive Control (self learning).

.1 Adaptive Control algorithm used on control loops, as indicated in

the I/O summary, where the controlled medium flow rate is variable (such as VAV units and variable flow pumping loops).

.2 Adaptive control algorithm monitor the loop response characteristics in accordance with the time constant changes imposed by variable flow rates. The algorithm operates in a continuous self learning manner and retains in memory a stored record of the system dynamics so that on system shutdown and restart, the learning process starts from where it left off and not from ground zero.

.3 Standard PID algorithms are not acceptable substitutes for variable flow applications since they will provide satisfactory control at only one flow rate and will require continued manual fine tuning.

.4 Make available DDC setpoints, gains and time constants associated with DDC programs to the operator for display and modification via the central operator interface and portable operators terminal.

.5 Adjustable execution interval of each DDC loop from two to 120 seconds in one second increments.

.6 Assignment of initialization values to all outputs to assure that controlled devices assume a fail safe position on initial system start up.

.9 Time and Event Programming

.1 Initiates a controlled sequence of events for execution at a specific time or upon the occurrence of an event.

.2 Program features required as a minimum are:

.1 Analog points to be commandable to a specific value

.2 Digital points commandable to a specific state; i.e., on or off; fast, slow or off

.3 Initiator to be a specific day and time or a specific event; i.e., either analog or digital alarm occurrence

.4 Manual initiation via operator's command

.5 Commands must honour command delays to prevent current surges and assigned minimum ON and OFF times

.6 Commands must honour command and residual priority structures allowing higher priority commands (like smoke control) to override lower priority commands (like duty cycle) and residual priority.

.7 Ability to chain TEP's

.8 Ability to enable and disable TEP's individually

.9 Ability to enable/disable TEP initiators

2.4 CONFIGURABLE ECU - HARDWARE

.1 General

.1 Pre-programmed, configurable packaged controller unit for:

.1 Variable volume terminal units

.2 Fan powered terminal units

.3 Unit heaters

.4 Fan coils

.5 Heat pumps

.6 Local reheat zones

.7 Perimeter heating control

.8 Free-standing fans

.2 Integral damper electronic actuator on terminal unit controllers.

.3 Optically isolated from other controllers on communication loop.

.4 Wired to wall mounted temperature sensor with jack-style communications wiring.

.5 Auxiliary universal I/O points for control of reheat coil hot water control valve and a second zone heating control valve.

.6 Factory calibrated velocity pressure sensor.

.7 Calibration data stored in EEPROM memory for at least 15 velocity/pressure points within terminal unit range.

.8 Memory: maintain all BIOS and programming information in the event of a power loss for at least 90 days.

.2 Operating Environment:

.1 Outdoors and/or wet ambient: mounted in NEMA 4 rated enclosures, rated for operation at -40°C to +65°C.

.2 Indoors: mounted in NEMA 1 rated enclosures, rated for operation at 0°C to +50°C.

.3 Power rating: 90% to 110% nominal voltage rating, with orderly shut-down below 80% voltage rating.

.4 Power:

.1 120 VAC, 60 Hz

.2 Provide control transformers as required to suit equipment

2.5 CONFIGURABLE ECU - SOFTWARE

.1 Programming

.1 Series of user selectable and configurable pre-programmed control functions.

.2 Control parameters field adjustable during balancing to compensate for variations in terminal unit installation, type and size.

.2 Data Input

.1 Entry of data through BCU, OWS or field interface unit through communications jack on room temperature sensor.

.2 Store and manipulate data including:

.1 Box type

.2 Box size

.3 Minimum and maximum air flows

.4 Reheat air flow: minimum turndown air flow prior to use of reheat

.5 Current air flow

.6 Calibration factor: for field calibration determines by air balancing

.7 Room temperature setpoint

.8 Maximum room temperature setpoint: occupant selectable

.9 Minimum room temperature setpoint: occupant selectable

.10 Cooling setpoint

.11 Heating setpoint

.12 Unoccupied cooling setpoint

.13 Unoccupied heating setpoint

.14 Afterhours Maximum Timer: maximum time occupant may override unoccupied cycle

.15 Internal Cooling Signal: used to reset supply air temperature if more cooling is required

.16 Internal Heating Signal: used to reset supply air temperature is less cooling is required

.3 Retain control of above listed variables in event of communication loss to Building Controller Units.

2.6 FIELD BUS COMMUNICATIONS

.1 General

.1 Communications between individual ECU's: single pair of twisted wires with a minimum transmission speed of 28,800 baud.

.2 Acoustically coupled to the bus to assure that single or multiple ECU failures will not cause loss of communications with other bus connected devices.

.2 Type:

.1 Polling from ECM.

.2 Manufacturer selectable communication protocol from the following:

.1 LonTalk standard network variable types - SNVTs

.2 (BACnet MS/TP)

.3 (Optimux)

2.7 PORTABLE OPERATORS TERMINAL

.1 Type

.1 Portable operator's terminal capable of direct plug-in to individual ECU's is to be provided for operator read out of:

.1 Temperatures

.2 Control values

.3 DDC parameters

.4 Manual commands, overrides and set point adjustment

.2 The POT is to be hand held, weigh less than [500 g][16 ounces], and plug directly into individual ECU's for power and data.

.2 Functionality

.1 Functionality to include ability to:

.1 Set points to a fixed value/state

.2 Display diagnostic results

.3 Display sequential all point summary and sequential alarm summary

.4 Display/change digital point state, analog point value

.5 Display/change time and date

.6 Display/change application and DDC parameters

.7 Display/change analog limits

.8 Display/change time schedules

.9 Display/change runtime counts and runtime limits

.10 Display/change daylight savings time changeover

.11 Display/change time/event initiation

.12 Display/change programmable offset values

.13 Access ECU initialization routines and diagnostics

.14 Enable/disable points, initiators and programs

.15 Display/change minimum on/off, maximum off time

.3 Interface

.1 Complete with:

.1 Command keys

.2 Data entry keys

.3 Cursor control keys

.4 24 character liquid crystal alpha-numeric display

.2 Access: via self prompting menu selection with arrow key control of next menu/previous menu and step forward/step backward within a given menu.

.4 Interconnection

.1 Connection of a POT to a ECU shall not interrupt nor interfere with normal peer network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.

.5 Alternative

.1 As an alternative to the POT, a fixed liquid crystal or LED display and entry keyboard may be provided per programmable-type ECUP controller. Functional capability must be equal to that described for the POT as a minimum. The fixed display and keyboard must be under lock and key control to prevent tampering.

PART - 3 EXECUTION

3.1 INSTALLATION

.1 Provide Equipment Controller Units for control and instrumentation strategies as detailed in sequence of operation, and mechanical drawings and specifications.

.2 Equipment mounting:

.1 Install equipment in accordance with manufacturer's recommendations.

.2 Mount units on channel frames adjacent to equipment being controlled.

.3 Install piping securely anchored to structure or equipment.

.4 Make power connections to controller units and sensors.

.3 Configuration:

.1 Total number of devices on each Field Bus not to exceed 80% of maximum device limitations (with the use of repeater devices).

.4 Labeling

.1 Provide labeling in accordance with Section 25 05 00.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for building automation controllers including:

.1 Master Control Unit (MCU).

.2 Local Control Unit (LCU).

.3 Equipment Control Unit (ECU).

.4 Terminal Control Unit (TCU).

.5 Input Output Units (IOU)

.2 Related Sections:

.1 Section 25 05 00 - Common Work for Building Automation.

.2 Section 25 05 01 - EMCS: General Requirements.

.3 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.4 Section 25 05 03 - EMCS: Project Record Documents.

.5 25 14 00_R1 Building Automation Local Control units

~~.5~~**.6** Section 25 30 02 - EMCS: Field Control Devices.

~~.6~~**.7** Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

~~.7~~**.8** Section - 25 95 00 **-** Bldg Automation Control Sequences

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE 2007, Applications Handbook, I-P Edition.

.2 Canadian Standards Association (CSA International).

.1 C22.2 No.205-M1983(R1999), Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.3 DEFINITIONS

.1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.5 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 20 % of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Required communications equipment and wiring (if remote units).

.4 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.5 Input Output interface to accept as minimum AI, AO, DI, DO, BI, BO functions as specified.

.6 Wiring terminations: use conveniently located screw type.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges. Installation of additional resistors for conversion purposes is acceptable:

.1 4 - 20 mA;

.2 0 - 10 V DC;

.3 100/1000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door to match existing NRC standard.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs to be mounted in equipment enclosures or separate enclosures.

.3 TCUs to be mounted [in equipment or separate enclosures] [without enclosures]

.4 Mounting details as approved by Departmental Representative for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 When existing cabinets are re-used, the front panel is to be painted fluorescent orange to match existing EMCS NRC campus colour code. Any openings are to be closed with matching orange blank-plates.

.8 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.1 Submit product data sheets for each product item proposed for this project.

Part 2 Products

.1 MASTER CONTROL UNIT (MCU)

.1 General:

.1 Master Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real time operating system. Each NCU control panel shall consist of modular hardware including power supply, CPU board, and input/output modules. A sufficient number of MCUs shall be supplied to fully meet the requirements of this specification and the attached point list.

.2 Hardware Specifications

.1 Memory:

.1 A minimum of 4MB of RAM shall be provided for MCUs with expansion up to 8MB. The 8MB versions shall include a floating-point math co-processor.

.2 Communication Ports:

.1 Each NCU shall provide communication to both the Workstation(s) and the field buses. In addition, each NCU must have at least 3 other communications ports that support a telephone modem, portable service tool, serial printer and connection to third party controllers such as a chiller control panel. On a LAN/WAN system the NCU shall be provided with a 10Mbps plug-in Ethernet TCP/IP network interface card (NIC).

.3 Input/Output (I/O):

.1 Each MCU shall support the addition of the following types of inputs and outputs:

.1 Digital Inputs for status/alarm contacts.

.2 Counter Inputs for summing pulses from meters.

.3 Thermistor inputs for measuring temperatures in space, ducts and thermowells.

.4 Analog inputs for pressure, humidity, flow and position measurements.

.5 Digital Outputs for on/off equipment control.

.6 Outs for valve and damper position control, and capacity control of primary equipment.

.4 Modular Expandability:

.1 The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

.5 Hardware Override Switches:

.1 All digital output units shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

.6 Local Status Indicator Lamps:

.1 Provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each output, provide LED indication of the value of the output (On/Off). For each output module provide an LED which gives a visual indication of whether any outputs on the module are manually overridden.

.7 Real Time Clock (RTC):

.1 Each MCU shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. In normal operation the system clock will be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

.8 Power Supply:

.1 The power supply for the NCUs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered outages. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (–48 VDC).

.9 Automatic Restart After Power Failure:

.1 Upon restoration of power after an outage, the ECU shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

.10 Battery backup:

.1 Each NCU with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or, a minimum of 2 hours of full UPS including modem power. This power backup system shall be configurable such that

at the end of a settable timeframe (such as 1 hour) of running on full UPS, the unit will shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

.3 Software Specifications

.1 General.

.1 The MCU shall contain flash ROM as the resident operating system. Application software will be RAM resident. Application software will only be limited by the amount of RAM memory. There will be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

.2 User Programming Language:

.1 The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

.4 Control Software:

.1 The NCU shall have the ability to perform the following pre-tested control algorithms:

.1 Proportional, Integral plus Derivative Control (PID)

.2 Self Tuning PID

.3 Two Position Control

.4 Digital Filter

.5 Ratio Calculator

.6 Equipment Cycling Protection

.2 Mathematical Functions:

.1 Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be

used in the same equations with the mathematical operators and nested up to five parentheses deep.

.5 Energy Management Applications:

.1 MCUs shall have the ability to perform any or all of the following energy management routines:

.1 Time of Day Scheduling
.2 Calendar Based Scheduling
.3 Holiday Scheduling
.4 Temporary Schedule Overrides
.5 Optimal Start
.6 Optimal Stop
.7 Night Setback Control
.8 Enthalpy Switchover (Economizer)
.9 Peak Demand Limiting
.10 Temperature Compensated Duty Cycling
.11 CFM Tracking
.12 Heating/Cooling Interlock
.13 Hot/Cold Deck Reset
.14 Free Cooling
.15 Hot Water Reset
.16 Chilled Water Reset
.17 Condenser Water Reset
.18 Chiller Sequencing

.6 History Logging:

.1 Each controller shall be capable of logging any system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32767 values can be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.

.7 Alarm Management:

.1 For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the MCU and can result in the display of one or more alarm messages or reports.

.2 Up to 8 alarms can be configured for each point in the controller.

.3 Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device.

.4 Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.

.5 If communication with the Operator Workstation is temporarily interrupted, the alarm will be buffered in the MCU. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.

.8 Reporting.

.1 The MCU shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

.9 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

2.2 Standalone Digital Control Units (SDCU's): (LCU's), (TCU's), (ECU's)

.1 General:

.1 Standalone Digital Control Units shall provide control of HVAC and lighting. Each controller shall have its own control programs and will continue to operate in the event of a failure or communication loss to its associated MCU.

.2 Memory:

.1 Control programs shall be stored in battery backed-up RAM and EPROM. Each controller shall have a minimum of 32K bytes of user RAM memory and 128K bytes of EPROM.

.3 Communication Ports:

.1 SDCUs shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the MCU online. It shall be possible from a service port on any SDCU to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any MCU or any SDCU on a different field bus.

.4 Input/Output:

.1 Each SDCU shall support the addition of the following types of inputs and outputs:

.1 Digital Inputs for status/alarm contacts.

.2 Counter Inputs for summing pulses from meters.

.3 Thermistor Inputs for measuring temperatures in space, ducts and thermowells.

.4 Analog inputs for pressure, humidity, flow and position measurements.

.5 Digital Outputs for on/off equipment control.

.6 Analog Outputs for valve and damper position control, and capacity control of primary equipment.

.5 Expandability:

.1 Input and output capacity shall be expandable through the use of plug-in modules. A minimum of two modules shall be added to the base SDCU before additional power is required.

.6 Networking:

.1 Each SDCU will be able to exchange information on a peer to peer basis with other Standalone Digital Control Units during each field bus scan. Each SDCU

shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled either locally through a portable service tool or through a workstation connected to an MCU.

.7 Indicator Lamps:

.1 SDCUs will have as a minimum, LED indication of CPU status, and field bus status.

.8 Real Time Clock (RTC):

.1 An SDCU shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NCU which synchronizes all SDCU real time clocks.

.9 Automatic Restart After Power Failure:

.1 Upon restoration of power, the SDCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

.10 Battery Back Up:

.1 Each SDCU shall have at least 3 years of battery back up to maintain all volatile memory.

.11 Alarm Management:

.1 For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the SDCU and can result in the display of one or more alarm messages or reports.

.2 Up to 8 alarms can be configured for each point in the controller enabling the escalation of the alarm priority (urgency) based upon which alarm(s) is/are triggered.

.3 Alarm messages can be sent to a local display or to the Operator's Workstation(s).

.4 Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.

.5 If communication with the MCU is temporarily interrupted, the alarm will be buffered in the SDCU. When communications return, the alarm will be transmitted to the NCU if the point is still in the alarm condition.

.12 Local Control Units (LCU's):

.1 LCU's shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.

.2 LCU's shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.

.3 LCU's shall be fully user programmable to allow for modification of the application software.

.4 An LCD display shall be optionally available for readout of point values and to allow operators to change setpoints and system parameters.

.5 A manual override switch shall be provided for all digital and analog outputs on the LCU. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

.13 Lighting Controller:

.1 Lighting controllers shall provide direct control of 20 Amp, 277 VAC lighting circuits using mechanically held, latching relays. Controllers will contain from 8 to 48 circuits per enclosure. Each controller shall also contain inputs for direct connection to light switches and motion detectors.

.2 Each controller shall have the capability for time of day scheduling, occupancy mode control, after hour operation, alarming, and trending.

.14 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.

.15 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.16 Points integral to one Building System to be resident on only one controller.

.17 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:

.1 Include minimum 2 interface ports for connection of local computer terminal.

.2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

.18 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.T

.2 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.

.3 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

.4 TCU's shall support, but not be limited to the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:

.1 Single Duct Cooling Only

.2 Single Duct Cooling with Reheat (Electric or Hot Water)

.3 Fan Powered (Parallel or Series)

.4 Dual Duct (Constant or Variable Volume)

.5 Supply/Exhaust

.5 TCUs for single duct applications will come equipped with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 in.-lb., and contain an override mechanism for manual positioning of the damper during startup and service.

.6 TCU's shall contain an integral velocity sensor accurate to +/- 5% of the full range of the box's CFM rating.

.7 Each controller shall perform the sequence of operation described in Part 3 of this specification, and have the capability for time of day scheduling, occupancy mode control, after hours operation, lighting control, alarming, and trending.

.8 TCU's shall be able to communicate with any other Standalone Digital Control Unit on the same field bus with or without communication to the MCU managing the field bus. Systems that fail to provide this (true peer-to-peer) capability will be limited to a maximum of 32 TCU's per field bus.

.9 ECU's shall support, but not be limited to, the control of the following systems as described in the Execution portion of this specification, and for future expansion:

.1 Unit Ventilators

.2 Heat Pumps (Air to Air, Water to Water)

.3 Packaged Rooftops

.4 Fan Coils (2 or 4 Pipe)

.10 The I/O of each ECU shall contain the sufficient quantity and types as required to meet the sequence of operation found in the Execution portion of this specification. In addition, each controller shall have the capability for time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.

2.3 SOFTWARE

.1 General Description

.1 The software architecture must be object-oriented in design, a true 32-bit application suite utilizing Microsoft's OLE, COM, DCOM and ODBC technologies. These technologies make it easy to fully utilize the power of the operating system to share, among applications (and therefore to the users of those applications), the wealth of data available from the EMCS.

.2 The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.

.3 Programming of controllers shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

.2 System Database

.1 The files server database engine must be Microsoft SQL Server, or another ODBC-compliant, relational database program. This ODBC (**O**pen **D**ata**b**ase **C**onnectivity)-compliant database engine allows for an owner to utilize "their" choice of database and due to it's "open" architecture, allows an owner to write custom applications and/or reports which communicate directly with the database avoiding data transfer routines to update other applications. The system database shall contain all point configurations and programs in each of the controllers that have been assigned to the network. In addition, the database will contain all workstation files including color graphic, alarm reports, text reports, historical data logs, schedules, and polling records.

.3 User Interface

.1 The EMCS workstation software shall allow the creation of a custom, browser-style interface linked to the user that has logged into the workstation software. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows operating system user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the EMCS software but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

.4 User Security

.1 The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. There shall be an inactivity timer adjustable in software that automatically logs off the current operator after the timer has expired.

.5 Configuration Interface

.1 The workstation software shall use a familiar Windows Explorer™-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions. Object names shall not be required to be unique throughout the system. This allows consistency in point naming. For example, each VAV controller can have an input called Space Temperature and a setpoint called CFM Setpoint. The VAV

controller name shall be unique such as VAV for LAB101. Systems requiring unique object names throughout the system will not be acceptable.

.2 The configuration interface shall also include support for template objects. These template objects shall be used as building blocks for the creation of the EMCS database. The types of template objects supported shall include all data point types (input, output, string variables, setpoints, etc.), alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of template object types shall be able to be set up as template subsystems and systems. The template system shall prompt for data entry if necessary. The template system shall maintain a link to all "child" objects created by each template. If a user wishes to make a change to a template object, the software shall ask the user if he/she wants to update all of child objects with the change. This template system shall facilitate configuration and programming consistency and afford the user a fast and simple method to make global changes to the EMCS.

.6 Color Graphic Displays

.1 The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

.2 Requirements of the color graphic subsystem include:

.1 SVGA, bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays.

.2 A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.

.3 Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

.4 Graphic panel objects shall be able to be configured with multiple "tabbed" pages allowing an operator to quickly view individual graphics of equipment, which make up a subsystem or system.

.5 Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.

.7 Automatic monitoring

.1 The software shall allow for the automatic collection of data and reports from any controller through either a hardwire or modem communication link. The frequency of data collection shall be completely user-configurable.

.8 Alarm Management

.1 The software shall be capable of accepting alarms directly from controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.

.2 Alarm management features shall include the ability to have:

.1 A minimum of 255 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, acknowledgment, keyboard annunciation, alarm printout and record keeping.

.2 Automatic logging in the database of the alarm message, point name, point value, connected controller, timestamp, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).

.3 Automatic printing of the alarm information or alarm report to an alarm printer or report printer.

.4 Playing an audible beep or audio (wav) file on alarm initiation or return to normal.

.5 Sending an email or alphanumeric page to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required.

.6 Individual alarms shall be able to be re-routed to a workstation or workstations at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.

.7 An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.

.8 The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.

.9 The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down

list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

.9 Custom Report Generation

.1 The software will contain a built-in custom report generator, featuring word processing tools for the creation of custom reports. These custom reports shall be able to be set up to automatically run or be generated on demand. Each workstation shall be able to associate reports with any word processing or spreadsheet program loaded on the machine. When the report is displayed, it will automatically spawn the associated report editor such as MS Word™.

.1 Reports can be of any length and contain any point attributes from any controller on the network.

.2 The report generator will have access to the user programming language in order to perform mathematical calculations inside the body of the report, control the display output of the report, or prompt the user for additional information needed by the report.

.3 It shall be possible to run other executable programs whenever a report is initiated.

.4 Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

.5 Standard reports shall include:

.1 Points in each controller.

.2 Points in alarm.

.3 Disabled points.

.4 Overridden points.

.5 Operator activity report.

.6 Alarm history log.

.7 Program listing by controller with status.

.8 Network status of each controller

.2 Spreadsheet-style reports

.1 The software shall allow the simple configuration of row/column (spreadsheet-style) reports on any class of object in the system. These reports shall be user-configurable and shall be able to extract live (controller) data and/or data from the database. The user shall be able to set up each report to display in any text font, color and background color. In addition the report shall be able to be configured to filter data, sort data and highlight data which meets user-defined criteria.

.2 HTML Reporting

.1 The above spreadsheet-style reports shall be able to be run to an HTML template file. This feature will create an HTML “results” file in the directory of the HTML template. This directory can be shared with other computer users, which will allow those users with access to the directory to “point” their web browser at the file and view the report.

.10 Scheduling

.1 It shall be possible to configure and download from the workstation schedules for any of the controllers on the network:

.1 Time of day schedules shall be in a calendar style and shall be programmable for a minimum of one year in advance. Each standard day of the week and user-defined day types shall be able to be associated with a color so that when the schedule is viewed it is very easy, at-a-glance, to determine the schedule for a particular day even from the yearly view. To change the schedule for a particular day, a user shall simply click on the day and then click on the day type.

.2 Each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

.3 Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

.11 Programmer's Environment

.1 The programmer's environment will include access to a superset of the same programming language supported in the controllers. Here the programmer will be able to configure application software off-line (if desired) for custom program development, write global control programs, system reports, wide area networking data collection routines, and custom alarm management software. On the same screen as the program editor, the programming environment shall include dockable debug and watch bars for program debugging and viewing updated values and point attributes during programming. In addition a wizard tool shall be available for loading programs from a library file in the program editor.

.2 Saving/Reloading

.1 The workstation software shall have an application to save and restore field controller memory files. This application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

.3 Data Logging

.1 The workstation software shall have the capability to easily configure groups of data points with trend logs and display the trend log data. A group of data points shall be created by drag-and-drop method of the points into a folder. The trend log data shall be displayed through a simply menu selection. This data shall be able to be saved to file and/or printed.

.4 Audit Trail

.1 The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from

logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

2.4 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.5 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support NRC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

2.6 ACCEPTABLE MANUFACTURER

.1 Andover Continuum series of controllers.

Part 3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures [as indicated] [or] [as directed by] Departmental Representative.

.2 Provide necessary power from local 120V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

END OF SECTION

PART - 1 GENERAL

.1 Section includes:

.1 Labour, products, equipment and services necessary to complete the work of this Section.

PART - 2 PRODUCTS

2.1 CONTROL AIR DAMPERS

.1 Type

.1 Modulating control dampers

.1 Opposed blades

.2 Two position control dampers

.1 Parallel blades

.2 Construction

.1 Bearings

.1 Thermal plastic resin copolymer, nylon or oil impregnated bronze,

.2 At blade axles, linkage devices, etc.

.2 Damper blades and frames

.1 Extruded aluminum

.2 Maximum blade length: 1.2 m without internal frame support

.3 Maximum blade length: 1.2 m without internal frame support

.4 Blade edge seals: EPDM gaskets

.5 Frame side seals: extruded TPE

.6 Frame style: flanged to duct.

.7 Jack shaft: extendable, combination of aluminum, and zinc/nickel coated steel

.8 Damper leakage: [50 l/s per m²][10 CFM per ft²] damper face area at 1 kPa differential static pressure.

.3 Damper blades for outside air applications

.1 As above

.2 Operating temperature: -40°C to 100°C

.3 Thermally broken and insulated blades; expanded polyurethane foam insulation

.4 Damper leakage: 21 l/s per m² damper face area at 1 kPa differential static pressure.

.4 Acceptable Manufacturer:

.1 Tamco - Series 1000

.2 Tamco - Series 9000 (outside air applications)

2.2 AUTOMATIC CONTROL VALVES

.1 Body Construction and Selection

.1 Proportional Valves:

.1 Ball valves in accordance with Section 23 05 23

.2 Pressure independent balancing and control valves in accordance with Section 23 05 23 and as follows:

.1 Danfoss AM-QM Self Balancing And Control Valves (13mm To 32mm)

.2 Danfoss AM-QM Self Balancing And Control Valves (38mm To 50mm)

.3 Danfoss AM-QM Self Balancing And Control Valves (65mm To 100mm)

.3 Globe valves in accordance with Section 23 05 23 and as follows:

.1 Bronze body with screwed ends in sizes NPS 2 and smaller.

.2 Cast iron with flanged ends in sizes NPS 2½ and larger.

.3 Forged steel with flanged ends in sizes NPS 2½ and larger for steam systems.

.4 Two butterfly valves, operated in tandem, are not acceptable for 3-way valves.

.2 Two Position Valves:

.1 Ball valves in accordance with Section 23 05 23

.2 Butterfly valves in accordance with Section 23 05 23 and as follows:

.1 Full lug-wafer style, drilled and tapped

.2 Extended neck for flange and insulation clearance

.3 Valve discs

.4 Composition type with bronze trim

.5 Steam service with supply pressures greater than 103 kPa: stainless steel trim

.3 Valve seat rings

.1 Screw in type.

.4 Proportional (2 way and 3 way)

.1 Ball, and Globe type in accordance with Section 23 05 23.

.5 Two Position

.1 Ball and Butterfly type in accordance with Section 23 05 23.

.6 Pressure ratings for steam and water valves

.1 Minimum one and a half times the maximum system pressure.

.2 Close against a minimum differential pressure rating of 275 kPa.

.7 Selection:

.1 Select control valves as follows unless otherwise shown:

Application	Proportional	Two Position
Central Air Handling Units	SB & FC Globe	---
Refrigeration Chillers, Boilers, Cooling Towers, etc	---	Butterfly
Steam Piping system pressure, temperature and flow control	Globe	---
3 Way Hydronic Piping system pressure, temperature and flow control	Globe	---
Hydronic Piping system pressure, temperature and flow control	SB & FC Globe	---
Piping system automatic drain-down, NPS 50mm and under	---	Ball
Piping System Isolation valves, NPS 50mm and under	---	Ball
Piping System Isolation valves, NPS 100mm and over	---	Butterfly
Terminal unit reheat coils and unit heaters, NPS 32mm and under	SB & FC Globe	Ball
Terminal unit reheat coils, NPS 39mm and over	SB & FC Globe	---
Radiant ceiling panels and wall fin convectors	SB & FC Globe	---

.2 Performance

.1 General

.1 C_v values to be corrected with piping geometry factor (Fp).

.2 Straight through water valves: single seated with equal percentage flow characteristics and minimum resolution of 40:1 or greater.

.3 Three-way mixing water valves: linear for each port giving constant total flow.

.4 Modulating steam valves: modified linear flow characteristics.

.2 Steam Valves, Pressure Drop, unless otherwise shown.

.1 Modulating, 100 kPa or less steam supply pressure: maximum 80% of inlet gauge pressure.

.2 Two position, 100 kPa or less steam supply pressure: maximum 15 kPa.

.3 Modulating, greater than 100 kPa steam supply pressure: 42% of the inlet absolute pressure.

.3 Water Valves, Pressure Drop, unless otherwise shown.

.1 Two position: maximum 10% of system pump head.

.2 Modulating, two-way: maximum of 36 kPa pressure drop.

.3 Modulating, three-way: maximum of 60 kPa pressure drop.

.4 Valve Flow Rates

.1 Valves at air handling units: refer to Coil schedules

.2 Valves at Terminal Units and Unit Heaters : refer to Terminal Unit schedule and Unit Heater schedule.

.3 Valves at distributed heating units including wall fin convectors and radiant panels: refer to plan drawings for flow rate or related heat rate.

.4 All other valves : refer to Control Valve schedule.

.5 Modulating steam loads greater than 900 kg/hr: provide two valves in parallel, controlled in sequence, with first valve in opening sequence sized for 1/3 and the second valve for 2/3 of steam load.

.6 Acceptable Manufacturers

.1 Danfoss

.2 Baumann

.3 Fisher

.4 Honeywell Industrial Series

2.3 VALVE AND DAMPER OPERATORS

.1 General:

.1 Provide valves and dampers with metal body operators sized to assure smooth, positive operation over the entire operating range, without chatter or slamming, and to give tight shutoff at end positions against the system pressures to be encountered.

.2 Failure position:

.1 Spring return, normally open or normally closed sequence as required so that systems will "Fail-safe" in case of control air pressure or power failure.

.2 On 2-way butterfly valves, provide double acting or reversible actuators.

.3 Sequencing by spring range will not be approved for valves or dampers.

.4 Furnish valves and dampers with operators and spring ranges designed to match as linearly as possible the full scale operating range of the control valve.

.5 Valves NPS6 and over: manual override to open and close valve and disable control signal.

.6 Adequately size operators and in sufficient quantity to ensure smooth damper operation

.2 Electronic Actuators

.1 General

.1 Low torque, fully modulating or two position as indicated.

.2 Time for full open to full close: two minutes nominal.

.3 Current limiting, digital motor rotation sensing circuits, or adjustable end of travel switches to provide motor protection.

.4 Tandem mounting of actuators for higher torque requirements are acceptable.

.5 Spring return with manual override unless otherwise indicated or specified.

.6 On loss of control signal, valve will fail to the designated normally open or closed position.

.2 Terminal equipment

.1 Non-spring return type.

.3 Power and Communications

.1 Positive positioning at 2-10 VDC or 4-20 mA signal

.2 Visual valve position indicator

.3 Built-in rotation reversing switch

.4 Actuator generated 2-10 VDC electronic feedback signal

.5 Capacity to add auxiliary switches when required

.6 Power: 24 VAC or VDC for proportional control, 24 or 120 VAC for 2 position, maximum 15 VA.

.4 Valves NPS 6 and larger

.1 Modulating motor resolution: 1%

.2 Two 1 metre pigtails or terminal strips

.3 Field changeable, printed circuit boards to provide either 2-position or modulating operation

.4 Actuator resolution: 80:1

.5 Run time, end-to-end: 15 to 45 seconds

.6 Power: 24 or 120 VAC, 60 Hz

.7 Auxiliary switches, 1 NO, 1 NC

.8 Housing. NEMA 4

2.4 SWITCHES

.1 Electric Space Thermostats

.1 "On-Off" thermostats for 120 volt service: minimum contact rating of seven amperes.

.2 Thermostats for unit heaters: complete with a manual switching sub-base.

.1 Switching action: "Heat-Off-Fan"

.2 Minimum contact rating: seven amperes at 120 volts A.C.

.3 Modulating electric thermostats: compatible with the equipment they are to control.

.2 Electric Temperature Switches

.1 General application

.1 Minimum contact rating of seven amperes at 120 volts A.C.

.2 Switch setting: adjustable differential.

.3 Switch to switch setting: adjustable differential.

.2 Outside air application

.1 As above

.2 Installed so as not to be affected by sunlight, exhaust air, or reverse warm air flow through air supply units should the supply be off.

.3 Thermowell

.1 Complete with compression fitting for 20 mm well

.2 Mounting length: 100 mm

.3 Immersion wells: type 316 stainless steel

.4 Strap-on pipe

.1 Complete with helical screw stainless steel clamps

.3 High Limit Controls

.1 For ducts under 1.5 sq m of cross sectional area or where the longest dimension is not over 760 mm:

.1 Bi-metal operated control complete with manual reset

.2 Switch contact: normally closed.

.2 Ducts of cross sectional area greater than 1.5 sq m:

.1 Temperature sensitive heads connected to a pressure switch so that, should a high temperature occur, one of the heads will operate to open the pressure switch and stop the respective equipment.

.2 Switch contact: normally closed.

.4 Low Limit Controls

.1 6 m of capillary, wired to stop the equipment should the temperature over any 300 mm one foot] length drop below its set point.

.2 Switch contact: normally closed with a manual reset.

.5 Fan Proof-of-Flow

.1 U.L. listed adjustable set point and differential pressure type:

.1 Fan static greater than 250 Pa: piped to fan discharge

.2 Fan static less than 250 Pa: piped across the fan

.3 For fractional horsepower and non-ducted fans, use relays or auxiliary contacts.

.2 Pressure ratings

.1 Adjustable set point: 0-2500 Pa

.2 Adjustable differential: 10-250 Pa

.3 U.L. listed adjustable differential pressure or flow type as specified in the sequence of operation:

.1 Chilled water flow switches: totally sealed vapour tight switch enclosure on 2060 kPa body

.2 Differential pressure switches: valve manifold for servicing

.4 Pressure ratings

.1 Chilled and condenser water systems: 860 k

.2 Hot water systems:860 kPa

.3 Steam system and control air systems: 1200 kPa

.4 High temp water systems above 110°C: 2700 kPa, with a full operating range of 0 to 270 kPa with an accuracy of 25 kPa

.5 Pigtail siphon between sensor and fluid line: steam lines and high temperature water lines.

.6 Isolation valve and snubber installed between sensor and pressure source.

.6 Flow Switches

.1 McDonnell and Miller FS-7 Series for liquids and AF Series for air flow.

.7 Fire Stats

.1 57°C manual reset, line voltage type with bimetal actuated switches.

.2 Size switch with adequate rating for the applied load.

2.5 ELECTRICAL RELAYS

.1 Current sensing (switch)

.1 Metering transformer ranged to match load being metered

.1 Plug-in base and shorting shunt to protect current transformer when relay is removed from socket

.2 Current transformer for single or three phase metering into single relay

.3 Adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level

.4 Discrimination between phases in three phase applications to allow worst case selection

.5 Mounted in motor starter cabinet and fed from starter control transformer

.6 Rating: 10 amps at 240 VAC

.2 General relays

.1 Relays for control and status indication

.1 Double voltage DPDT

.2 Relays for implementation of control strategy

.1 Single voltage with appropriate number of contacts

2.6 ELECTRONIC SENSORS

.1 General Requirements

.1 Input/output sensors and devices: closely matched to the requirements of the DCP for accurate, responsive, noise free signal input/output.

.2 Control input response: high sensitivity and matched to the loop gain requirements for precise and responsive control.

.3 In no case shall computer inputs be derived from pneumatic sensors. In no case shall thermocouples or thermistors be used.

.2 Temperature Sensors

.1 Resistance Temperature Detector (RTD) type:

.1 500 ohm balco

.2 or, 100 or 3000 ohm platinum

.3 Factory calibrated

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 End-to-end accuracy: ±0.25°C (±0.5°C) over full range of variable

.6 Transducing output circuit to suit DCP

.2 Thermistor for Terminal Box Control

.1 As above, or 100,000 ohm thermistor

.2 Accuracy: ± 0.5°C

.3 Air Temperature Sensors, Space Type 1

.1 RTD type

.2 Concealed single linear set-point adjustment

.3 Tamper-resistant access door

.4 Field Bus communications jack for portable POT connection

.5 On/Off button to allow occupant override feature

.6 (Plastic mono-chromatic) (brushed aluminum) cover and casing

.4 Air Temperature Sensors, Space Type 2 sensor:

.1 Thermistor type

.2 Stainless steel flat plate surface sensor; sensor epoxy-bonded to back of cover plate.

.3 Field Bus communications jack for portable POT connection

.5 Outside air wall mounted sensors:

.1 RTD type

.2 Provided with a sun shield.

.3 Inert section for passing through wall to unit.

.6 Duct temperature sensors:

.1 Rigid stem or averaging type as specified in the sequence of operation.

.2 Averaging element style for ducts greater than 0.4 m^2 cross-sectional area.

.7 Water temperature sensor:

.1 RTD type

.2 Immersion well: NPS 3/4 stainless steel spring loaded construction, with heat transfer compound compatible with sensor, minimum height of 50mm or to clear insulation thickness

.3 Minimum insertion length: 100 mm

.3 Dewpoint sensor

.1 Type:

.1 Non-reactive organic bobbin material to give precise dewpoint readings with accuracy of not more than +1°C

.2 Integral draft shield as part of the instrument for air velocities in excess of 0.25 m/s

.3 Operate over a minimum dewpoint temperature range suitable to the application.

.4 Provide one additional bobbin assembly with each dewpoint sensor

.4 Humidity Sensors Relative Humidity Sensors

.1 Capacitance type with 5% to 90% range

.2 Operating temperature range: 0-60°C

.3 Absolute accuracy:

.1 Duct sensors: ±5%

.2 Room sensors: ±2%

.4 Duct mounted humidity sensors: provided with a stainless steel sampling chamber for operation up to 10 m/s.

.5 Wall mounted sensors: provided with covers identical to temperature sensors.

.6 Combination temperature and humidity sensor:

.1 Combination temperature compensated humidity and temperature sensors, with remote transmitter and interconnecting cabling

.2 Stainless steel sensor probe, length as identified on drawings

.3 Cable length:[5000 mm

.5 Differential and Static Pressure Sensors

.1 Air flow and static pressure analog sensors

.1 High accuracy suitable for the low velocity pressures to be encountered:

.2 Selected for approximately 50% over-range

.3 4 to 20 ma output

.4 Adjustments for zero and span

.5 Connect differential pressure sensors to the air flow measuring station with valved lines for testing and calibration.

.2 Space pressure

.1 Flush mounted 10 gauge stainless steel welded casing with No. 4 finish

.2 Shielded space probe unaffected by airflows up to 5 m/s from a 360° radial source

.3 Accuracy: ±1% of actual space pressure

.3 Outdoor air pressure

.1 Exposed 10 gauge anodized aluminum with NPT 2 connection

.2 Shielded space probe unaffected by airflows up to 5 m/s from a 360° radial source

.3 Accuracy: ±2% of actual outdoor air static pressure when subjected to a radial wind velocities up to 35 m/s with approach angles up to 30° from the horizontal

.6 Carbon Dioxide Sensor

.1 Provide duct mounted carbon dioxide sensing devices which provide a suitable analog signal to the BMS. Operating range shall be 200 to 2000 PPM with end to end accuracy of +/- 5% full range. The device shall not be sensitive to air temperature or relative humidity.

2.7 FLOW METERS

.1 Water

.1 Provided under Section 23 05 19.

.2 Steam Flow Measurement

.1 Measure steam flow by means of an inline vortex flow meter and separately installed pressure sensor and transmitter. Flow meter shall be suitable for wet steam mass flow integrated temperature detection and measurement for steam quality falling within the range of 80% and 100%.

.2 Approvals:

.1 Approval: CSA C/US NI Cl.I Div.2 Gr. ABCD

.3 Output Signal:

.1 Output; Input: 4-20mA HART, pulse/freq./switch;

.4 Input:

.1 4-20mA input

.5 Display:

.1 Display; Operation: SD03 4-line, illum.; touch control + data backup function

.6 Construction:

.1 Housing: GT20 dual compartment, aluminium coated

.7 Sensor Version:

.1 Mass flow (integrated temperature measurement)

.8 AAS Process Connection:

.1 Cl.150 RF Sch.40, flange ASME B16.5

.9 Calibration Flow:

.1 0.75% volume 3-point

.10 Operation Language Display:

.1 English

.11 Application Package:

.1 Wet steam detection

.12 Performance

.1 Accuracy, measured mass flow to within ±2% of the full scale.

.1 Velocity range: 20 to 50 m/s

.2 Re > 20,000

.3 Operating temperatures: 150 °C

.13 Acceptable Products:

.1 Endress and Hauser (or equivalent)

.14 (Steam Flow Meter Companion) Pressure Sensor and Transmitter

.1 Measure steam pressure with condensate temperature buffer installation arrangement as indicated on the drawings.

.2 Approval:

.1 CSA C/US IS Cl.I,II,III Div.1 Gr.A-G, Cl.I Div.2 Gr.A-D, Ex ia, C: zone 0,1,2/ US: zone 0,1,2,20,21,22

.3 Output; Operating:

.1 4-20mA HART; inside + LCD

.4 Housing;

.1 Cover Sealing; Cable Entry: T14 Aluminium IP66/67 NEMA6P; EPDM; NPT1/2 thread, T14 = side cover

.5 Sensor Range;

.1 Sensor Overload Limit: 10bar/1MPa/150psi gauge; 40bar/4MPa/600psi

.6 Calibration;

.1 Unit: Sensor range; psi

.7 RA Process Connection:

.1 Thread ANSI MNPT1/2 FNPT1/4, 316L

.8 A Seal:

.1 FKM Viton

.9 Additional Option 1: Not selected

.10 Additional Option 2: Mounting bracket, wall/pipe, 316L

.11 Performance

.1 Accuracy, measured pressure up to plus / minus 0.05 % of the set span.

.12 Acceptable Products:

.1 Endress and Hauser (or equivalent)

.3 Airflow Measuring Stations

.1 Measure airflow by means of a network of static and total pressure sensors factory positioned and connected in parallel to produce an averaged velocity pressure.

.2 Performance:

.1 Accuracy, measured velocity pressure converted to airflow l/s: ±2% of the full scale

.2 Velocity range: 3.5 to 20 m/s

.3 Maximum airflow resistance: 0.6 times the velocity head

.4 Maximum operating temperatures: 121°C

.3 Construction:

.1 Casing: heavy gauge (galvanized steel) construction

.2 Duct to duct mounting flanges

.3 Aluminum pitot traverse tubes

.4 Inlet honeycomb air straightening section minimum free area: 97%.

2.8 TRANSMITTERS

.1 Temperature Transmitters

.1 Standalone transmitter

.1 Microprocessor based transmitter

.2 Input circuit: 3 lead, 100 ohm at 0°C, platinum RTD type sensor.

.3 Integral multi-line digital display

.4 Combined non-linearity, repeatability, hyseterisis effects: ±0.5% of full scale range.

.5 Integral zero and span adjustments

.6 Outputs: 4-20 mA linear into maximum 500 Ohm load

.7 Power: 24 VAC, or 24 VDC, or 120 VAC

.8 Provide transformer and ac/dc converter for 24 V devices

.2 Humidity Transmitters

.1 Standalone transmitter

.1 Microprocessor based transmitter

.2 Input circuit: from RH sensor

.3 Integral multi-line digital display

.4 Combined non-linearity, repeatability, hyseterisis effects: ±1% of full scale range.

.5 Integral zero and span adjustments

.6 Outputs: 4-20 mA linear into maximum 500 Ohm load

.7 Power: 24 VAC, or 24 VDC, or 120 VAC

.8 Provide transformer and ac/dc converter for 24 V devices

.3 Pressure (Static and Airflow) Transmitters

.1 Standalone transmitters

.1 Microprocessor based transmitter

.2 Receive flow signals (total and static pressure) from an airflow station or pressure probe and produce dual output linear and scaled signals for air volume, velocity and differential pressure

.3 Integral multi-line digital display

.4 Natural full span: 0-125 Pa

.5 Accuracy: ±0.25% of natural spans

.6 Outputs

.1 0-5 VDC

.2 0-10VDC

.3 or 4-20 mA linear into maximum 500 Ohm load

.7 Power: 24 VAC, or 24 VDC, or 120 VAC

.8 Provide transformer and ac/dc converter for 24 V devices

.9 Outdoor static pressure reference

2.9 TRANSDUCERS

.1 Kilowatt Transducers

.1 Integrated electronic type with accuracy of .2% of scale.

.1 For balanced (such as motors) three phase loads, provide two current transformers (CT's).

.2 Provide two or three potential transformers (PT's) as recommended by the manufacturer for the application.

.3 Output: 4 to 20 ma.

.4 Provide suitable CT's and PT's unless specifically specified with other equipment.

.2 Current Transducers

.1 Integrated electronic type with accuracy of .2% of scale.

.1 For balanced (such as motors) three phase loads, provide two current transformers (CT's).

.2 Measure line current, with output proportional signal:

.1 4-20 mA

.2 0-1 VDC

.3 0-10 VDC

.4 0-20 VDC

2.10 ANCILLIARY DEVICES

.1 Smoke Detectors

.1 Ionization plug-in type device

.1 Two ionization chambers

.2 A comparator-switching circuit

.3 An integral alarm light indicator

.4 Solid state detector circuits

.5 Alarm status indicating lights shall be visible on the front of the detector.

.2 Self compensating for the effects of:

.1 Velocity 0-5 m/s

.2 Changes in temperature 0-50°C

.3 Humidity (5-95% RH)

.4 Atmospheric pressure

.3 Wiring connections: colour coded leadwires located on the mounting base.

.4 Mounting base: standard four inch square electrical box.

.5 Single chamber detectors and photoelectric smoke detectors will not be acceptable.

.2 Duct Smoke Detectors

.1 As above

.2 Listed by Underwriters Laboratories, Inc. for use in air handling systems.

.3 Designed to provide detection of combustion gases and fire and smoke in air conditioning and ventilating duct systems in compliance with the National Fire Protection Association and Underwriters Laboratories, Inc. Standard UL l67.

.4 Air sampling chamber with sampling tubes extending through the width of the air duct.

.5 Key controller test and reset switches plus an easily accessible test jack.

.6 Alarm relay contacts (DPDT) capable of handling loads of up to five (5) amperes at 120 VAC or 28 VDC resistive.

.7 Power: self-contained power supply requiring 120/220/240V power.

.3 Carbon Monoxide Sensors

.1 Solid state, plug-in type with a minimum 3 year sensor life, calibration to be set at 50 to 100 ppm.

.1 CSA approved

.2 Local sensors:

.1 Complete with local LED indication for High and Low alarm as well as a green LED power “ON” light.

.2 Power: low voltage control transformer mounted adjacent to sensor for sensing device

.3 Central control panel:

.1 NEMA 12 lockable steel enclosure containing LED indicators for High, Low and power “ON” for each detection system

.2 BAS interface: one auxiliary alarm contact

.3 Power: 120 VAC, 60 Hz, single phase

.4 Calibration kit:

.1 One canister each of 50 and 100 ppm CO, one adapter and one carrying case.

.5 System supplier to provide site inspection, operating and maintenance instructions and a trained technician to perform system start-up and calibration checks.

.4 Surface Water Detection

.1 Provide alarm on presence of water on floor.

.1 Expendable cartridge sensor

.2 Internal waterproof switch

.3 One set of dry contacts: 2 A at 24 VAC or VDC

.4 Unaffected by moisture in air

.5 Self-powered.

PART - 3 EXECUTION

3.1 INSTALLATION

.1 General

.1 Provide instrumentation, control devices, (pneumatic system) and electrical wiring for control and monitoring strategies as detailed in sequences of operation.

.2 Install equipment in accordance with manufacturers instructions.

.3 Make sensors and elements accessible for replacement and servicing

.4 Install transmitters, transducers, receiver-controllers, solenoid air valves and relays in NEMA 12 enclosures with wiring and tubing within panels in trays or individually clipped to back of panel and clearly identified. Install in NEMA 4 enclosures for outdoor installation.

.5 Install outdoor sensors in NEMA 12 enclosure.

.6 Support field mounted transmitters on pipe stands or channel brackets. Pipe pneumatic sensing lines to transmitters, complete with dirt pockets at transmitter.

.7 Support wall mounted devices on plywood back board, supported from wall or floor. Paint plywood one coat of primer and two top coats, light grey colour.

.2 Thermowells

.1 Install for all piping installations.

.2 Where pipe diameter is less than well insertion length, locate well in elbow, or expand pipe size to be equal to insertion length plus 25 mm.

.3 Thermowell to restrict flow area by less than 30%.

.3 Identification

.1 Identify field devices in accordance with Section 23 05 01.

.4 Testing

.1 Calibrate and test all field devices for accuracy and performance.

.2 Submit report detailing tests performed, results obtained to Consultant for approval. Consultant will verify results at random. Provide all testing equipment and manpower necessary for this verification.

3.2 SENSORS AND SWITCHES

.1 General

.1 Install room type 1 sensors in all general areas.

.2 Install room type 2 sensors where indicated.

.3 Use combination temperature and humidity sensors only when shown on drawings, otherwise provide separate sensors.

.2 Duct Installation

.1 Do not mount in dead air space.

.2 Thermally isolate elements from brackets and supports so as to respond to air temperature only.

.3 Support sensor element independently from coils and filter racks.

.3 Averaging duct type sensor or switch

.1 Sensor length: not less than 1000 mm for each square meter of duct cross-sectional area.

.2 Wire multiple sensors in parallel for freeze protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 High Limit Controls:

.1 Coverage

.1 Provide a temperature sensitive head for approximately every 1.5 sq m of duct cross sectional area.

.2 Install heads in a staggered arrangement to give complete coverage of the duct.

.5 Low Limit Controls

.1 Coverage:

.1 String horizontally across the full width of duct or coil with runs at a maximum of 300 mm centres.

.2 Where one control is insufficient to provide the specified coverage, provide two or more controls to be wired in series.

.3 Coordinate with other trades so that the capillary does not obstruct access from access openings or doors to other duct mounted equipment.

.4 Coordinate with other trades so that the capillary does not obstruct access from access openings or doors to other duct mounted equipment.

.6 Flow Switches

.1 Install flow switches upright in horizontal pipe lines with at least five pipe diameters of straight pipe (without fittings, restrictions etc.) on each side of the flow switch.

.7 Airflow Stations

.1 Locate airflow stations in accordance with manufacturer's guidelines so as to approach ideal laboratory conditions.

.2 Cap off manifold until cleaning of ducts is complete.

.8 Pressure and Differential Switches

.1 Install isolation valve and snubber between sensor and pressure source.

.2 Protect sensing elements on steam and high temperature greater than 98°C with pigtail syphon between valve and sensor.

.9 Pressure Gauges

.1 Provide air pressure gauges as follows:

.1 All pneumatic devices

.2 I/P transducers

.3 Pilot positioners

.4 Motor operators

.5 Switches

.6 Relays

.7 Valves

.8 Damper operators

.9 Valve actuators

.10 Controller outputs

.10 Provide six tracer gas sensor connection points in ducts as directed by Owner. Sensors to be provided by Owner.

END OF SECTION

CS 801 BUILDING SANITARY EXHAUST

Exhaust Fan 22XAF-09 building Sanitary Exhaust

Control Diagram	Detail:	1-M03	Drawing:	3788-M03

System Start	Exhaust Fan start by operator OR BAS master schedule. When main air handling 22-AHU-03 has a run status of ON (software interlock), open exhaust air damper CD19 and enable exhaust fan to start. When damper is proved open by hardwire MDNC, exhaust fan 22XAF-10 starts.
Normal Operation	Continuous operation
Building Flushing	N/A
System Stop	When main air handling unit 22-AHU-03 stop (software interlock), stop exhaust fan 22XAF-10 and close exhaust air damper CD19.
Schedule	Same as associated main building air handling system 22-AHU-03
Fire Alarm	Fan continuous to operate in current state (no FAS interlock)
Alarms	EFA Exhaust fan run failure.
Monitor	EFA Exhaust fan status (current switch)
Trend Logs	None
Emergency Power	No

Remarks:

1. Exhaust air damper prove-open switch is wired to the fan starter as a running interlock; single DO point required.

2. CS 802 similar to CS 801.

End of Section

CS ~~801~~802 ~~BUILDING~~ FLEXIBLE CABIN SANITARY EXHAUST

Refer to CS 801 for Details

~~*Exhaust Fan 22XAF-09 building Sanitary Exhaust*~~

~~Control Diagram~~	~~Detail:~~	~~1-M03~~	~~Drawing:~~	~~3788-M03~~

~~System Start~~	~~Exhaust Fan start by operator OR BAS master schedule. When main air handling 22-AHU-03 has a run status of ON (software interlock), open exhaust air damper CD19 and enable exhaust fan to start. When damper is proved open by hardwire MDNC, exhaust fan 22XAF-10 starts.~~
~~Normal Operation~~	~~Continuous operation~~
~~Building Flushing~~	~~N/A~~
~~System Stop~~	~~When main air handling unit 22-AHU-03 stop (software interlock), stop exhaust fan 22XAF-10 and close exhaust air damper CD19.~~
~~Schedule~~	~~Same as associated main building air handling system 22-AHU-03~~
~~Fire Alarm~~	~~Fan continuous to operate in current state (no FAS interlock)~~
~~Alarms~~	~~EFA Exhaust fan run failure.~~
~~Monitor~~	~~EFA Exhaust fan status (current switch)~~
~~Trend Logs~~	~~None~~
~~Emergency Power~~	~~No~~

~~**Remarks:**~~

1. ~~Exhaust air damper prove-open switch is wired to the fan starter as a running interlock; single DO point requi~~red.

End of Section

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM D698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft^3) (600kN-m/m^3).

.2 CSA International

.1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA A3000-08, Cementitious Materials Compendium.

.3 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation

.1 OPSS 1004-05, Material Specification for Aggregates - Miscellaneous.

.2 OPSS 1010-04, Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.

.4 U.S. Environmental Protection Agency (EPA)/Office of Water

.1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Co-ordination: arrange with authority having jurisdiction for relocation of buried services that interfere with execution of work.

.1 Pay costs of relocating services.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Site Quality Control Submittals: submit in accordance with Section 01 45 00 - Quality Control.

.1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article.

.2 Submit testing and inspection results report as described in PART 3 - FIELD QUALITY CONTROL.

Part 2 Products

2.1 MATERIALS

.1 Granular A to OPSS 1010.

.2 Clear Crushed Stone: clean 19 mm granular, free-draining, washed crushed stone from an approved source, free from organic matter, rubbish, shale, silt, clay, loam, and friable or soluble substances.

Part 3 Execution

3.1 EXAMINATION

.1 Evaluation and Assessment:

.1 Examine soil reports attached as Appendix 1 and 2.

.2 Before commencing work establish locations of buried services on and adjacent to site.

3.2 PREPARATION

.1 Temporary erosion and sedimentation control:

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.2 Protection of in-place conditions:

.1 Protect excavations from freezing.

.2 Keep excavations clean, free of standing water, and loose soil.

.3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to NRC Departmental Representative's approval.

.4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.

.5 Protect buried services that are required to remain undisturbed.

3.3 EXCAVATION

.1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Provincial regulations.

.2 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.

.1 Stockpile topsoil on site for later use.

.3 Excavate as required to carry out work.

.1 Do not disturb soil or rock below bearing surfaces.

.2 Notify NRC Departmental Representative when excavations are complete.

.3 If bearings are unsatisfactory, additional excavation will be authorized in writing and paid for as additional work.

.4 Excavation taken below depths shown without NRC Departmental Representative's written authorization to be filled with concrete of same strength as for footings at Contractor's expense.

.4 Excavate trenches to provide uniform continuous bearing and support for 150 mm thickness of pipe bedding material on solid and undisturbed ground.

.1 Trench widths below point 150 mm above pipe not to exceed diameter of pipe plus 600 mm.

.5 Excavate for slabs and paving to subgrade levels.

.1 In addition, remove all topsoil, organic matter, debris and other loose and harmful matter encountered at subgrade level.

3.4 FIELD QUALITY CONTROL

.1 Testing of materials and compaction of backfill will be carried out by testing laboratory designated by NRC Departmental Representative.

.2 Not later than 1 week minimum before backfilling or filling, submit to designated testing agency, samples of backfill as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.3 Do not begin backfilling or filling operations until material has been approved for use by NRC Departmental Representative.

.4 Not later than 48 hours before backfilling or filling with approved material, notify NRC Departmental Representative to allow compaction tests to be carried out by designated testing agency.

3.5 BACKFILLING

.1 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.

.2 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures.

.3 Compaction of subgrade: compact existing subgrade under walks, paving, and slabs on grade, to same compaction as fill.

.1 Fill excavated areas with Granular “A” compacted as specified for fill.

.4 Placing:

.1 Place backfill, fill and base course material in 150 mm lifts: add water as required to achieve specified density.

.5 Compaction: compact each layer of material to following densities for material to ASTM D698:

.1 To underside of base courses: 95%.

.2 Base courses: 100%.

.3 Elsewhere: 90%.

.6 Under slabs and paving:

.1 Use 98 up to bottom of granular base courses.

.2 Use 100 for base courses.

.7 In trenches:

.1 Up to 300 mm above pipe or conduit: sand placed by hand.

.2 Over 300 mm above pipe or conduit: native material approved by NRC Departmental Representative.

.8 Under seeded and sodded areas: use site excavated material to bottom of topsoil except in trenches and within 600 mm of foundations.

.9 Blown rock material, not capable of fine grading, is not acceptable, imported material must be placed on this type of material

.10 Against foundations (except as applicable to trenches and under slabs and paving): excavated material or imported material with no stones larger than 200 mm diameter within 600 mm of structures.

.11 Underground tanks: use sand to bottom of granular base courses or to bottom of topsoil, as applicable.

3.6 GRADING

.1 Grade so that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by NRC Departmental Representative.

.1 Grade to be gradual between finished spot elevations shown on drawings.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Dispose of cleared and grubbed material off site daily.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM C117-04, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C136-06, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

.3 ASTM D698-07e1, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3)).

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 CSA International

.1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA A23.4-09, Precast Concrete-Materials and Construction.

.3 CSA B66-10, Design, Material and Manufacturing Requirements for Prefabricated Septic Tanks and Sewage Holding Tanks.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for utility septic tanks and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.2 Shop Drawings: to CSA A23.4.

.1 Indicate on drawings:

.1 Design calculations for items designed by manufacturer.

.2 Tables and bending diagrams of reinforcing steel.

.3 Camber.

.4 Formwork.

.5 Finishing schedules.

.6 Methods of handling and erection.

.7 Storage facilities.

.8 Openings, sleeves, inserts and related reinforcement.

1.3 QUALITY ASSURANCE

.1 Manufacturers and erectors of precast concrete elements are to be certified by CSA as meeting requirements of CSA A23.4.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect utility septic tanks from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Design precast concrete septic tank in accordance with CSA B66, and to carry handling stresses and indicated service loads.

.2 Tank to have minimum total working capacity of 3400 L.

.3 Inlet and outlet sizes: 150 dia

2.2 CONCRETE MIXES AND MATERIALS

.1 Concrete mixes and materials: to CSA B66, CSA A23.1/A23.2.

.2 Use type 1 cement.

.3 Concrete exposure classification: C-1.

2.3 MANUFACTURE

.1 Manufacture units in accordance to CSA A23.4. Unit to be suitable for vehicular loading of 12 kPa.

2.4 FINISHES

.1 Finish tanks to CSA A23.4, commercial grade.

2.5 ACCESS

.1 Include access holes to surface to facilitate cleaning and inspection complete with cast iron covers at grade.

2.6 TANK BEDDING AND SURROUND MATERIAL

.1 Granular material in accordance with following requirements:

.1 Crushed or screened stone, gravel or sand.

.2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1, CAN/CGSB-8.2.

.3 Table

Sieve Designation	% Passing
200 mm	-
75 mm	-
50 mm	-
37.5 mm	-
25 mm	-
19 mm	-
12.5 mm	100
9.5 mm	-
4.75 mm	80-100
2.00 mm	50- 90
0.425 mm	10- 50
0.180 mm	-
0.075 mm	0- 10

2.7 BACKFILL MATERIAL

.1 Granular “A” in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.8 MODULAR WALL SEALS

.1 Include modular wall seals: silicone with 316 stainless steel hardware and corrosion resistant sleeves.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for utility septic tank installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of NRC Departmental Representative.

.2 Inform NRC Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NRC Departmental Representative.

3.2 INSTALLATION

.1 Place bedding and surround material in unfrozen condition.

.2 Do excavation in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.3 Place tank bedding material in accordance with details as indicated.

.1 Compact to 95% maximum dry density to ASTM D698.

.4 Make inlet and outlet joints of septic tank watertight, using modular wall seals. Connect discharge to building main sanitary.

.5 Conduct leakage test on septic tank in presence of NRC Departmental Representative, before backfilling.

.1 Fill tank to level of effluent pipe, and allow to stand for 24 hours.

.2 Allowable leakage is zero.

.3 If leakage occurs, remove seal materials and reseal as directed by NRC Departmental Representative.

.6 Do backfilling in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.1 Compact to 90% maximum dry density to ASTM D698.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

January 20, 2015
File: 122411073

Robin Craig
NRC-ASPM
1200 Montreal Road, Bldg M22
Ottawa, ON K1A 0R6

Dear Robin Craig:

Reference: DRAFT - Geotechnical Investigation
Addition to Building M22, NRC Montreal Road Campus, Ottawa, ON

This letter provides the geotechnical engineering results and recommendations from the geotechnical investigation completed for the proposed building addition for Building M22 at the National Research Council (NRC) Montreal Road Campus in Ottawa, ON.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the investigation and provides geotechnical recommendations for the design and construction of the proposed development.

Limitations associated with this report and its contents are provided in the statement of conditions included in Appendix A.

1.0 PROPOSED DEVELOPMENT

Building M22 is located at the NRC Montreal Road Campus, the location of the site and proposed addition is shown on the Key Plan, Drawing No. 1 and Borehole Location Plan, Drawing No. 2 in Appendix B. The proposed building addition for Building M22 is located on the east and west side of the east portion of the existing building. The east addition is planned to be a two level addition with one above grade level and one below grade level. The west addition is planned to be a single above grade level.

2.0 SCOPE OF WORK

The scope of work for this geotechnical investigation included the following:

- A borehole program consisting of four (4) sampled boreholes to characterize the subsurface soil conditions within the footprint of the proposed building addition.
- Laboratory testing program consisting of moisture content determination and grain size analysis on selected soil samples. Submitting two (2) samples to Paracel Laboratories in Ottawa for chemical analyses.
- Complete a Seismic MASW and Refraction Survey to calculate shear wave velocities in the soil and rock for calculations of the V_{s30} value to determine the Site Class.

- Prepare a geotechnical engineering report that includes borehole location plan, borehole logs and provides a summary of the findings and geotechnical comments and recommendations regarding the proposed development.

3.0 METHOD OF INVESTIGATION

3.1 Field Investigation

The borehole drilling program consisted of four (4) borehole (BH14-1, 14-2, 14-3 and 14-4), boreholes BH14-1, 14-2 and 14-4 were advanced to refusal on inferred bedrock, borehole BH14-3 was advanced to bedrock and 3.0 m of bedrock was cored using NQ size coring equipment. The borehole locations are shown in Drawing No. 2 in Appendix B.

Prior to carrying out the investigation, Stantec Consulting Ltd. (Stantec) marked the proposed borehole locations. As a component of our standard procedures and due diligence, Stantec contacted the public utility authorities to clear the locations of both private and public underground utilities.

The field drilling program was carried out on December 11, 2014, and was carried out using a track-mounted CME-75 drill rig equipped with soil sampling capabilities. Standard Penetration Tests (SPT) were completed at regular intervals while collecting soil samples. The subsurface stratigraphy encountered in each borehole was recorded in the field by experienced Stantec personnel. Upon completion of drilling, the boreholes were backfilled with the augered material.

All recovered soil samples were stored in moisture-proof bags and transported to the Stantec Ottawa laboratory for detailed geotechnical classification and testing.

3.2 Survey

The elevations of the boreholes were determined using a Trimble GPS Receiver with decimeter accuracy. The instrument's accuracy may be affected by satellite coverage at the time of the survey; the ground surface elevation could not be accurately measured at borehole BH14-1 with the GPS receiver. Geodetic elevations are shown on the Borehole Records in Appendix C.

3.3 Laboratory Testing

All soil samples returned to the laboratory were subjected to detailed visual examination and additional classification by a geotechnical engineer. Moisture content determination was undertaken on all recovered soil samples. Grain size analyses were conducted on selected soil samples. Unconfined compressive strength testing was conducted on selected rock core samples.

Two soil samples were submitted to Paracel Laboratories Limited for resistivity, pH, sulphate and chloride testing.

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in Appendix C and the figures included in Appendix D.

Soil samples will be stored for one (1) month after the issuance of the final report unless otherwise directed by the client.

4.0 SUBSURFACE CONDITIONS

In general, the subsurface profile at this site consisted of topsoil over a silty sand with gravel fill material over a deposit of silty gravel with sand till underlain by limestone bedrock. Bedrock was encountered between 1.8 m and 3.7 m below ground surface.

4.1 Topsoil

Topsoil was encountered at ground surface in boreholes BH14-2, 14-3 and 14-4. The thickness of the topsoil ranged from 50 mm to 80 mm.

4.2 Fill

Silty sand with gravel fill was encountered beneath the topsoil or at ground surface. This material is likely backfill material from the excavation of the existing foundations. Occasional cobbles and boulders were inferred from auger grinding during the field investigation. The fill ranged in thickness from 1.5 m to 3.0 m. The moisture content of this material ranged from 8% to 26%. One sample of this material was submitted for a gradation test and yielded the following results:

- Gravel: 19%
- Sand: 50%
- Fines (silt and clay size particles): 31%

According to the Unified Soil Classification System (USCS), this material can be classified as a silty sand with gravel (SM). The gradation results are presented in Figure 1 in Appendix D.

4.3 Silty Gravel with Sand Till

A deposit of silty gravel with till was encountered beneath the fill in all boreholes. The thickness of the silty gravel with sand till ranged from 0.2 m to 0.7 m. Borehole BH14-1, 14-2 and 14-4 were terminated within this material at depths ranging from 1.8 m to 3.7 m below ground surface. The moisture content of this material ranged from 8% to 20%. Three samples of this material were submitted for gradation testing and yielded the following results:

- Gravel: 37 to 47%
- Sand: 30 to 37%
- Fines: 17 to 33%

According to the USCS, this material can be classified as a silty gravel with sand (GM). The gradation results are presented in Figure 2 in Appendix D.

4.4 Bedrock

Bedrock was inferred from auger refusal in Boreholes 14-1, 14-2 and 14-4 at depths of 1.8 m, 3.7 m and 3.3 m below ground surface, respectively. Bedrock was proven by coring in Borehole 14-3, bedrock was encountered at a depth of 3.7 m below ground surface and 3.0 m of bedrock was cored using NQ-size coring equipment. The bedrock encountered consisted of grey limestone, the total core recovery (TCR) ranged from 89% to 100%, the rock quality designation (RQD) ranged from 71% to 80%, indicating fair to good rock quality.

Two samples of rock core from BH 14-3 were submitted for unconfined compressive strength testing. The unconfined compressive strength of the rock was 71.6 MPa and 211.3 MPa, indicating strong to very strong bedrock.

While coring bedrock during the field investigation, a 15 cm void was noted during the coring of NQ-7.

4.5 Groundwater

Groundwater was inferred in the open boreholes during drilling at a depth of 1.5 m in Borehole 14-1, and 3.0 m in Borehole 14-3.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 General

The following geotechnical issues should be considered during design activities:

- Conventional spread footings founded on bedrock or on native till are appropriate to support the building addition.
- The boreholes drilled on the east side of the building encountered an approximately 3.0 m thick layer of fill material which should be removed from beneath the footprint of the footings.
- The underside elevation of the proposed footings should match the existing underside elevation of the existing footings.

5.2 Site Preparation

All fill material and loose soil should be removed from beneath the footprint of the building addition. The lateral extent of the excavations should extend beyond the footprint of the footing pad by a distance equal to the depth of excavation below the underside of the footing. This excavation effort must not undermine the existing foundation and therefore should be monitored by a geotechnical engineer.

The excavated area should be backfilled with Structural Fill material such as OPSS Granular A, OPSS Granular B Type I or OPSS Granular B Type II, placed in lifts no thicker than 300 mm and compacted to 100% Standard Proctor Maximum Dry Density (SPMDD).

5.3 Foundations

5.3.1 Spread Footings

The proposed building addition can be supported by footings designed to bear on the sound limestone bedrock or native fill. Footings up to 3 m wide, founded on the sound bedrock can be designed for a factored geotechnical resistance at Ultimate Limit State (ULS) of 1000 kPa and 500 kPa for footings founded on native till. The factored geotechnical resistance at ULS incorporates a resistance factor of 0.5. The factored geotechnical resistance at ULS will govern, since failure within the soil and bedrock mass is likely to occur before the SLS deformation of 25 mm is realized.

Exposed limestone surfaces should be free of loose bedrock, soil, water and bedrock irregularities. Hand cleaning and pressure washing of the bearing areas to remove any loose materials will be required to achieve the recommended geotechnical resistance. Till subgrades should be free of loose material and water. The base of all footing excavations should be inspected by a geotechnical engineer prior to placing concrete to confirm the factored geotechnical resistance at ULS and to ensure that there is no disturbance.

The proposed structures are assumed to be heated structures. Therefore, the required cover to protect footings of heated structures from frost is 1.5 m. For footings founded on sound bedrock with proper drainage of the rock, the cover can be reduced to 1.0 m. Where proposed footings have insufficient soil cover for frost protection, the use of equivalent rigid insulation will be required.

Where construction is undertaken during winter conditions, all footing subgrades should be protected from freezing. Foundation walls and columns should be protected against heave due to soil adfreeze by backfilling with free draining granular material such as OPSS Granular A or Granular B Type II.

5.4 Seismic Site Class and Liquefaction Potential

5.4.1 Seismic Site Classification

Geophysics GPR International completed a seismic shear wave survey at the site of the proposed building addition. The purpose of the survey was to estimate the seismic site class according to the

National Building Code of Canada. The investigation methodologies and results are summarized in the letter report included in Appendix E.

The harmonic mean average shear wave velocity over 30 m, V_{S30}, measured from ground surface was calculated as 883.3 m/sec. In accordance with Table 4.1.8.4A of the 2010 National Building Code of Canada, a seismic Site Class B is recommended for the design, conditional on there being less than 3 m of unconsolidated material between the rock surface and the bottom of the foundations. If the foundations of the building addition are constructed directly on the rock, Site Class A is appropriate for design.

A copy of the seismic hazard calculation for the site corresponding to a 2% chance of exceedance in 50 years is included in Appendix E. The hazard calculation indicates a Peak Ground Acceleration (PGA) equal to 0.321g.

5.4.2 Liquefaction Potential

An assessment for seismic liquefaction has been carried out for this site. Seismic liquefaction is the sudden loss in stiffness and strength of soil due to the loading effects of an earthquake. Liquefaction can cause significant settlements and structural failure.

Based on the subsurface conditions at the site, the site is not considered to be susceptible to liquefaction.

5.5 Lateral Earth Pressure on Subsurface Walls

Earth pressures will need to be considered in the design of shoring systems for temporary excavations during construction and for basement walls. Table 5.1 gives the coefficients of lateral earth pressure for shoring systems and basement walls. These values are based on the assumption that a horizontal back slope will be utilized behind the shoring system and wall.

5.5.1 Static Lateral Earth Pressures

For subsurface walls that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied and unyielding structures, the at-rest earth pressure should be used for design. The unfactored soil parameters provided in Table 5.1 may be used for design of walls with a horizontal backfill. The effects of compaction should be accounted for by applying a compaction surcharge.

The total active (P_A), passive (P_P) and at-rest (P_O) thrusts can be calculated using the following equations

$P_A = \frac{1}{2} K_a \gamma H^2$
$P_P = \frac{1}{2} K_p \gamma H^2$
$P_O = \frac{1}{2} K_o \gamma H^2$

where H is the height of the wall and γ is the unit weight of the backfill soil. Values for K_a, K_p, K_o and γ are provided below. The thrust acts at a point one third up the height of the wall.

Table 5.1: Static Lateral Earth Pressure Parameters

Material	K_o (at rest)	K_a (active)	K_p (passive)	ϕ (friction angle)	Unit Weight (kN/m³)
OPSS Granular A	0.43	0.27	3.69	35°	22
OPSS Granular B Type II	0.47	0.31	3.25	32°	22
Silty Sand	0.47	0.31	3.25	32°	21

5.5.2 Seismic Lateral Earth Pressures

Seismic earth pressures may be calculated using the parameters detailed in Table 5.2 below.

The total active and passive thrusts under seismic loading conditions can be calculated using the following equations:

$P_{AE} = ½ K_{AE} \gamma H^2 (1 - k_v)$
$P_{PE} = ½ K_{PE} \gamma H^2 (1 - k_v)$

where:

K_{AE} = active earth pressure coefficient (combined static and seismic)
K_{PE} = passive earth pressure coefficient (combined static and seismic)
H = height of wall
k_h = horizontal acceleration coefficient
k_v = vertical acceleration coefficient
γ = total unit weight of soil

For this site, the following design parameters were used to develop the recommended K_{AE} and K_{PE} values. A yielding wall was assumed.

Zonal Acceleration Ratio, A or PGA	0.32
Horizontal Acceleration Coefficient, k_h	0.16
Vertical Acceleration Coefficient, k_v	0.11
Horizontal Backslope to Wall	0°
Vertical Back of Wall	0°

The k_h value above corresponds to half of the A value for yielding walls. The k_v value corresponds to 0.67 of the k_h value. The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate.

Table 5.2: Seismic Lateral Earth Pressure Parameters (Yielding Wall)

Material	K_{AE}	Height of Application of P_{AE} from base as a ratio of wall height, (H)	K_{PE}	Height of Application of P_{PE} from base as a ratio of wall height, (H)	ϕ (friction angle)	Unit Weight (kN/m^3)
OPSS Granular A	0.38	0.39	3.33	0.27	35°	22
OPSS Granular B Type II	0.42	0.38	2.91	0.27	32°	22
Silty Sand	0.42	0.38	2.91	0.27	32°	21

If the wall is designed as a non-yielding wall it could be designed based on values obtained from the Wood (1973) method:

$$\Delta P_{eq} = \gamma H^2 \frac{a_h}{g} F_p$$

ΔP_{eq} : Steady state dynamic thrust

γ : Bulk unit weight of soil

H : Height of wall (m)

g : Gravity (m/s^2)

a_h : Amplitude of harmonic base acceleration = k_h

F_p : Dimensionless thrust factor at v=0.5; F = 1.1

$$h_{eq} = \frac{\Delta M_{eq}}{\Delta P_{eq}} \approx 0.63H$$

5.6 Excavation and De-Watering Requirements

5.6.1 Excavations

Excavations for footings are anticipated to extend to bedrock, up to approximately 3.7 m below ground surface. Excavations can be undertaken by conventional excavating equipment capable of removing possible cobbles and boulders.

Open cut, unsupported excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA). The soils are considered to be Type 3, in accordance with OHSA excavation sideslopes must be cut back at 1H:1V from the bottom of the excavation. Flatter sideslopes may be required in zones of water seepage.

In areas of restricted space where unsupported excavations are not feasible, the excavations can be undertaken within the confines of an engineered, hydraulic or prefabricated (trench box) support system designed and installed in accordance with OHSA.

Since the proposed structures will be located in close proximity to the existing building, it is recommended that preconstruction surveys be undertaken of the nearby buildings and any underground services prior to start of construction. In addition, caution should be exercised during construction so as not to undermine foundations of existing buildings.

5.6.2 De-Watering Requirements

It is anticipated that dewatering of excavations can be undertaken by conventional sump and pump methods.

5.7 Foundation Backfill

Backfill for foundations should consist of non frost susceptible, compactible material such as OPSS Granular A or Granular B Type I or II materials. The foundation backfill can be placed in 300 mm thick lifts compacted using suitable equipment to 95% Standard Proctor Maximum Dry Density (SPMDD). Care should be taken immediately adjacent to the footings to avoid over-compaction of the soil which could result in damage to these foundation units.

5.8 Reuse of Site Generated Material

Portions of the silty sand and till may be re-used as backfill material in areas where non-free draining material is required, subject to further evaluation during construction. These materials can be reused as noted above, provided they are free of organic material and debris and the moisture content is such that adequate compaction can be achieved.

5.9 Cement and Corrosion Potential

Two representative soil samples were submitted to Paracel Laboratories Limited in Ottawa, Ontario for resistivity, pH, sulphate and chloride testing. The results of the testing are as follows:

Table 5.3: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)	Chloride(µg/g)	Resistivity (Ohm·m)
14-2	SS4	2.3 – 2.9	7.39	8	5	84.3
14-4	SS4	2.3 – 2.9	7.39	19	14	67.9

The testing was completed to determine the potential for degradation of concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in buried infrastructure.

The pH, resistivity and chloride concentrations provide an indication of the degree of corrosiveness of the subsurface environment. The soil pH was 7.39 in both samples which is within what is considered the normal range for soil pH of 5.5 to 9.0. The pH levels of the tested soil do not indicate a highly corrosive environment. The results are provided to aid in the selection of coatings and corrosion protection systems for buried steel objects.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. Type GU Portland Cement should therefore be suitable for use in concrete at this site.

6.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of National Research Council Canada, who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying of unexpected site conditions
- Planning, design or construction

This report has been prepared by Katurah Firdawsi and reviewed by Chris McGrath.

Respectfully submitted,

STANTEC CONSULTING LTD.

Katurah Firdawsi, EIT, B.Sc.Eng

Christopher McGrath, P.Eng.
Associate, Senior Geotechnical Engineer

APPENDIX A

Statement of General Condition

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

Key Plan

Borehole Location Plan

JANUARY 2015
Project No. 122411073

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NOTES

BASEPLAN FROM MAPART 2006.

Client/Project

NATIONAL RESEARCH COUNCIL CANADA
BUILDING M22 ADDITION
NRC MONTREAL ROAD CAMPUS, OTTAWA, ON.

Drawing No.

1

Title

KEY PLAN

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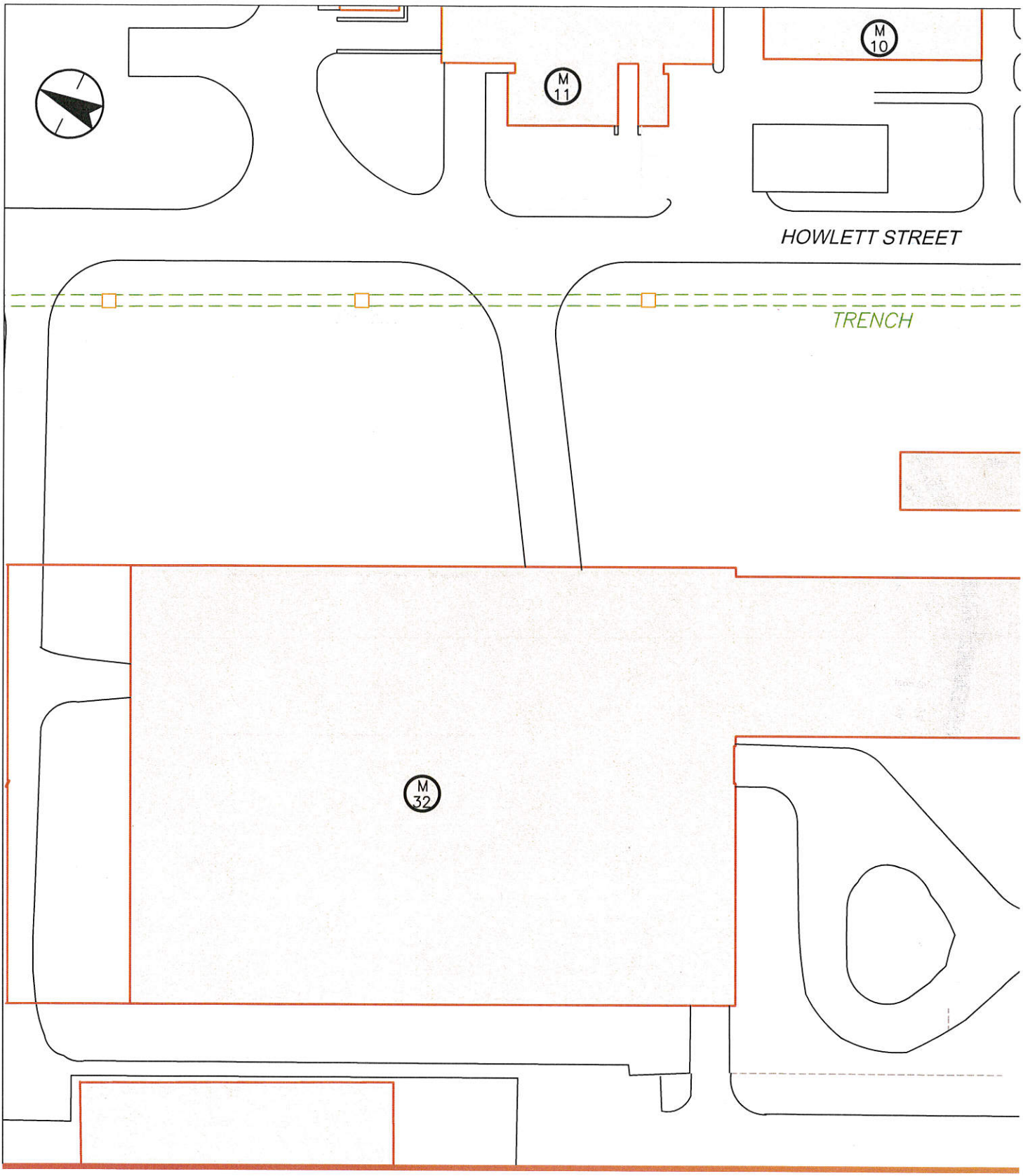

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LEGEND

PROPOSED BUILDING ADDITION

BOREHOLE

APPENDIX C

Symbols and Terms Used on Borehole Records

Borehole Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

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BOREHOLE RECORD

BH14-1

CLIENT National Research Council — BOREHOLE No. BH14-1

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0		FILL: Loose brown silty SAND with gravel (SM)			SS	1	110	9
1		- occasional cobbles/boulders inferred from auger grinding			SS	2	140	5
		Very dense silty gravel with sand till (GM)		▽	SS	3	160	50/ 150 mm
2		- pieces of fractured bedrock						
		End of Borehole						
		Refusal on Inferred Bedrock						
3								
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

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BOREHOLE RECORD

BH14-2

CLIENT National Research Council — BOREHOLE No. BH14-2

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.00							
	99.9	70 mm TOPSOIL						
		FILL: Very loose to loose brown silty sand with gravel (SM) - occasional cobbles/boulders inferred from auger grinding			SS	1	210	3
1					SS	2	150	7
2					SS	3	200	5
					SS	4	300	4
3	97.0							
		Very dense brown-grey silty gravel with sand till (GM)			SS	5	380	54
	96.3							
4		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd _____

Date _____

Stantec

BOREHOLE RECORD

BH14-3

CLIENT National Research Council — BOREHOLE No. BH14-3

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.96							
	99.9	50 mm TOPSOIL						
		FILL: Loose to compact brown silty sand with gravel (SM)			SS	1	150	5
1		- occasional cobbles/boulders inferred from auger grinding			SS	2	100	15
2					SS	3	350	9
					SS	4	150	9
3	96.9			▽				
		Very loose brown-grey silty gravel with sand till (GM)			SS	5	200	3
	96.3	- pieces of fractured rock						
4		Limestone BEDROCK - Fair to good quality - Grey - Very close joint set spacing - Slightly weathered (Refer to Field Bedrock Core Log)			NQ	6	100%	75%
5					NQ	7	89%	80%
6					NQ	8	91%	71%
	93.3							
7		End of Borehole						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

□ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

STN13-STAN-GEO 122411073 - NRC BUILDING M-22.GPJ SMART.GDT 1/21/15

Stantec

BOREHOLE RECORD

BH14-4

CLIENT National Research Council — BOREHOLE No. BH14-4

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.50							
	99.4	80 mm TOPSOIL						
		FILL: Very loose to loose brown silty sand with gravel (SM) - occasional cobbles/boulders inferred from auger grinding			SS	1	140	4
1					SS	2	100	3
2					SS	3	220	8
					SS	4	330	4
3	96.5							
	96.2	Very dense light brown-grey silty gravel with sand till (GM) - pieces of fractured rock			SS	5	110	50/ 75 mm
4		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

Field Be

Stantec

Client: NRC National Research Council Canada
Project: Building M-22 Addition
Contractor: Marathon Drilling

Project No.:
Date:
Borehole No.:
Logger:

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES						
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING
3.66	NQ-6	100%	75%	4.21	Light grey limestone	VS	S		B	F	VC	RP		O
4.21	NQ-7	89%	80%	5.74	Light grey to dark grey limestone		S		B	F	VC	RP		O, S
5.74	NQ-8	91%	71%	6.7	Light grey to dark grey limestone	S	S		B	F	VC	RP		SA

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

V:\01224\active\1224110XX\1224110

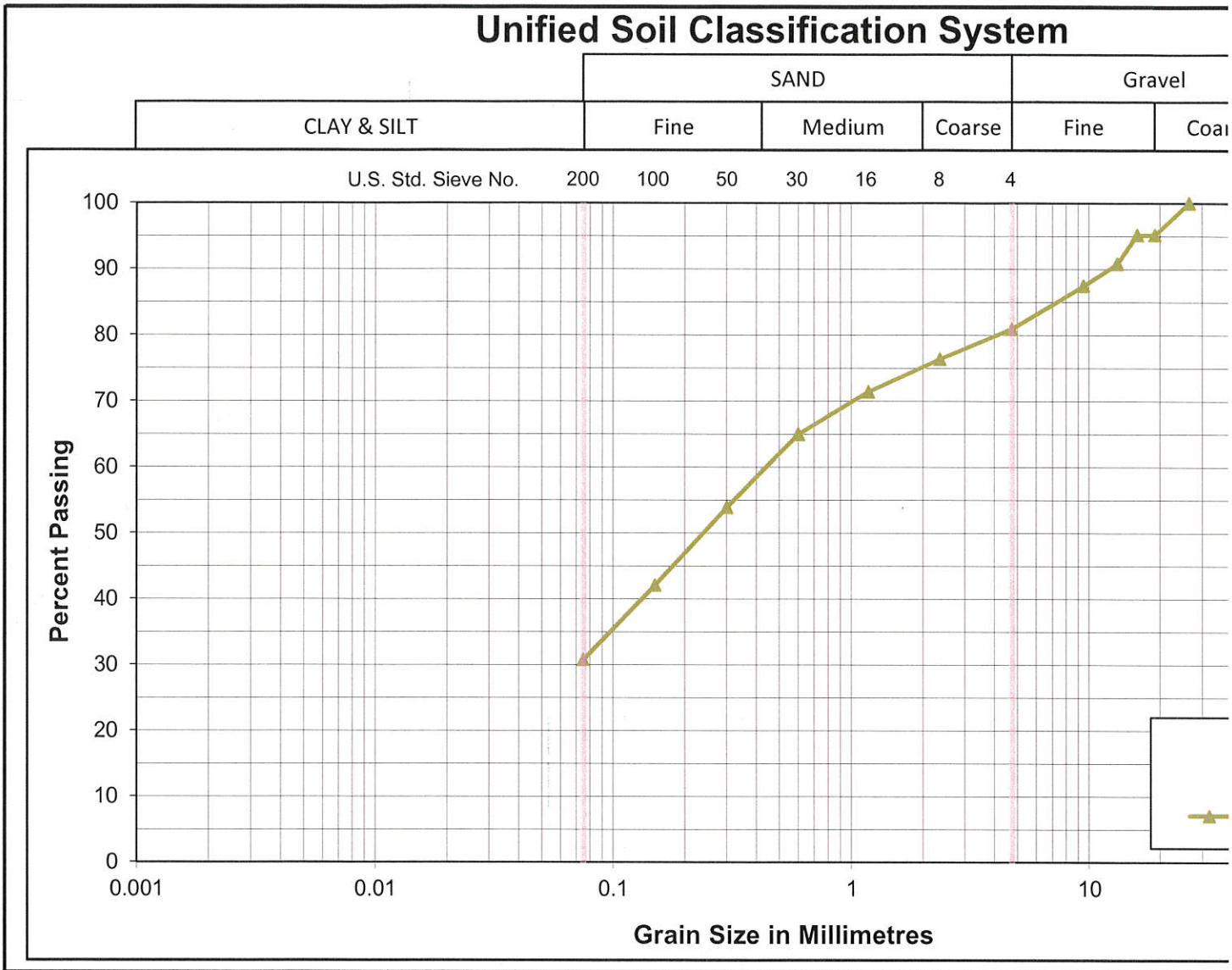
Stantec	Project No.: 1224110473 Project Name: NRC Building M-22	Rockcore Photographs

Rock Core Photo No.: 1	Borehole: 14-3	Depth: 3.66 m – 5.74 m

Rock Core Photo No.: 2	Borehole: 14-3	Depth: 5.74 m – 6.70 m

APPENDIX D

Laboratory Test Results



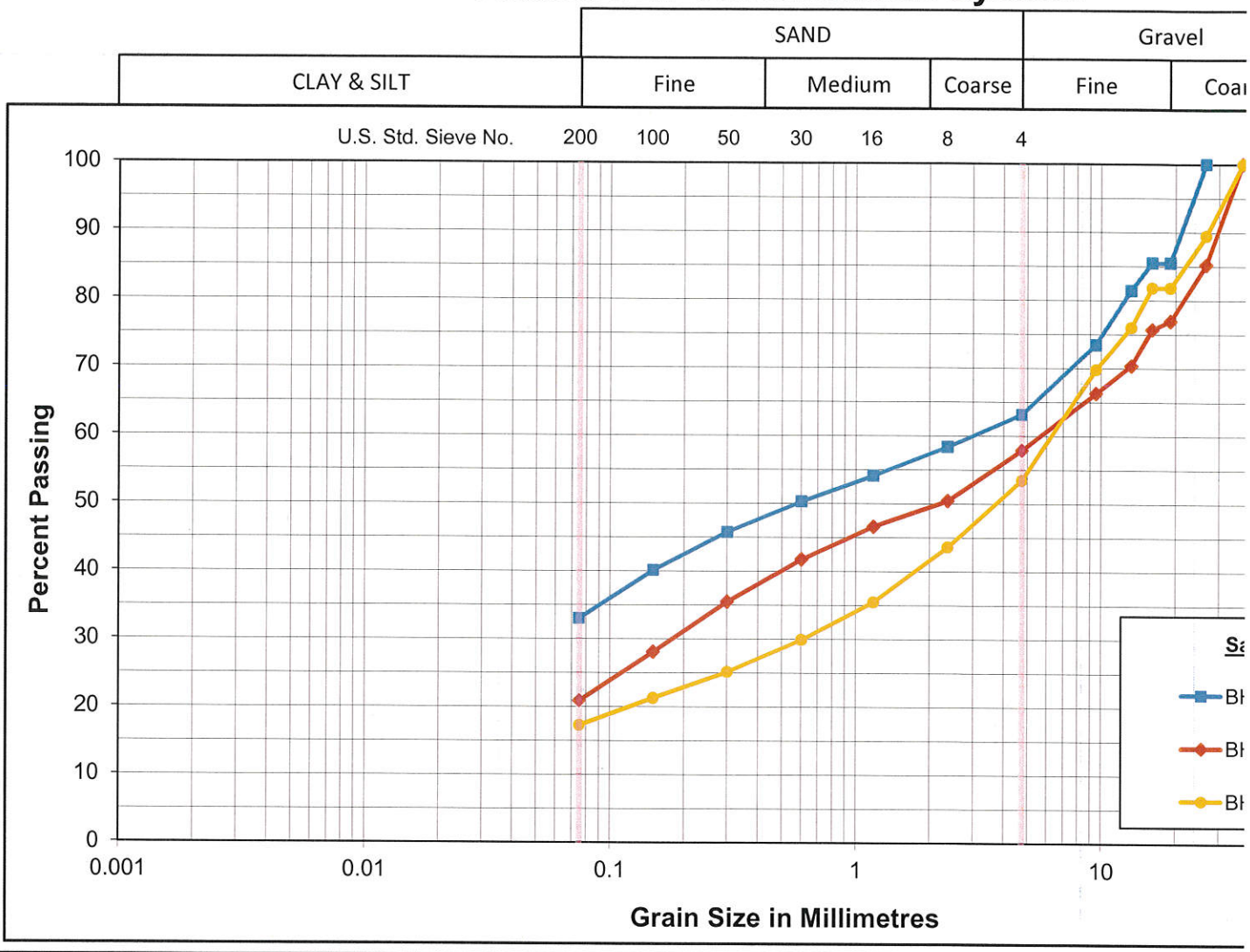
Stantec

GRAIN SIZE DISTRIBUTION

FILL: Silty Sand with Gravel (SM)

Proje

Unified Soil Classification System



Stantec

GRAIN SIZE DISTRIBUTION

Silty Gravel with Sand (GM) TILL

Proje

APPENDIX E

Geophysics GPR International MASW Survey

NBC Seismic Hazard Calculation

GEOPHYSICS GPR INTERNATIONAL INC.

100 – 2545 Delorimier Street
Longueuil (Québec)
Canada J4K 3P7

Tel. : (450) 679-2400
Fax : (514) 521-4128
info@gprmtl.com
www.geophysicsgpr.com

December 18th, 2014

Transmitted by email: Katurah.Firdawsi@stantec.com
Our Ref.: M-14957

Mrs. Katurah Firdawsi
Stantec Inc.
400 – 1331 Clyde Avenue
Ottawa (ON) K2C 3G4

Subject: **Shear-wave Velocity Surveys, Montreal Road Campus, Ottawa (ON)**

[Project N°: 122411073]

Dear Mrs. Firdawsi,

Geophysics GPR International Inc. has been requested by Stantec inc. to carry out seismic shear wave surveys on a site beside the east wall of the National Research Council of Canada M22 building, west of the Howlett Street and Hutcheon Ave. intersection, in Ottawa. The geophysical investigations used the Multi-channel Analysis of Surface Waves (MASW), the Extended SPatial AutoCorrelation (ESPAC), and the seismic refraction methods. From the subsequent results, the Site Class was identified.

The surveys were carried out December 3rd, by Mr. Charles Trottier, M.A.Sc., phys. and Mr. Denis Tessier. Figure 1 shows the regional location of the site, and Figure 2 illustrates the location of the seismic spread. Both figures are presented in the appendix.

The following paragraphs briefly describe the survey design, the principles of the test methods, and the results in graphic and table format.

METHODS PRINCIPLES

MASW Survey

The *Multi-channel Analysis of Surface Waves* (MASW) and the *Extended SPatial AutoCorrelation* (ESPAC or MAM for *Microtremors Array Method*) are seismic methods used to evaluate the shear wave velocities of subsurface materials through the analysis of the dispersion properties of the Rayleigh surface waves ("ground roll"). The MASW is considered an "active" method, as the seismic signal is induced at known location and time in the geophones spread axis. Conversely, the ESPAC is considered a "passive" method, using the low frequency "noises" produced far away. The method can also be used with "active" seismic source records. The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. The inversion of the Rayleigh wave dispersion curve yields a shear wave (V_S) velocity depth profile (sounding). Figure 3 outlines the basic operating procedure for the MASW method.

Figure 4 illustrates an example of one of the MASW/ESPAC records, the corresponding spectrogram analysis and resulting 1D V_S model. The ESPAC method allows deeper Vs soundings, but generally with a lower resolution for the surface portion. Its dispersion curve can then be merged with the higher frequency one from the MASW to calculate a more complete inversion.

More detailed descriptions of the methods are presented in *Shear wave velocity measurement guidelines for Canadian seismic site characterization in soil and rock*, Hunter, J.A., Crow, H.L., et al., Geological Surveys of Canada, public file 7078, 2012. For the MASW method, one can also refer to *Multi-channel Analysis of Surface Waves*, Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); p. 800–808. For the ESPAC method, one could refer to the paper *Shear Velocity Profiles Obtained from Microtremor Array Data with an Example from Direct Fitting of SPAC Curves*, Asten, M.W., 2007, Proceedings of the 20th SAGEEP Conference, Denver, Environmental and Engineering Geophysical Society, and for more details: *The Microtremor Survey Method*, Okada, H., S.E.G., Geophysical Monograph Series No. 12.

Seismic Refraction Survey

The method consists to measure the propagation delays of the direct and refracted seismic waves (P and/or S) produced by an artificial source in the axis of the seismic spread. The seismic velocities of the materials can be directly calculated, then the refractors depths. A detailed description of the seismic refraction method is presented in the document *Seismic Refraction Exploration for Engineering Site* Investigation, Redpath, Bruce B., AD-768 710, Explosive Excavation Research Laboratory, Livermore, California, 1973.

INTERPRETATION METHODS

MASW surveys

The main processing sequence involved data inspection; editing (when required); spectral analysis ("phase shift" for MASW, and cross-correlation for ESPAC); picking the fundamental mode; and 1D inversion of the MASW and ESPAC shot records using the SeisImagerSW™ software. The data inversions were realized with a non-linear least square method. In theory, all the shot records for a given seismic spread should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation, localized surface seismic velocities variations, and/or dipping of overburden layers or rock. In general the precision of the calculated seismic shear wave velocities (V_S) is of the order of 15% or better.

Seismic Refraction surveys

The considered seismic wave's arrival times are identified for each geophone. The General Reciprocal Method was used, with shot points at both ends of the seismic spread, in order to consider seismic wave propagation for two opposite directions. The measurements were realised to calculate the rock depth, and its seismic velocity. Conversely to the MASW method, the seismic rock velocity measured by seismic refraction is only representative of its superior part, due to the evanescent nature of the refracted wave. The rock seismic velocities were calculated using two methods: the reduced travel-times (the Hobson and Overton method) and the opposite apparent velocities. The first one allows independence from the surface and rock topography effect, as well as the overburden lateral variation of its seismic velocity, but remains limited to common geophones. The second one can use longer segments of opposite directions signals, improving the regressions accuracy, but remains affected by the surface and rock topography effect, as well as the overburden lateral variation of the seismic velocity.

Survey Design

The main seismic spread was located 8.7 metres from the east side of the NRCC M22 building, centered 14.3 metres SE from BH-14-3 (cf. Figure 2). Its geophone spacing was 3 metres, which means that the total length of a 24 geophones spread was 69 metres. It was used for the MASW as well as for the seismic refraction surveys. A second shorter seismic spread, with geophone spacing of 1 metre, was dedicated to the near surface details.

The seismic records counted 4096 data, sampled at 1000 µs for the MASW, and 50 µs for the seismic refraction method. They were triggered by electrical close-contact between a sledgehammer and a steel plate.

The seismic records were realized with a seismograph Terraloc MK6 (from ABEM Instrument), and the geophones were 4.5 Hz. A 20 pounds sledgehammer was used as the primary energy source with impacts being recorded off both ends of the seismic spreads, with a records stacking procedure to enhance the S/N ratio.

RESULTS

The rock depth was calculated close to 6.7 metres deep from seismic refraction data, using the compressional seismic waves (V_P) and the critical distances method. The rock's seismic shear wave velocity was then calculated from two different methods (cf. Figure 5). Its sounder portion of the shallow part could reveal a V_S value of 2008 m/s (from the Obson & Hoverton method) to 2047 m/s (from the opposite directions apparent velocities method) .

The V_{S30} value results from the harmonic mean of the shear wave velocities, from the surface to 30 metres deep. It is calculated by dividing the total depth of interest (e.g. 30 metres) by the sum of the time spent in each velocity layer from the surface up to 30 metres. This value reflects an equivalent homogeneous single layer response. The calculated V_{S30} value is 883.3 m/s (cf. Table 1), corresponding to the Site Class "B". Nevertheless, this Site Class can not be used if there is more than 3 metres of unconsolidated material between the rock surface and the bottom of the foundations, even if the V_{S30} computed value is more than 760 m/s.

Also, low seismic shear wave velocities were calculated for the unconsolidated materials, from the surface to approximately 2 metres deep.

CONCLUSION

Seismic surveys were realized with the MASW/ESPAC and seismic refraction methods, to calculate the V_{S30} value for the Site Class determination. The seismic spreads were laid parallel to Howlett Street, at 9 metres east from the National Research Council of Canada M22 building. The V_{S30} calculation is presented in Table 1.

The calculated V_{S30} value is 883 m/s for the actual site. Based on this value (determined through the MASW/ESPAC methods), Table 4.1.8.4.A of the NBCC, and the Building Code, O. Reg. 332/12, the investigated actual site presents a Class "B" ($760 < V_{S30} \leq 1500$ m/s). Nevertheless, this Site Class can not be considered if there is more than 3 metres of unconsolidated material between the rock surface and the bottom of the foundations (cf. Commentary J, #100 of the NBCC).

The rock seismic shear wave velocity was calculated from two different methods. Its sounder portion of the shallow part revealed a V_S value between 2008 to 2047 m/s. If the foundations of the building addition are to be on the rock, the Site Class would be "A" ($V_{S30}^* > 1500$ m/s).

Between the surface and approximately 2 metres deep, low seismic velocities were calculated.

It must be noted that other geotechnical information gleaned onsite; including the presence of liquefiable soils, soft clays, high moisture content etc. can supersede the site classification provided in this report based on the V_{S30} value.

The V_S values calculated are representative of the in situ materials, and were not corrected for the total and effective stress.

This report has been written by Jean-Luc Arsenault, M.A.Sc., P.Eng.

Jean-Luc Arsenault, M.A.Sc., P.Eng.
Project Manager

18/12/2014

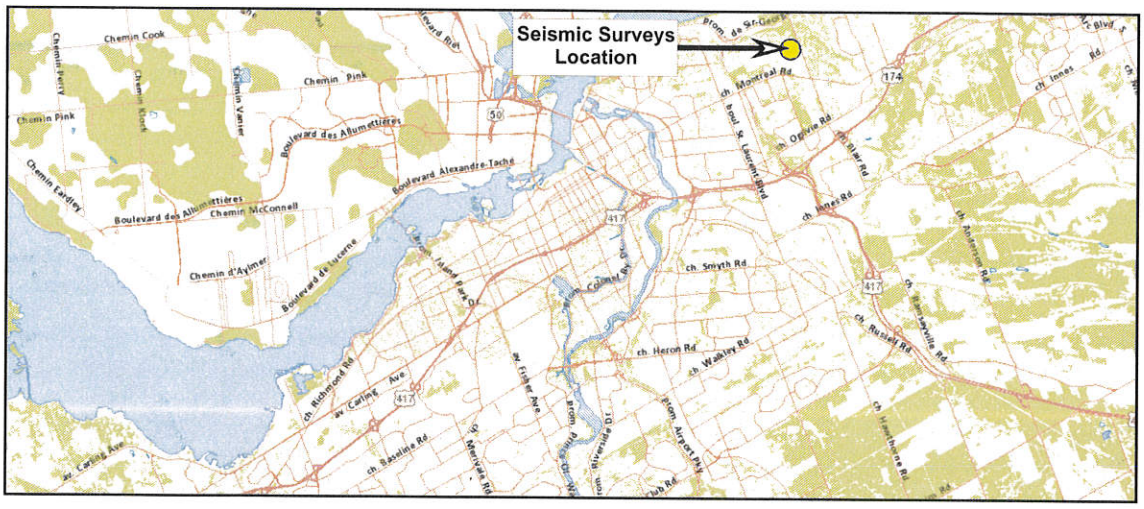


Figure 1: Regional location of the Site
(source: ***geo Ottawa***)

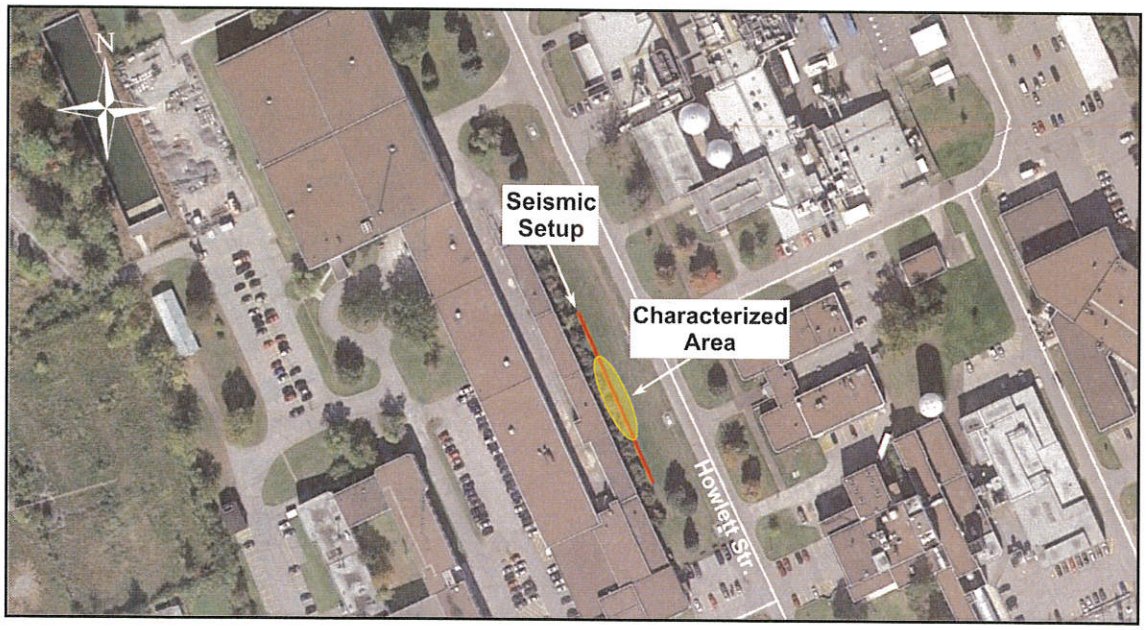


Figure 2: Location of the *seismic* spreads
(source ***Google Earth***™)

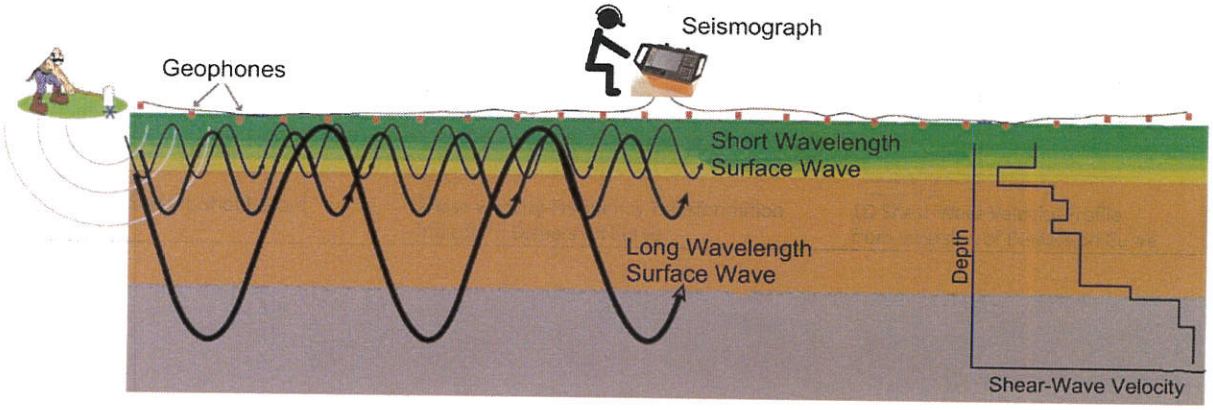


Figure 3: MASW Operating Principle

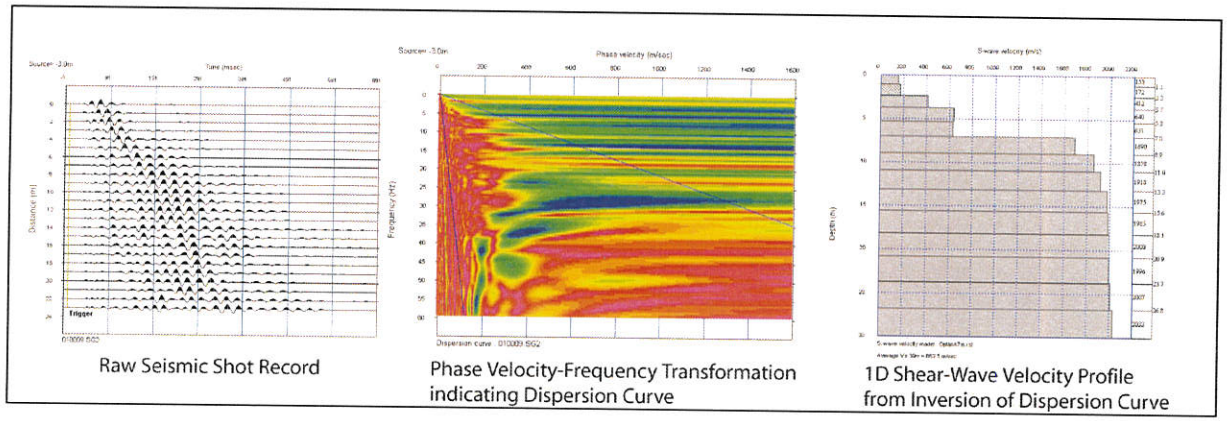


Figure 4: Example of a MASW/ESPAC shot record, phase velocity/frequency curve and resulting 1D shear wave velocity model

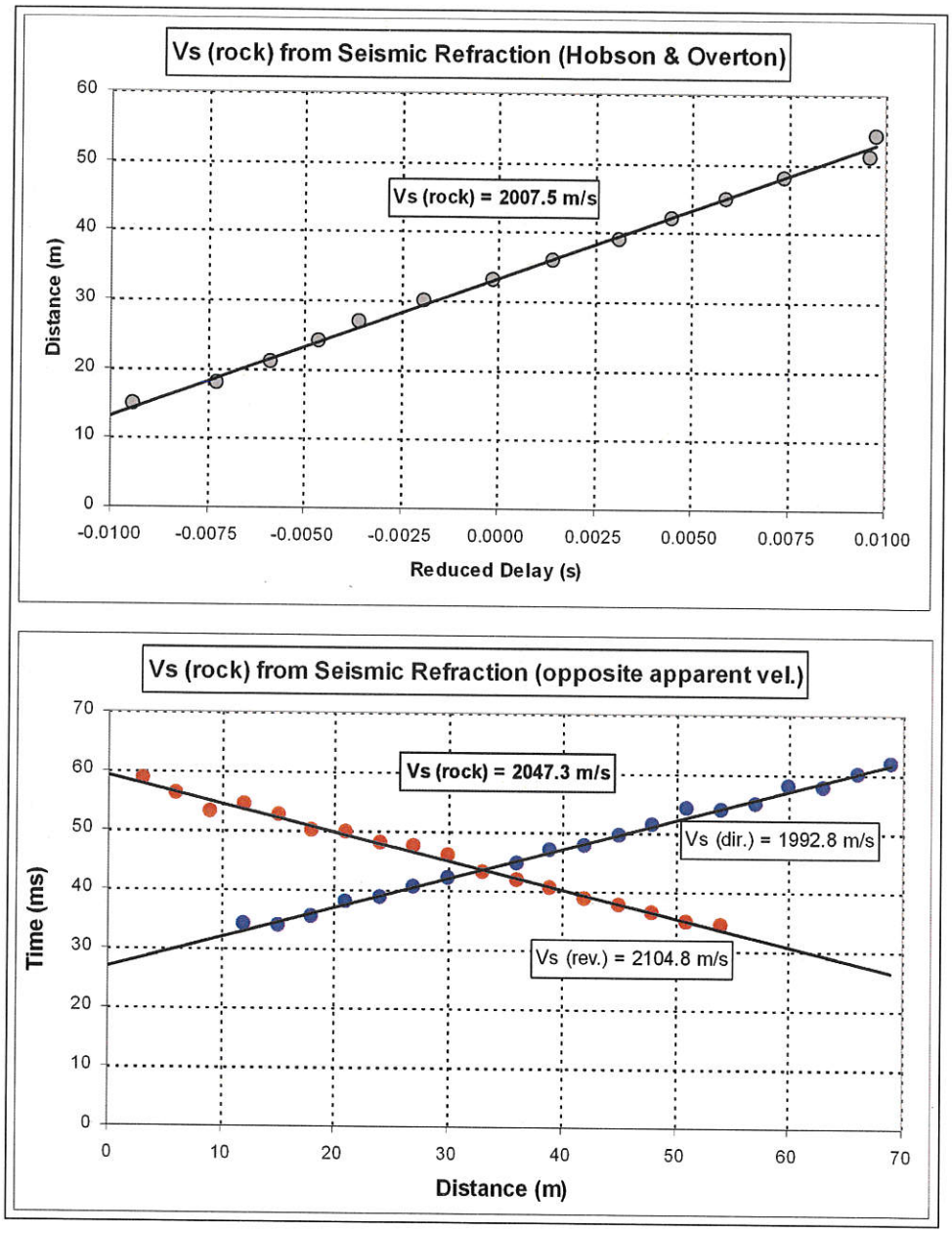


Figure 5: Rock Seismic Shear Wave Velocities from Seismic Refraction

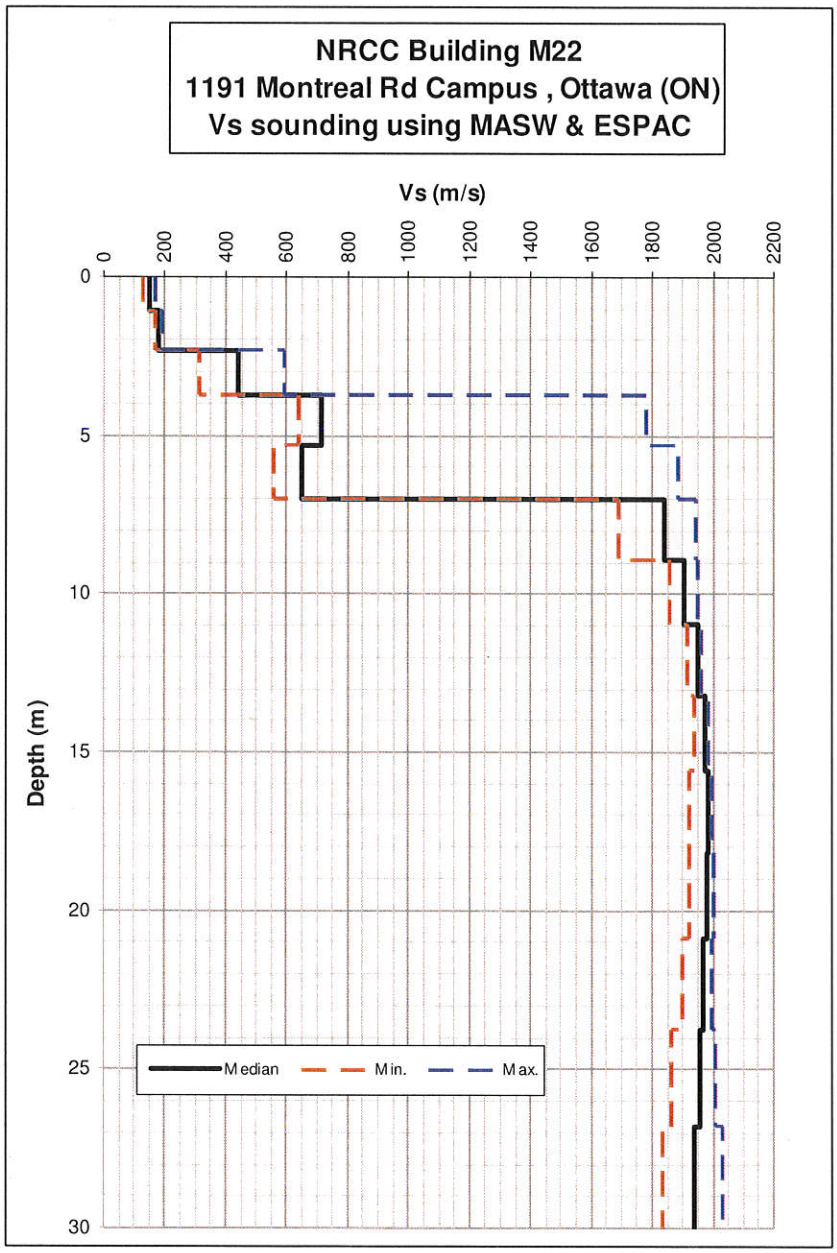


Figure 6: MASW Shear-wave Velocity Sounding

TABLE 1
V_{S30} Calculation for the Site Class (actual site)

Depth (m)	Vs			Thickness (m)	Cumulated Thickness (m)	Delay for med. Vs (s)	Cumulated Delay (s)	Average Vs for given Depth (m/s)
	Min. (m/s)	Median (m/s)	Max. (m/s)					
0.00	124.8	148.1	167.1					
1.07	165.7	179.7	191.0	1.07	1.07	0.007233	0.007233	148.1
2.31	314.8	440.2	589.7	1.24	2.31	0.006877	0.014110	163.5
3.71	636.0	712.6	1780.4	1.40	3.71	0.003183	0.017293	214.4
5.27	557.7	648.6	1889.3	1.57	5.27	0.002198	0.019490	270.6
7.01	1690.7	1842.0	1945.1	1.73	7.01	0.002669	0.022159	316.1
8.90	1858.1	1902.2	1951.1	1.90	8.90	0.001029	0.023188	383.9
10.96	1918.4	1949.9	1963.3	2.06	10.96	0.001083	0.024271	451.6
13.19	1941.5	1975.9	1987.1	2.23	13.19	0.001141	0.025412	518.9
15.58	1922.0	1985.3	1995.1	2.39	15.58	0.001210	0.026622	585.1
18.13	1919.7	1977.9	2000.0	2.56	18.13	0.001287	0.027909	649.7
20.85	1898.1	1969.1	1996.9	2.72	20.85	0.001375	0.029284	712.0
23.74	1863.7	1957.2	2007.9	2.89	23.74	0.001465	0.030749	771.9
26.79	1835.1	1941.1	2033.8	3.05	26.79	0.001558	0.032307	829.1
30.00	1951.1	1995.1	2094.0	3.21	30.00	0.001656	0.033963	883.3

V_{S30} (m/s) =	**883.3**
Site Class :	**B ***

*: conditional to less than 3 metres of unconsolidated material between the rock surface and the bottom of the foundations (cf. Table 4.1.8.4.A, and Commentary J, # 100 of the NBCC). Encountering such condition, the Site Class would be "A".

2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: ,

January 19, 2015

Site Coordinates: 45.4514 North 75.621 West

User File Reference:

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.633	0.309	0.138	0.046	0.321

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.090	0.249	0.386
Sa(0.5)	0.043	0.123	0.187
Sa(1.0)	0.017	0.056	0.088
Sa(2.0)	0.006	0.018	0.028
PGA	0.039	0.123	0.201

References

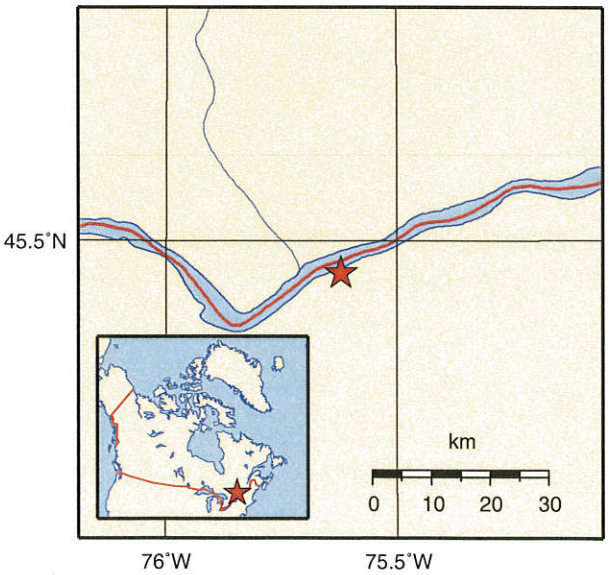
National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



Stantec Consulting Ltd.
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

April 24, 2015
File: 122411097

Christopher Eby
Norr Limited.
55 Murray Street, Suite 600
Ottawa, Ontario K1N 5M3

Dear Christopher Eby:

Reference: DRAFT - Geotechnical Recommendations
Ramp Modification - Addition to Building M22, NRC Montreal Road Campus, Ottawa, ON

This letter provides the geotechnical engineering recommendations for the ramp and retaining wall modifications as part of the Building M22 Addition at the National Research Council (NRC) Montreal Road Campus in Ottawa, ON. The proposed ramp modification is understood to include lowering of the ramp by approximately 880 mm at the south edge of the ramp.

These recommendations have been provided based on the results of the geotechnical investigation completed for the addition to Building M22. The results and recommendation were reported separately for the NRC (project number 122411073 - report dated January 20, 2015).

This report has been prepared specifically and solely for the project described herein. It provides geotechnical recommendations for the design and construction of the proposed ramp and retaining wall modifications.

Limitations associated with this report and its contents are provided in the statement of conditions included in Appendix A.

1.0 PROPOSED DEVELOPMENT

Building M22 is located at the NRC Montreal Road Campus, the location of the site and proposed addition is shown on the Key Plan, Drawing No. 1 and Borehole Location Plan, Drawing No. 2 in Appendix B. The proposed building addition for Building M22 is located on the east and west side of the east portion of the existing building. The proposed ramp and retaining wall modifications are located at the north end of the building.

2.0 SCOPE OF WORK

The scope of work for this project included providing geotechnical engineering recommendations for the following:

- Excavation and backfill requirements;
- Site preparation (stripping, grading, filling);
- Pavement design and pavement structure recommendations; and

- Lateral earth pressure for retaining wall.

It should be noted that it was initially proposed to complete a field investigation at the proposed location of the ramp and retaining wall; however the schedule did not permit for this work to be completed. Subsequently, the recommendations provided herein are based on the existing borehole information completed for the building addition mentioned above. The existing information from these boreholes suggest a relatively uniform subsurface condition with shallow overburden (fill and native till) overlying limestone bedrock. However, a slight variation of the subsurface conditions may be anticipated at the proposed ramp and retaining wall locations. For the purpose of the current recommendations, the subsurface conditions in the existing boreholes are considered representative for the proposed ramp and retaining wall.

3.0 METHOD OF INVESTIGATION – NRC BUILDING M-22 ADDITION

The following field investigation results refer to the field investigation completed for the addition to building M-22. These results are included herein as they provide the basis for our recommendations.

3.1 Field Investigation

The borehole drilling program for the NRC Building M-22 Addition consisted of four (4) boreholes (BH14-1, 14-2, 14-3 and 14-4). The borehole locations are shown in Drawing No. 2 in Appendix B. Boreholes BH14-1, 14-2 and 14-4 were advanced to refusal on inferred bedrock. In BH14-3, bedrock was confirmed by coring 3.0 m into bedrock using NQ size coring equipment.

Prior to carrying out the investigation, Stantec Consulting Ltd. (Stantec) marked the proposed borehole locations. As a component of our standard procedures and due diligence, Stantec contacted the public utility authorities to clear the locations of both private and public underground utilities.

The field drilling program was carried out on December 11, 2014, using a track-mounted CME-75 drill rig equipped with soil sampling capabilities. Standard Penetration Tests (SPT) were completed at regular intervals while collecting soil samples. The subsurface stratigraphy encountered in each borehole was recorded in the field by experienced Stantec personnel. Upon completion of drilling, the boreholes were backfilled with the augered material.

All recovered soil samples were stored in moisture-proof bags and transported to the Stantec Ottawa laboratory for detailed geotechnical classification and testing.

3.2 Survey

The elevations of the boreholes were determined using a Trimble GPS Receiver with decimeter accuracy. The instrument's accuracy may be affected by satellite coverage at the time of the survey; the ground surface elevation could not be accurately measured at borehole BH14-1 with the GPS receiver. Geodetic elevations are shown on the Borehole Records in Appendix C.

3.3 Laboratory Testing

All soil samples returned to the laboratory were subjected to detailed visual examination and additional classification by a geotechnical engineer. Moisture content determination was undertaken on all recovered soil samples. Grain size analyses were conducted on selected soil samples. Unconfined compressive strength testing was conducted on selected rock core samples.

Two soil samples were submitted to Paracel Laboratories Limited for resistivity, pH, sulphate and chloride testing.

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in Appendix C and the figures included in Appendix D.

Soil samples will be stored for one (1) month after the issuance of the final report unless otherwise directed by the client.

4.0 SUBSURFACE CONDITIONS

In general, the subsurface profile at this site consisted of topsoil over a silty sand with gravel fill material over a deposit of silty gravel with sand till underlain by limestone bedrock. Bedrock was encountered between 1.8 m and 3.7 m below ground surface.

4.1 Topsoil

Topsoil was encountered at ground surface in boreholes BH14-2, 14-3 and 14-4. The thickness of the topsoil ranged from 50 mm to 80 mm.

4.2 Fill

Silty sand with gravel fill was encountered beneath the topsoil or at ground surface. This material is likely backfill material from the excavation of the existing foundations. Occasional cobbles and boulders were inferred from auger grinding during the field investigation. The fill ranged in thickness from 1.5 m to 3.0 m. The moisture content of this material ranged from 8% to 26%. One sample of this material was submitted for a gradation test and yielded the following results:

- Gravel: 19%
- Sand: 50%
- Fines (silt and clay size particles): 31%

According to the Unified Soil Classification System (USCS), this material can be classified as a silty sand with gravel (SM). The gradation results are presented in Figure 1 in Appendix D.

4.3 Silty Gravel with Sand Till

A deposit of silty gravel with sand till was encountered beneath the fill in all boreholes. The thickness of the silty gravel with sand till ranged from 0.2 m to 0.7 m. Borehole BH14-1, 14-2 and 14-4 were terminated within this material at depths ranging from 1.8 m to 3.7 m below ground surface. The moisture content of this material ranged from 8% to 20%. Three samples of this material were submitted for gradation testing and yielded the following results:

- Gravel: 37 to 47%
- Sand: 30 to 37%
- Fines: 17 to 33%

According to the USCS, this material can be classified as a silty gravel with sand (GM). The gradation results are presented in Figure 2 in Appendix D.

4.4 Bedrock

Bedrock was inferred from auger refusal in Boreholes 14-1, 14-2 and 14-4 at depths of 1.8 m, 3.7 m and 3.3 m below ground surface, respectively. Bedrock was proven by coring in Borehole 14-3, bedrock was encountered at a depth of 3.7 m below ground surface and 3.0 m of bedrock was cored using NQ-size coring equipment. The bedrock encountered consisted of grey limestone, the total core recovery (TCR) ranged from 89% to 100%, the rock quality designation (RQD) ranged from 71% to 80%, indicating fair to good rock quality.

Two samples of rock core from BH 14-3 were submitted for unconfined compressive strength testing. The unconfined compressive strength of the rock was 71.6 MPa and 211.3 MPa, indicating strong to very strong bedrock.

While coring bedrock during the field investigation, a 15 cm void was noted during the coring of NQ-7. Rock core records and photographs are provided in Appendix C.

4.5 Groundwater

Groundwater was inferred in the open boreholes during drilling at a depth of 1.5 m in Borehole 14-1, and 3.0 m in Borehole 14-3.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 Site Preparation

All fill material and loose soil should be removed from beneath the footprint of the proposed retaining wall. The lateral extent of the excavations should extend beyond the footprint of the footing pad by a distance equal to the depth of excavation below the underside of the footing. This excavation effort must not undermine the existing foundation and therefore should be monitored by a geotechnical engineer.

The excavated area should be backfilled with Structural Fill material such as OPSS Granular A, OPSS Granular B Type I or OPSS Granular B Type II, placed in lifts no thicker than 300 mm and compacted to 100% Standard Proctor Maximum Dry Density (SPMDD).

5.2 Foundations

The proposed retaining wall can be supported by foundations designed to bear on the sound limestone bedrock or native till.

Footings up to 3 m wide, founded on the sound bedrock can be designed for a factored geotechnical resistance at Ultimate Limit State (ULS) of 1000 kPa and for footings founded on native till a ULS of 500 kPa. The factored geotechnical resistance at ULS incorporates a resistance factor of 0.5. The factored geotechnical resistance at ULS will govern, since failure within the soil and bedrock mass is likely to occur before the Serviceability Limit State (SLS) deformation of 25 mm is achieved. The SLS value has been set equal to the ULS value.

Exposed limestone surfaces should be free of loose bedrock, soil, water and bedrock irregularities. Hand cleaning and pressure washing of the bearing areas to remove any loose materials will be required to achieve the recommended geotechnical resistance. Till subgrades should be free of loose material and water. The base of all footing excavations should be inspected by a geotechnical engineer prior to placing concrete to confirm the factored geotechnical resistance at ULS and to ensure that there is no disturbance. Armour stone and gabion basket walls (if applicable) should be provided with a 300 mm thick bedding layer of OPSS Granular A, compacted to 100% Standard Proctor Maximum Dry Density (SPMDD).

All footings will require an equivalent minimum soil cover of 1.8 m for protection against frost action. The equivalent minimum soil cover for footings placed directly on sound bedrock can be reduced to 1.0 m for protection against frost action.

Where construction is undertaken during winter conditions, all footing subgrades should be protected from freezing. Foundation walls should be protected against heave due to soil adfreeze by backfilling with free draining granular material such as OPSS Granular A or Granular B Type II.

5.3 Seismic Site Class and Liquefaction Potential

5.3.1 Seismic Site Classification

Geophysics GPR International completed a seismic shear wave survey at the site of the proposed building addition. The purpose of the survey was to estimate the seismic site class according to the National Building Code of Canada. The investigation methodologies and results are summarized in the letter report included in Appendix E.

The harmonic mean average shear wave velocity over 30 m, V_{S30}, measured from ground surface was calculated as 883.3 m/sec. In accordance with Table 4.1.8.4A of the 2010 National Building Code of Canada, a seismic Site Class B is recommended for the design, conditional on there being less than 3 m of unconsolidated material between the rock surface and the bottom of the foundations. If the foundations of the building addition are constructed directly on the rock, Site Class A is appropriate for design.

A copy of the seismic hazard calculation for the site corresponding to a 2% chance of exceedance in 50 years is included in Appendix E. The hazard calculation indicates a Peak Ground Acceleration (PGA) equal to 0.321g.

5.3.2 Liquefaction Potential

An assessment for seismic liquefaction has been carried out for this site. Seismic liquefaction is the sudden loss in stiffness and strength of soil due to the loading effects of an earthquake. Liquefaction can cause significant settlements and structural failure.

Based on the subsurface conditions at the site, the site is not considered to be susceptible to liquefaction.

5.4 Lateral Earth Pressure on Subsurface Walls

Earth pressures will need to be considered in the design of shoring systems for temporary excavations during construction and for retaining walls. Table 5.1 gives the coefficients of lateral earth pressure for shoring systems and basement walls. These values are based on the assumption that a horizontal back slope will be utilized behind the shoring system and wall.

5.4.1 Static Lateral Earth Pressures

For subsurface walls that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied and unyielding structures, the at-rest earth pressure should be used for design. The unfactored soil parameters provided in Table 5.1 may be used for design of walls with a horizontal backfill. The effects of compaction should be accounted for by applying a compaction surcharge.

The total active (P_A), passive (P_P) and at-rest (P_O) thrusts can be calculated using the following equations

$P_A = ½ K_a \gamma H^2$
$P_P = ½ K_p \gamma H^2$
$P_O = ½ K_o \gamma H^2$

where H is the height of the wall and γ is the unit weight of the backfill soil. Values for K_a, K_p, K_o and γ are provided below. The thrust acts at a point one third up the height of the wall.

Table 5.1: Static Lateral Earth Pressure Parameters

Material	K_o (at rest)	K_a (active)	K_p (passive)	ϕ (friction angle)	Unit Weight (kN/m³)
OPSS Granular A	0.43	0.27	3.69	35°	22
OPSS Granular B Type II	0.47	0.31	3.25	32°	22
Silty Sand	0.47	0.31	3.25	32°	21

5.4.2 Seismic Lateral Earth Pressures

Seismic earth pressures may be calculated using the parameters detailed in Table 5.2 below.

The total active and passive thrusts under seismic loading conditions can be calculated using the following equations:

$P_{AE} = ½ K_{AE} \gamma H^2 (1 - k_v)$
$P_{PE} = ½ K_{PE} \gamma H^2 (1 - k_v)$

where:

K_{AE} = active earth pressure coefficient (combined static and seismic)
K_{PE} = passive earth pressure coefficient (combined static and seismic)
H = height of wall
k_h = horizontal acceleration coefficient
k_v = vertical acceleration coefficient
γ = total unit weight of soil

For this site, the following design parameters were used to develop the recommended K_{AE} and K_{PE} values. A yielding wall was assumed.

Zonal Acceleration Ratio, A or PGA	0.32
Horizontal Acceleration Coefficient, k_h	0.16
Vertical Acceleration Coefficient, k_v	0.11
Horizontal Backslope to Wall	0°
Vertical Back of Wall	0°

The k_h value above corresponds to half of the A value for yielding walls. The k_v value corresponds to 0.67 of the k_h value. The angle of friction between the soil and the wall has been set at 0° to provide a conservative estimate.

Table 5.2: Seismic Lateral Earth Pressure Parameters (Yielding Wall)

Material	K_{AE}	Height of Application of P_{AE} from base as a ratio of wall height, (H)	K_{PE}	Height of Application of P_{PE} from base as a ratio of wall height, (H)	ϕ (friction angle)	Unit Weight (kN/m³)
OPSS Granular A	0.38	0.39	3.33	0.27	35°	22
OPSS Granular B Type II	0.42	0.38	2.91	0.27	32°	22
Silty Sand	0.42	0.38	2.91	0.27	32°	21

5.5 Excavation and De-Watering Requirements

5.5.1 Excavations

Excavations for the retaining wall and the lowered ramp are anticipated to extend to bedrock. Excavations can be undertaken by conventional excavating equipment capable of removing possible cobbles and boulders. The strength of the bedrock is classified as strong to very strong; if excavation in bedrock is required, controlled blasting will likely be required for bedrock excavation.

Open cut, unsupported excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA). The soils are considered to be Type 3, in accordance with OHSA excavation sideslopes must be cut back at 1H:1V from the bottom of the excavation. Flatter sideslopes may be required in zones of water seepage.

Excavation side slopes in bedrock can be sloped at vertical, provided trench sides are cleared of loose rock prior to workers entering the trench.

In areas of restricted space where unsupported excavations are not feasible, the excavations can be undertaken within the confines of an engineered, hydraulic or prefabricated (trench box) support system designed and installed in accordance with OHSA.

The stability of the side slopes of the open cut and supported excavations may be affected by surcharge loads, stockpiles and building foundations as well as groundwater seepage conditions.

Since the proposed structures will be located in close proximity to the existing building, it is recommended that preconstruction surveys be undertaken of the nearby buildings and any underground services prior to start of construction. In addition, caution should be exercised during construction so as not to undermine foundations of existing buildings.

5.5.2 De-Watering Requirements

It is anticipated that dewatering of excavations can be undertaken by conventional sump and pump methods.

5.6 Foundation Backfill

Backfill for foundations should consist of non frost susceptible, compactible material such as OPSS Granular A or Granular B Type I or II materials. The foundation backfill can be placed in 300 mm thick lifts compacted using suitable equipment to 95% Standard Proctor Maximum Dry Density (SPMDD). Care should be taken immediately adjacent to the footings to avoid over-compaction of the soil which could result in damage to these foundation units.

5.7 Reuse of Site Generated Material

Portions of the silty sand and till may be re-used as backfill material in areas where non-free draining material is required, subject to further evaluation during construction. These materials can be reused as noted above, provided they are free of organic material and debris and the moisture content is such that adequate compaction can be achieved.

5.8 Cement and Corrosion Potential

Two representative soil samples were submitted to Paracel Laboratories Limited in Ottawa, Ontario for resistivity, pH, sulphate and chloride testing. The results of the testing are as follows:

Table 5.3: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)	Chloride(µg/g)	Resistivity (Ohm·m)
14-2	SS4	2.3 – 2.9	7.39	8	5	84.3
14-4	SS4	2.3 – 2.9	7.39	19	14	67.9

The testing was completed to determine the potential for degradation of concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in buried infrastructure.

The pH, resistivity and chloride concentrations provide an indication of the degree of corrosiveness of the subsurface environment. The soil pH was 7.39 in both samples which is within what is considered the normal range for soil pH of 5.5 to 9.0. The pH levels of the tested soil do not indicate a highly corrosive environment. The results are provided to aid in the selection of coatings and corrosion protection systems for buried steel objects.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. Soluble sulphate concentrations less than 1000 µg/g generally indicate a low degree of sulphate attack is expected

for concrete in contact with soil and groundwater. Type GU Portland Cement should therefore be suitable for use in concrete at this site.

5.9 Granular Material and Pavement Structure Recommendations

The subgrade in paved areas should be prepared as described in Section 5.2. The minimum pavement recommendations for the heavy-duty paved access ramp are provided in Table 5.4.

Table 5.4: Recommended Pavement Design

Material	Heavy-Duty Access Ramp
SP12.5 (surface course asphalt) (40 mm lift) SP19 (base course asphalt) (40 mm lift) SP19 (base course asphalt) (40 mm lift)	120 mm
150 mm OPSS Granular A	150 mm
450 mm OPSS Granular B Type II	450 mm

The pavement surface and the underlying subgrade should be graded to direct runoff water towards suitable drainage.

All granular materials should be tested and approved by a geotechnical engineer prior to delivery to the site. Both base and subbase materials should be compacted to at least 100% SPMDD. Asphalt should be compacted to at least 97% Marshal bulk density.

Tack coat is recommended between all asphalt layers.

It is recommended that the lateral extent of the subbase and base layers not be terminated in a vertical fashion. A taper with a grade of 5 horizontal to 1 vertical is recommended in the subgrade line to minimize differential frost heave problems.

Where new grades do not match existing at the end limits of the project, the new grade will need to be tapered out at the project ends. A final grade transition of 100H:1V is recommended. A two-step joint is recommended at the transition point to match the thickness of the proposed upper binder and surface courses as per City of Ottawa detail R10 titled "Standard Road Cut Reinstatement". A tack coat should be applied to all milled surfaces. The subgrade line should be tapered upwards at 15H:1V where the levels differ.

5.10 Existing Pavement Structure

The existing pavement structure was not evaluated as part of this scope of work. Depending on the conditions of the existing pavement structure, it may not be suitable to support the proposed heavy loads.

6.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. It is the responsibility of Norr Limited., who is identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Stantec Consulting Ltd. should any of these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying of unexpected site conditions
- Planning, design or construction

This report has been prepared by Katurah Firdawsi and reviewed by Chris McGrath.

Respectfully submitted,

STANTEC CONSULTING LTD.

Katurah Firdawsi, EIT, B.Sc.Eng

Simon Gudina, P.Eng.
Geotechnical Engineer

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APPENDIX A

Statement of General Condition

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

Key Plan

Borehole Location Plan

200 0 200 m 400 m

1 : 20 000

JANUARY 2015
Project No. 122411073

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NOTES

BASEPLAN FROM MAPART 2006.

Client/Project

NATIONAL RESEARCH COUNCIL CANADA
BUILDING M22 ADDITION
NRC MONTREAL ROAD CAMPUS, OTTAWA, ON.

Drawing No.

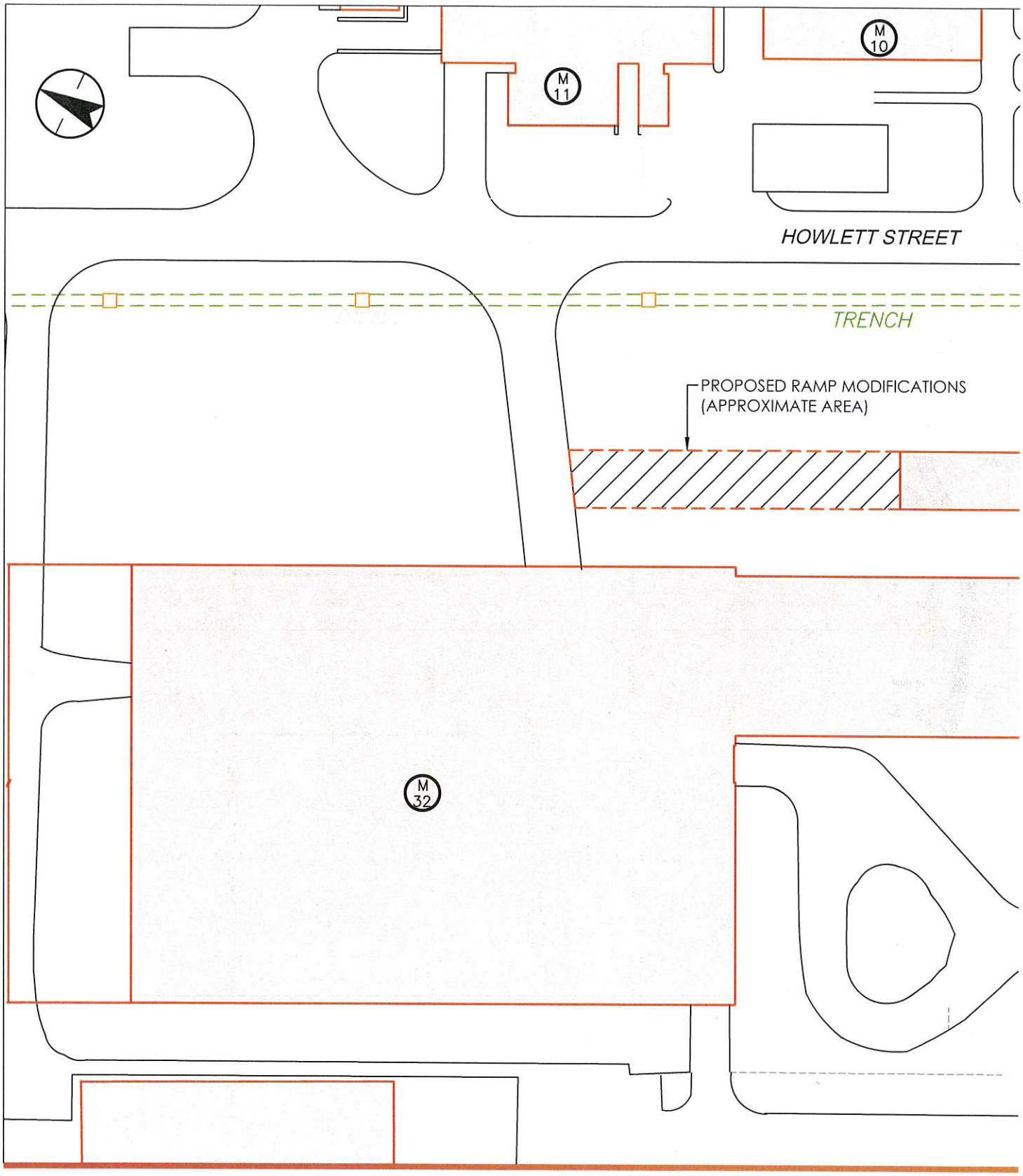
1

Title

KEY PLAN

Stantec

400 - 1331 Clyde Avenue
Ottawa, ON, Canada K2C 3G4
www.stantec.com



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LEGEND

- PROPOSED BUILDING ADDITION
- BOREHOLE

APPENDIX C

Symbols and Terms Used on Borehole Records

Borehole Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

Stantec

BOREHOLE RECORD

BH14-1

CLIENT National Research Council — BOREHOLE No. BH14-1

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0		FILL: Loose brown silty SAND with gravel (SM)			SS	1	110	9
1		- occasional cobbles/boulders inferred from auger grinding			SS	2	140	5
		Very dense silty gravel with sand till (GM) - pieces of fractured bedrock			SS	3	160	50/ 150 mm
2		End of Borehole Refusal on Inferred Bedrock						
3								
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

Stantec

BOREHOLE RECORD

BH14-2

CLIENT National Research Council — BOREHOLE No. BH14-2

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 — WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.00							
	99.9	70 mm TOPSOIL						
		FILL: Very loose to loose brown silty sand with gravel (SM) - occasional cobbles/boulders inferred from auger grinding			SS	1	210	3
1					SS	2	150	7
2					SS	3	200	5
					SS	4	300	4
3	97.0							
		Very dense brown-grey silty gravel with sand till (GM)			SS	5	380	54
	96.3							
4		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

Stantec

BOREHOLE RECORD

BH14-3

CLIENT National Research Council — BOREHOLE No. BH14-3

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.96							
	99.9	50 mm TOPSOIL						
		FILL: Loose to compact brown silty sand with gravel (SM)			SS	1	150	5
1		- occasional cobbles/boulders inferred from auger grinding			SS	2	100	15
2					SS	3	350	9
					SS	4	150	9
3	96.9			▽				
		Very loose brown-grey silty gravel with sand till (GM)			SS	5	200	3
	96.3	- pieces of fractured rock						
4		Limestone BEDROCK - Fair to good quality - Grey - Very close joint set spacing - Slightly weathered (Refer to Field Bedrock Core Log)			NQ	6	100%	75%
5					NQ	7	89%	80%
6					NQ	8	91%	71%
	93.3							
7		End of Borehole						
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

STN13-STAN-GEO 122411073 - NRC BUILDING M-22.GPJ SMART.GDT 1/21/15

Stantec

BOREHOLE RECORD

BH14-4

CLIENT National Research Council — BOREHOLE No. BH14-4

LOCATION Building M-22, NRC Montreal Road Campus, Ottawa, ON — PROJECT No. 122411073

DATES: BORING December 11, 2014 WATER LEVEL — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.50							
	99.4	80 mm TOPSOIL			SS	1	140	4
		FILL: Very loose to loose brown silty sand with gravel (SM) - occasional cobbles/boulders inferred from auger grinding			SS	2	100	3
2					SS	3	220	8
					SS	4	330	4
3	96.5							
	96.2	Very dense light brown-grey silty gravel with sand till (GM) - pieces of fractured rock			SS	5	110	50/ 75 mm
4		End of Borehole Auger Refusal on Inferred Bedrock						
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m *

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa App'd

△ Pocket Penetrometer Test, kPa Date

Field Be

Stantec

Client: NRC National Research Council Canada
Project: Building M-22 Addition
Contractor: Marathon Drilling

Project No.:
Date:
Borehole No.:
Logger:

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES						
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING
3.66	NQ-6	100%	75%	4.21	Light grey limestone	VS	S		B	F	VC	RP		O
4.21	NQ-7	89%	80%	5.74	Light grey to dark grey limestone		S		B	F	VC	RP		O, S
5.74	NQ-8	91%	71%	6.7	Light grey to dark grey limestone	S	S		B	F	VC	RP		SA

STRENGTH (MPa)
EH = Extremely Strong = > 250
VS = Very Strong = 100-250
S = Strong = 50-100
MS = Medium Strong = 25-50
W = Weak = 5 - 25
VW = Very Weak = 1-5
EW = Extremely Weak = < 1

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

Stantec	Project No.: 1224110473 Project Name: NRC Building M-22	Rockcore Photographs

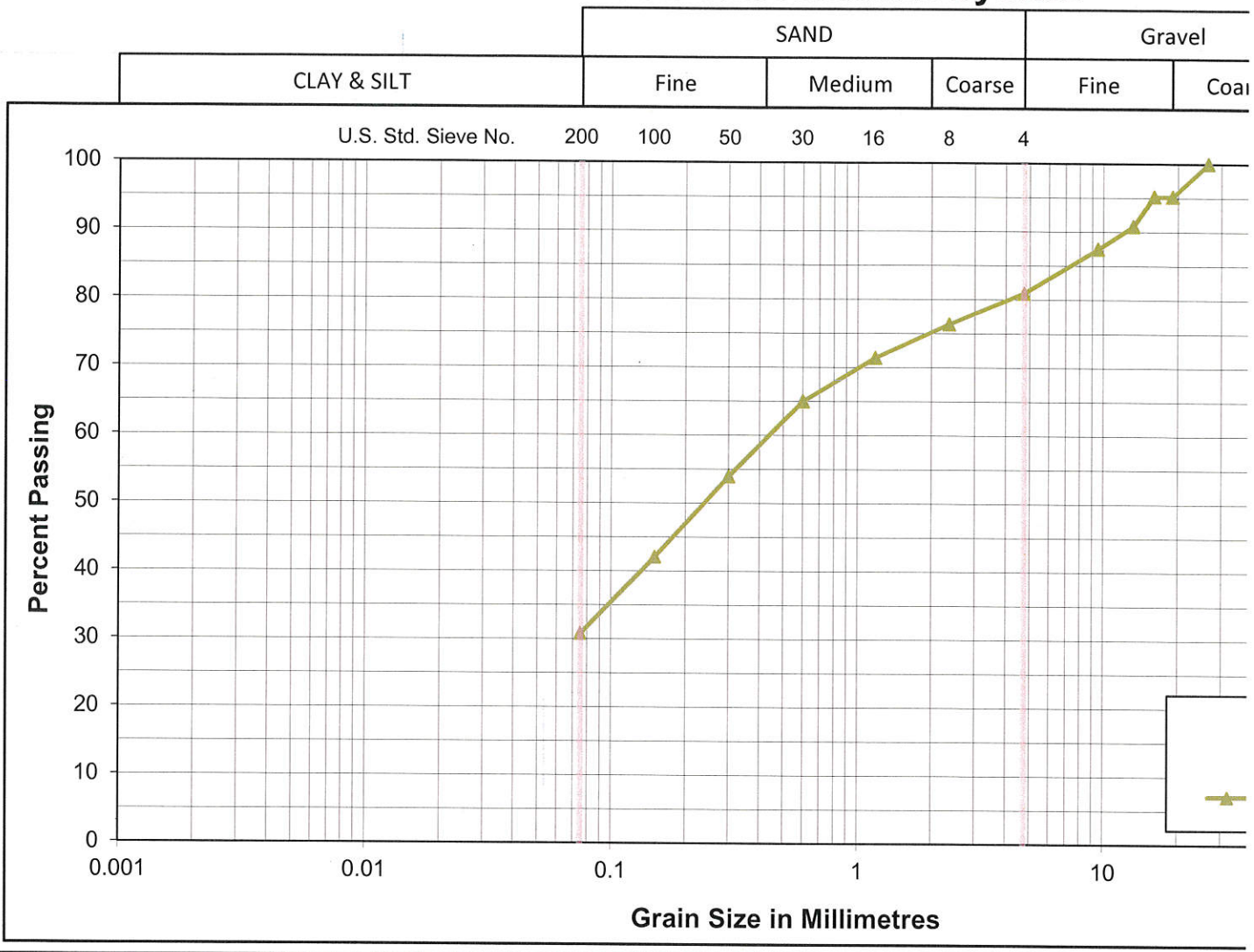
Rock Core Photo No.: 1	Borehole: 14-3	Depth: 3.66 m – 5.74 m

Rock Core Photo No.: 2	Borehole: 14-3	Depth: 5.74 m – 6.70 m

APPENDIX D

Laboratory Test Results

Unified Soil Classification System

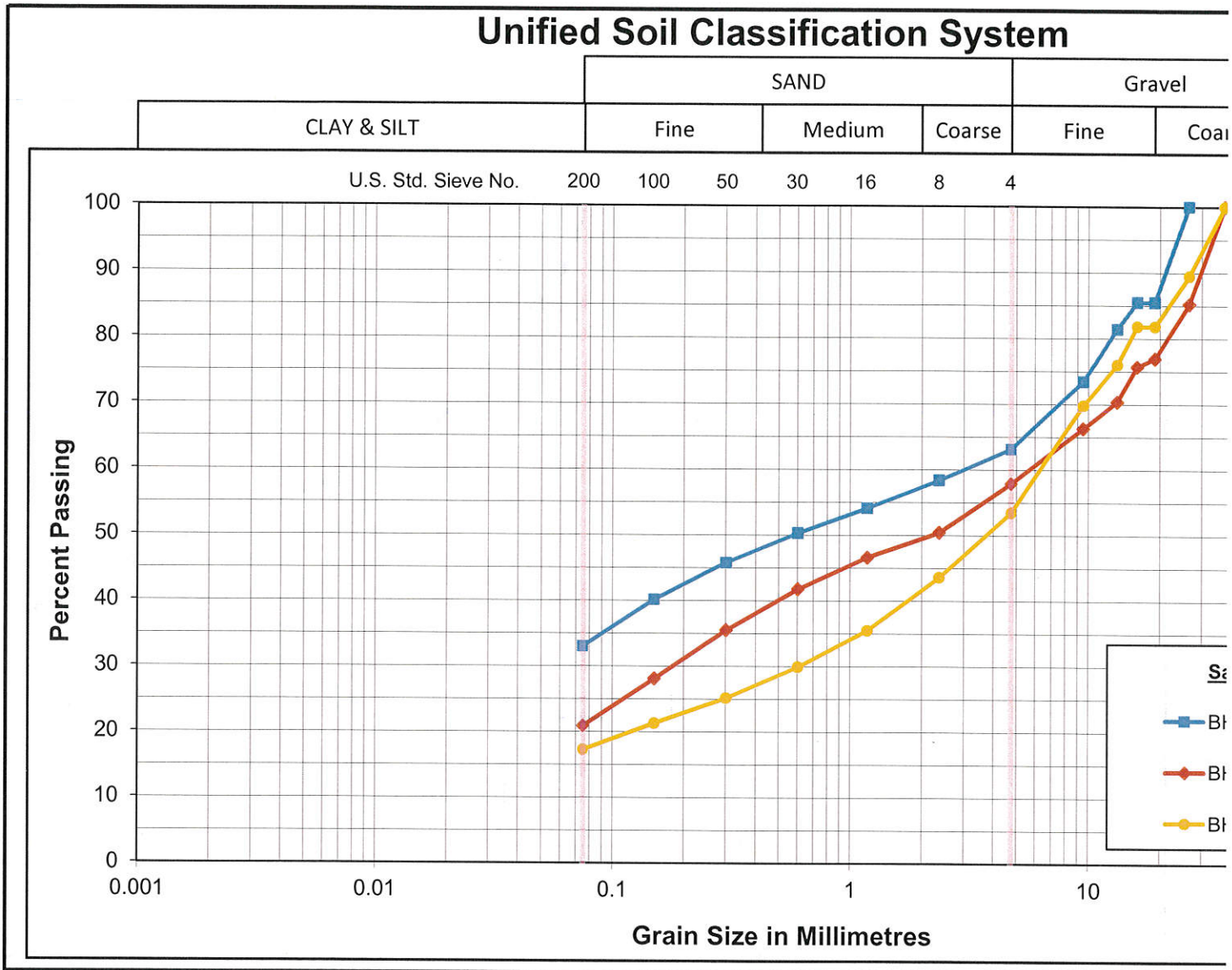


Stantec

GRAIN SIZE DISTRIBUTION

FILL: Silty Sand with Gravel (SM)

Proje



Stantec

GRAIN SIZE DISTRIBUTION

Silty Gravel with Sand (GM) TILL

Proje

APPENDIX E

Geophysics GPR International MASW Survey

NBC Seismic Hazard Calculation

GEOPHYSICS GPR INTERNATIONAL INC.

100 – 2545 Delorimier Street
Longueuil (Québec)
Canada J4K 3P7

Tel. : (450) 679-2400
Fax : (514) 521-4128
info@gprmtl.com
www.geophysicsgpr.com

December 18th, 2014

Transmitted by email: Katurah.Firdawsi@stantec.com

Our Ref.: M-14957

Mrs. Katurah Firdawsi
Stantec Inc.
400 – 1331 Clyde Avenue
Ottawa (ON) K2C 3G4

Subject: **Shear-wave Velocity Surveys, Montreal Road Campus, Ottawa (ON)**

[Project N°: 122411073]

Dear Mrs. Firdawsi,

Geophysics GPR International Inc. has been requested by Stantec inc. to carry out seismic shear wave surveys on a site beside the east wall of the National Research Council of Canada M22 building, west of the Howlett Street and Hutcheon Ave. intersection, in Ottawa. The geophysical investigations used the Multi-channel Analysis of Surface Waves (MASW), the Extended SPatial AutoCorrelation (ESPAC), and the seismic refraction methods. From the subsequent results, the Site Class was identified.

The surveys were carried out December 3rd, by Mr. Charles Trottier, M.A.Sc., phys. and Mr. Denis Tessier. Figure 1 shows the regional location of the site, and Figure 2 illustrates the location of the seismic spread. Both figures are presented in the appendix.

The following paragraphs briefly describe the survey design, the principles of the test methods, and the results in graphic and table format.

METHODS PRINCIPLES

MASW Survey

The *Multi-channel Analysis of Surface Waves* (MASW) and the *Extended SPatial AutoCorrelation* (ESPAC or MAM for *Microtremors Array Method*) are seismic methods used to evaluate the shear wave velocities of subsurface materials through the analysis of the dispersion properties of the Rayleigh surface waves ("ground roll"). The MASW is considered an "active" method, as the seismic signal is induced at known location and time in the geophones spread axis. Conversely, the ESPAC is considered a "passive" method, using the low frequency "noises" produced far away. The method can also be used with "active" seismic source records. The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. The inversion of the Rayleigh wave dispersion curve yields a shear wave (V_S) velocity depth profile (sounding). Figure 3 outlines the basic operating procedure for the MASW method.

Figure 4 illustrates an example of one of the MASW/ESPAC records, the corresponding spectrogram analysis and resulting 1D V_S model. The ESPAC method allows deeper Vs soundings, but generally with a lower resolution for the surface portion. Its dispersion curve can then be merged with the higher frequency one from the MASW to calculate a more complete inversion.

More detailed descriptions of the methods are presented in *Shear wave velocity measurement guidelines for Canadian seismic site characterization in soil and rock*, Hunter, J.A., Crow, H.L., et al., Geological Surveys of Canada, public file 7078, 2012. For the MASW method, one can also refer to *Multi-channel Analysis of Surface Waves*, Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); p. 800–808. For the ESPAC method, one could refer to the paper *Shear Velocity Profiles Obtained from Microtremor Array Data with an Example from Direct Fitting of SPAC Curves*, Asten, M.W., 2007, Proceedings of the 20th SAGEEP Conference, Denver, Environmental and Engineering Geophysical Society, and for more details: *The Microtremor Survey Method*, Okada, H., S.E.G., Geophysical Monograph Series No. 12.

Seismic Refraction Survey

The method consists to measure the propagation delays of the direct and refracted seismic waves (P and/or S) produced by an artificial source in the axis of the seismic spread. The seismic velocities of the materials can be directly calculated, then the refractors depths. A detailed description of the seismic refraction method is presented in the document *Seismic Refraction Exploration for Engineering Site* Investigation, Redpath, Bruce B., AD-768 710, Explosive Excavation Research Laboratory, Livermore, California, 1973.

INTERPRETATION METHODS

MASW surveys

The main processing sequence involved data inspection; editing (when required); spectral analysis ("phase shift" for MASW, and cross-correlation for ESPAC); picking the fundamental mode; and 1D inversion of the MASW and ESPAC shot records using the SeisImagerSW™ software. The data inversions were realized with a non-linear least square method. In theory, all the shot records for a given seismic spread should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation, localized surface seismic velocities variations, and/or dipping of overburden layers or rock. In general the precision of the calculated seismic shear wave velocities (V_S) is of the order of 15% or better.

Seismic Refraction surveys

The considered seismic wave's arrival times are identified for each geophone. The General Reciprocal Method was used, with shot points at both ends of the seismic spread, in order to consider seismic wave propagation for two opposite directions. The measurements were realised to calculate the rock depth, and its seismic velocity. Conversely to the MASW method, the seismic rock velocity measured by seismic refraction is only representative of its superior part, due to the evanescent nature of the refracted wave. The rock seismic velocities were calculated using two methods: the reduced travel-times (the Hobson and Overton method) and the opposite apparent velocities. The first one allows independence from the surface and rock topography effect, as well as the overburden lateral variation of its seismic velocity, but remains limited to common geophones. The second one can use longer segments of opposite directions signals, improving the regressions accuracy, but remains affected by the surface and rock topography effect, as well as the overburden lateral variation of the seismic velocity.

Survey Design

The main seismic spread was located 8.7 metres from the east side of the NRCC M22 building, centered 14.3 metres SE from BH-14-3 (cf. Figure 2). Its geophone spacing was 3 metres, which means that the total length of a 24 geophones spread was 69 metres. It was used for the MASW as well as for the seismic refraction surveys. A second shorter seismic spread, with geophone spacing of 1 metre, was dedicated to the near surface details.

The seismic records counted 4096 data, sampled at 1000 µs for the MASW, and 50 µs for the seismic refraction method. They were triggered by electrical close-contact between a sledgehammer and a steel plate.

The seismic records were realized with a seismograph Terraloc MK6 (from ABEM Instrument), and the geophones were 4.5 Hz. A 20 pounds sledgehammer was used as the primary energy source with impacts being recorded off both ends of the seismic spreads, with a records stacking procedure to enhance the S/N ratio.

RESULTS

The rock depth was calculated close to 6.7 metres deep from seismic refraction data, using the compressional seismic waves (V_P) and the critical distances method. The rock's seismic shear wave velocity was then calculated from two different methods (cf. Figure 5). Its sounder portion of the shallow part could reveal a V_S value of 2008 m/s (from the Obson & Hoverton method) to 2047 m/s (from the opposite directions apparent velocities method) .

The V_{S30} value results from the harmonic mean of the shear wave velocities, from the surface to 30 metres deep. It is calculated by dividing the total depth of interest (e.g. 30 metres) by the sum of the time spent in each velocity layer from the surface up to 30 metres. This value reflects an equivalent homogeneous single layer response. The calculated V_{S30} value is 883.3 m/s (cf. Table 1), corresponding to the Site Class "B". Nevertheless, this Site Class can not be used if there is more than 3 metres of unconsolidated material between the rock surface and the bottom of the foundations, even if the V_{S30} computed value is more than 760 m/s.

Also, low seismic shear wave velocities were calculated for the unconsolidated materials, from the surface to approximately 2 metres deep.

CONCLUSION

Seismic surveys were realized with the MASW/ESPAC and seismic refraction methods, to calculate the V_{S30} value for the Site Class determination. The seismic spreads were laid parallel to Howlett Street, at 9 metres east from the National Research Council of Canada M22 building. The V_{S30} calculation is presented in Table 1.

The calculated V_{S30} value is 883 m/s for the actual site. Based on this value (determined through the MASW/ESPAC methods), Table 4.1.8.4.A of the NBCC, and the Building Code, O. Reg. 332/12, the investigated actual site presents a Class "B" ($760 < V_{S30} \leq 1500$ m/s). Nevertheless, this Site Class can not be considered if there is more than 3 metres of unconsolidated material between the rock surface and the bottom of the foundations (cf. Commentary J, #100 of the NBCC).

The rock seismic shear wave velocity was calculated from two different methods. Its sounder portion of the shallow part revealed a V_S value between 2008 to 2047 m/s. If the foundations of the building addition are to be on the rock, the Site Class would be "A" ($V_{S30}^* > 1500$ m/s).

Between the surface and approximately 2 metres deep, low seismic velocities were calculated.

It must be noted that other geotechnical information gleaned onsite; including the presence of liquefiable soils, soft clays, high moisture content etc. can supersede the site classification provided in this report based on the V_{S30} value.

The V_S values calculated are representative of the in situ materials, and were not corrected for the total and effective stress.

This report has been written by Jean-Luc Arsenault, M.A.Sc., P.Eng.

Jean-Luc Arsenault, M.A.Sc., P.Eng.
Project Manager

18/12/2014

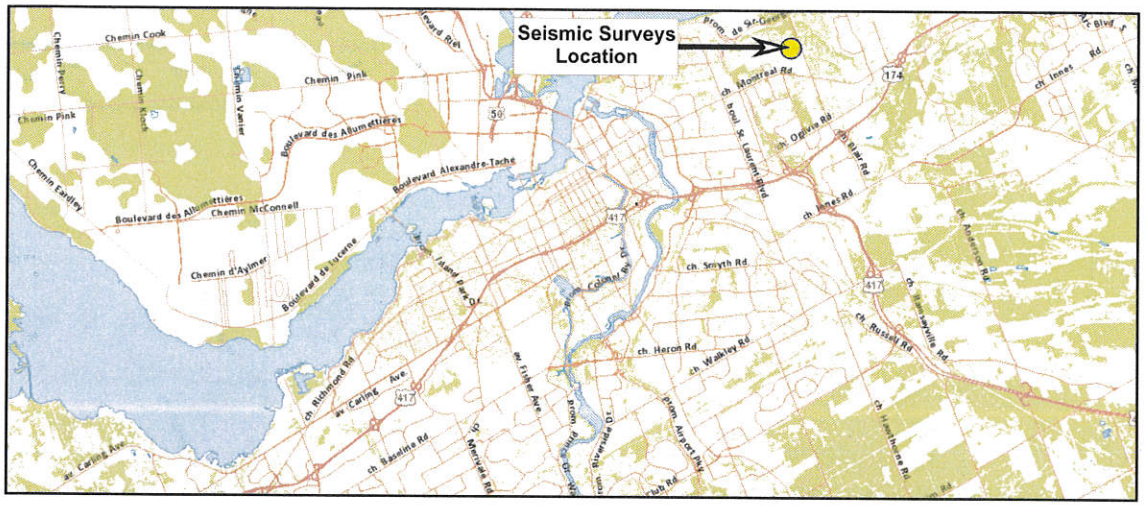


Figure 1: Regional location of the Site
(source: ***geo Ottawa***)

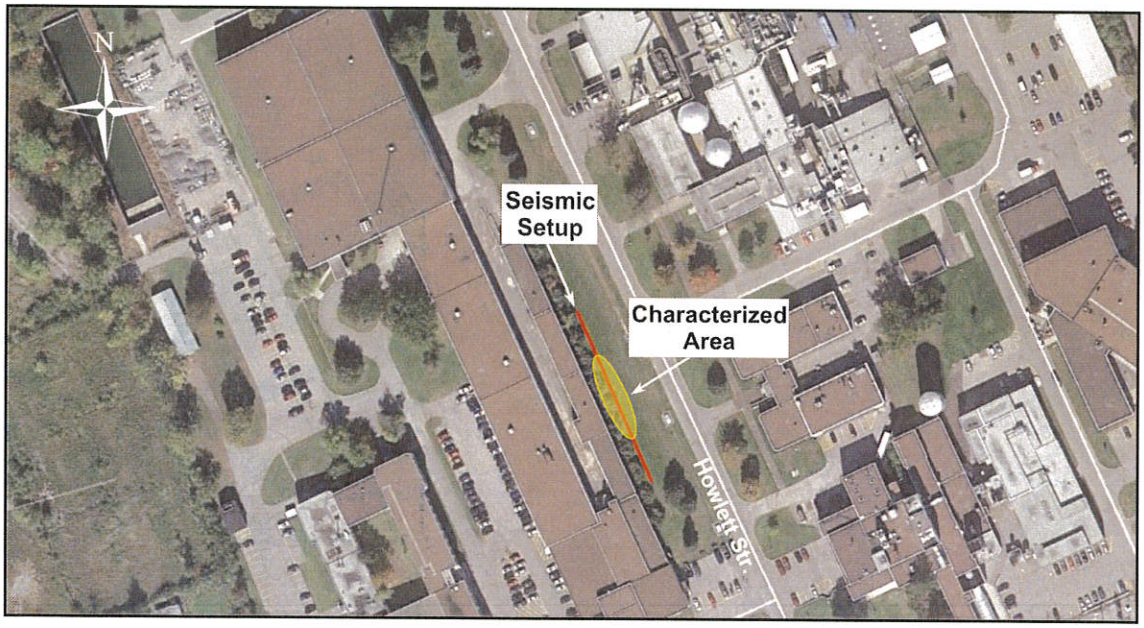


Figure 2: Location of the *seismic* spreads
(source ***Google Earth***™)

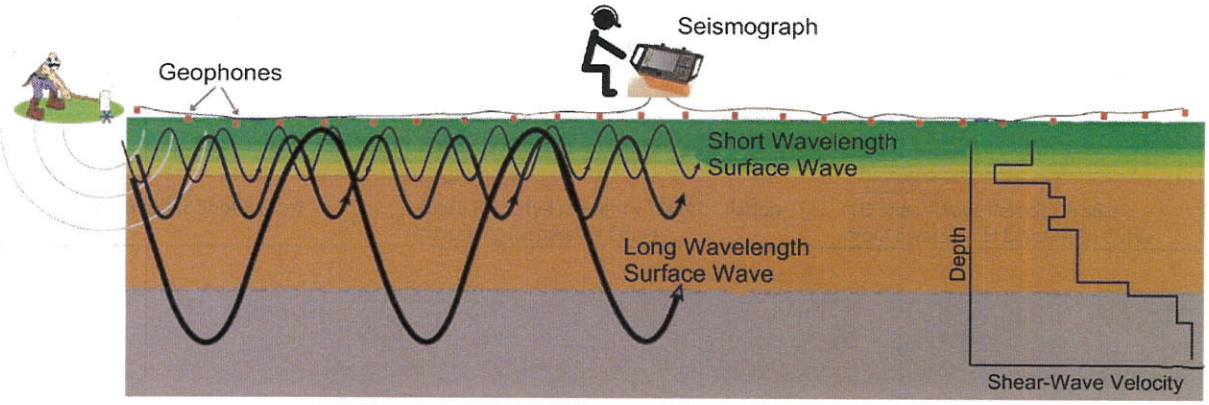


Figure 3: MASW Operating Principle

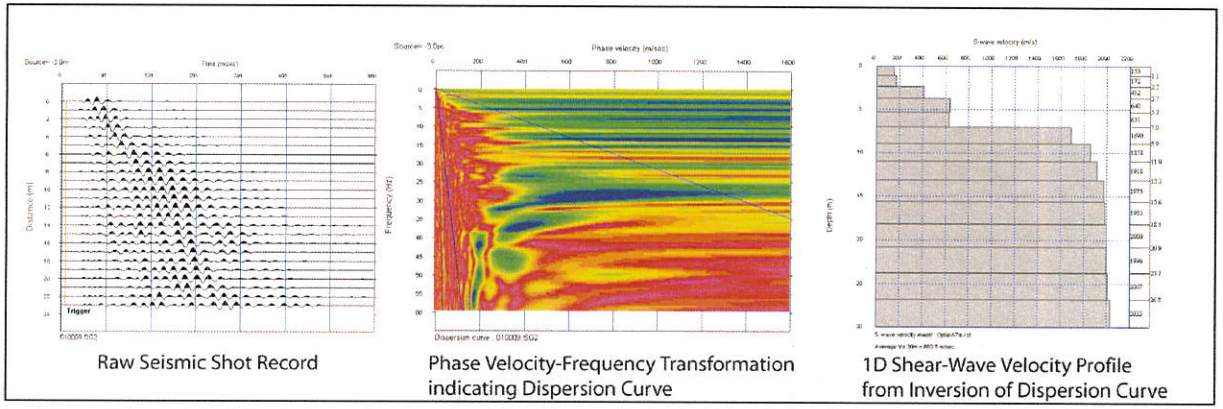


Figure 4: Example of a MASW/ESPAC shot record, phase velocity/frequency curve and resulting 1D shear wave velocity model

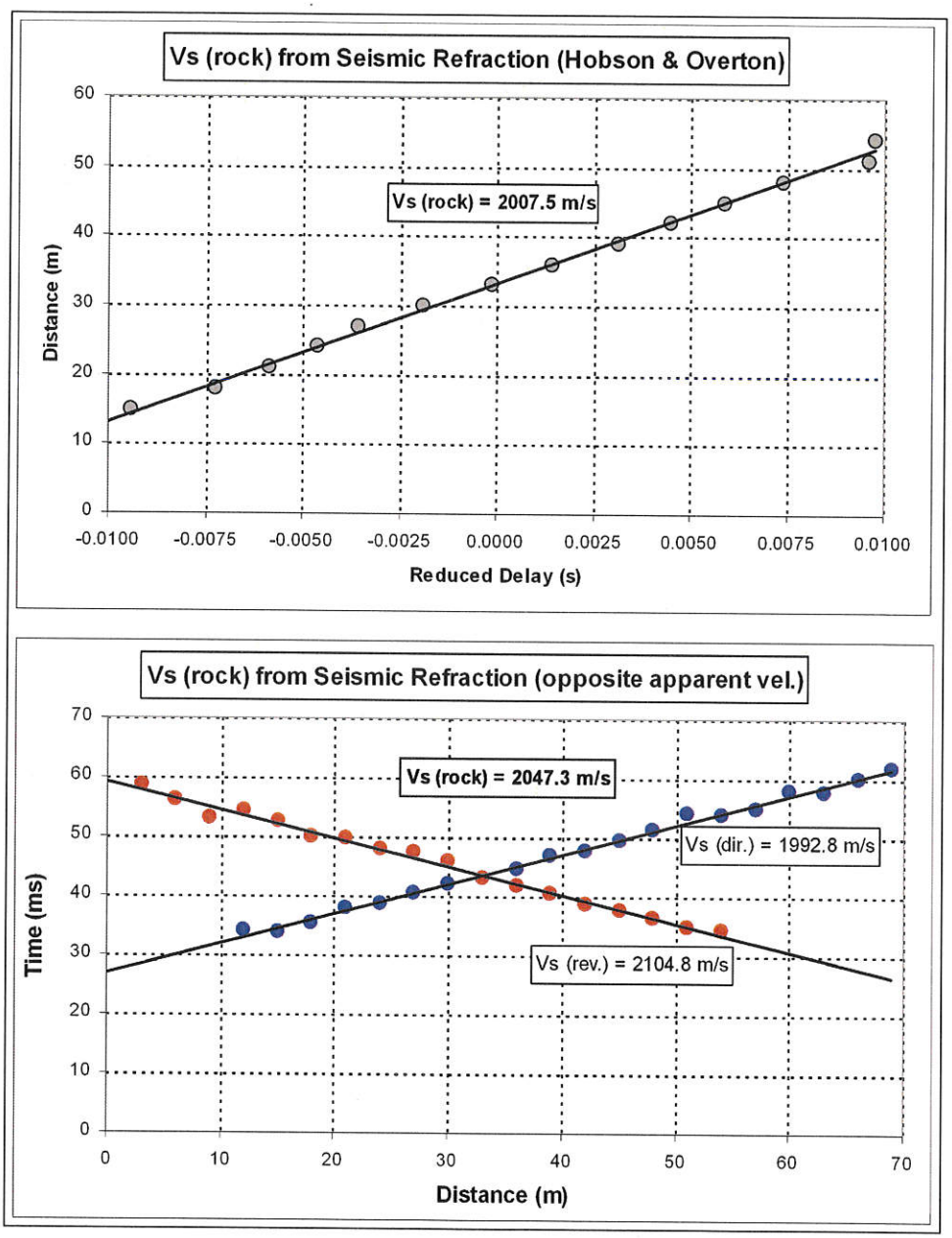


Figure 5: Rock Seismic Shear Wave Velocities from Seismic Refraction

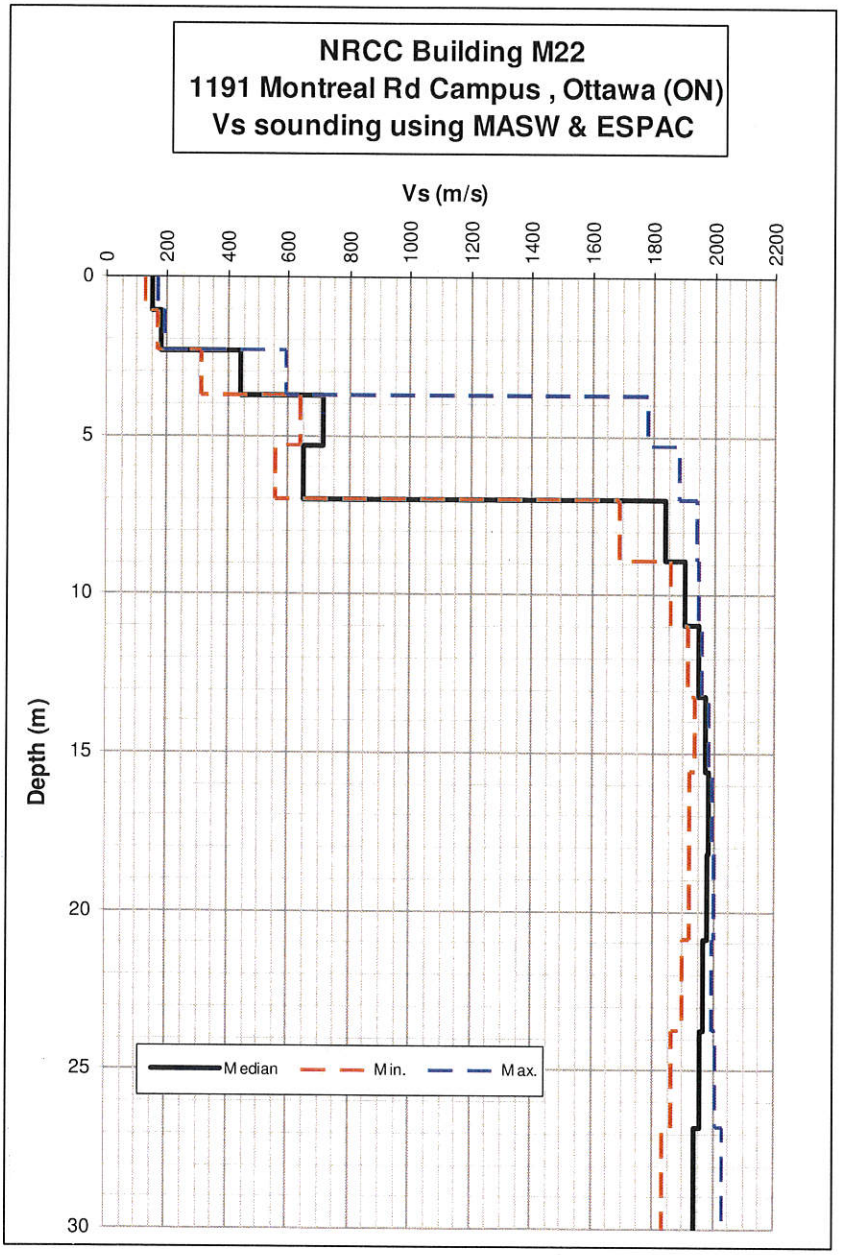


Figure 6: MASW Shear-wave Velocity Sounding

TABLE 1

V_{S30} Calculation for the Site Class (actual site)

Depth (m)	Vs			Thickness (m)	Cumulated Thickness (m)	Delay for med. Vs (s)	Cumulated Delay (s)	Average Vs for given Depth (m/s)
	Min. (m/s)	Median (m/s)	Max. (m/s)					
0.00	124.8	148.1	167.1					
1.07	165.7	179.7	191.0	1.07	1.07	0.007233	0.007233	148.1
2.31	314.8	440.2	589.7	1.24	2.31	0.006877	0.014110	163.5
3.71	636.0	712.6	1780.4	1.40	3.71	0.003183	0.017293	214.4
5.27	557.7	648.6	1889.3	1.57	5.27	0.002198	0.019490	270.6
7.01	1690.7	1842.0	1945.1	1.73	7.01	0.002669	0.022159	316.1
8.90	1858.1	1902.2	1951.1	1.90	8.90	0.001029	0.023188	383.9
10.96	1918.4	1949.9	1963.3	2.06	10.96	0.001083	0.024271	451.6
13.19	1941.5	1975.9	1987.1	2.23	13.19	0.001141	0.025412	518.9
15.58	1922.0	1985.3	1995.1	2.39	15.58	0.001210	0.026622	585.1
18.13	1919.7	1977.9	2000.0	2.56	18.13	0.001287	0.027909	649.7
20.85	1898.1	1969.1	1996.9	2.72	20.85	0.001375	0.029284	712.0
23.74	1863.7	1957.2	2007.9	2.89	23.74	0.001465	0.030749	771.9
26.79	1835.1	1941.1	2033.8	3.05	26.79	0.001558	0.032307	829.1
30.00	1951.1	1995.1	2094.0	3.21	30.00	0.001656	0.033963	883.3

V_{S30} (m/s) =	**883.3**
Site Class :	**B ***

*: conditional to less than 3 metres of unconsolidated material between the rock surface and the bottom of the foundations (cf. Table 4.1.8.4.A, and Commentary J, # 100 of the NBCC). Encountering such condition, the Site Class would be "A".

2010 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Requested by: ,

January 19, 2015

Site Coordinates: 45.4514 North 75.621 West

User File Reference:

National Building Code ground motions:
2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA (g)
0.633	0.309	0.138	0.046	0.321

Notes. Spectral and peak hazard values are determined for firm ground (NBCC 2010 soil class C - average shear wave velocity 360-750 m/s). Median (50th percentile) values are given in units of g. 5% damped spectral acceleration (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are tabulated. Only 2 significant figures are to be used. ***These values have been interpolated from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.2)	0.090	0.249	0.386
Sa(0.5)	0.043	0.123	0.187
Sa(1.0)	0.017	0.056	0.088
Sa(2.0)	0.006	0.018	0.028
PGA	0.039	0.123	0.201

References

National Building Code of Canada 2010 NRCC no. 53301; sections 4.1.8, 9.20.1.2, 9.23.10.2, 9.31.6.2, and 6.2.1.3
Appendix C: Climatic Information for Building Design in Canada - table in Appendix C starting on page C-11 of Division B, volume 2

User's Guide - NBC 2010, Structural Commentaries NRCC no. 53543 (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File xxxx
Fourth generation seismic hazard maps of Canada: Maps and grid values to be used with the 2010 National Building Code of Canada (in preparation)

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français