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SOLICITATION AMENDMENT
MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Comments - Commentaires

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Phase III
Gatineau, Québec K1A 0S5

Title - Sujet Sir Frederick Banting Fit-up	
Solicitation No. - N° de l'invitation EP076-141420/A	**Amendment No. - N° modif.** 004
Client Reference No. - N° de référence du client 20141420	**Date** 2014-02-07
GETS Reference No. - N° de référence de SEAG PW-$$FG-356-64066	
File No. - N° de dossier fg356.EP076-141420	**CCC No./N° CCC - FMS No./N° VME**
Solicitation Closes - L'invitation prend fin **at - à 02:00 PM** **on - le 2014-02-20**	**Time Zone** **Fuseau horaire** Eastern Standard Time EST
F.O.B. - F.A.B. **Plant-Usine:** ☐ **Destination:** ☐ **Other-Autre:** ☐	
Address Enquiries to: - Adresser toutes questions à: Lagacé, Hélène	**Buyer Id - Id de l'acheteur** fg356
Telephone No. - N° de téléphone (819) 956-0060 ( )	**FAX No. - N° de FAX** (819) 956-8335
Destination - of Goods, Services, and Construction: **Destination - des biens, services et construction:** Sir Frederick Banting Research Centre 251 Sir Frederick Banting Way Ottawa, Ontario	

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This solicitation amendment 004 is being issued to **re-issue** Addendum 01 (that should have been a part of amendment 002). Note this was also attempted on solicitation amendment 003, however, due to technical errors was not successful.

All other terms and conditions remain unchanged.

ADDENDUM NO. 01

The following changes in bid documents are effective immediately. This addendum will form part of the contract documents.

All drawings that are referred to as "revised drawing" replace the original drawing of the same number.

All drawings that are referred to as "partial drawing revision" are in addition to the original drawing of the same number and only revise the change noted in the addendum list.

DRAWINGS

1. A531- MISCELLANEOUS DETAILS

.1 Add new detail 12/A531R1. Add temporary construction fence panels per Section 01 56 00 – Temporary Barriers and Enclosures in penthouse where shown on partial drawing revision A531-R1, issued as part of this Addendum.

.2 Add new detail 13/A531. Add partitions and door at UPS Room A503A and Electrical Room A503B to match architectural drawings, as shown on partial drawing revision A531-R2, issued as part of this Addendum.

2. A532 – ROOF DETAILS

.1 Add new details 5/A532 Section Detail Box Curb, and 6/A532 Guy Wire Support Detail, as shown on partial drawing revision A532R1 and A532R2, issued as part of this Addendum.

3. S100 – GENERAL NOTES AND DETAILS

.1 Add new Guy Wire Support Detail, as shown on partial drawing revision FS-S100-01, issued as part of this Addendum.

4. S203 – PENTHOUSE ROOF PLAN

.1 Add new RTU Support Details, as shown on partial drawing revision FS-S203-01, FS-S203-02, and FS-S203-03, issued as part of this Addendum.

5. MH130 - THIRD FLOOR PLAN HYDRONICS

.1 Delete drawing MH130 and replace with drawing MH130-X1, issued as part of this Addendum. Refer to revised drawing MH130-X1 for general revisions to pipe sizing, addition of thermostats, and oxygen sensors.

6. MH140 - FOURTH FLOOR PLAN HYDRONICS

.1 Delete drawing MH140 and replace with MH140-X1, issued as part of this Addendum. Refer to revised drawing MH140-X1 for general revisions to pipe sizing, addition of thermostats, and oxygen sensors.

7. MP120 - SECOND FLOOR PLAN PLUMBING

.1 Provide 100 mm dia. sanitary drain and trap in ceiling of 2nd floor to connect floor drain on 3rd floor, located at gridline LY-22. Connect to riser 'P120'.

.2 Add new General Note, as follows:

.1 Work on second floor will require staging/phasing. Cooperate with Departmental Representative, and coordinate schedule with Departmental Representative to minimize disruption.

8. MP130 - THIRD FLOOR PLAN – PLUMBING

.1 Refer to partial drawing revision MP130-R1 for revisions to water pipe sizes and connection of sterilizer and glassware washer.

9. MP150 - PENTHOUSE PLAN – PLUMBING + LABORATORY GAS

.1 Delete drawing MP150 and replace with MP150-X1, issued as part of this Addendum. Refer to revised drawing MP150-X1 for addition of nitrogen generator, compressed air system, floor drains.

10. M001 - MECHANICAL LEGEND
MP130 - THIRD FLOOR PLAN – PLUMBING,
MP140 - FOURTH FLOOR PLAN – PLUMBING

.1 Drawing MP140: Plumbing line shown at the east and west sides of the floor plan, tagged with “150 RWL” should be revised to be “150 ST” to match legend (line are above grade storm water lines). These lines are new, replacing existing pipe currently in place.

.2 Drawings MP130, MP140: Lines tagged with “72F TWS” should be revised to “TWS” to match legend.

11. MG130 - THIRD FLOOR PLAN LABORATORY GAS

.1 Refer to partial drawing revision MG130-R1 for additional detail of gas and equipment layout.

.2 Room A369: Room is a mechanical shaft. Lines entering into shaft shall be 25mm diameter for CA and N2 and rise up to 4th floor level. CO2 line shall be 19mm and rise up to 4th floor level.

12. MG140 - FOURTH FLOOR PLAN LABORATORY GAS

.1 Refer to partial drawing revision MG140-R1 for additional detail of gas and equipment layout.

.2 Refer to partial drawing revision MG140-R2 for additional detail of gas and equipment layout.

.3 Room A474: Room is a mechanical shaft. Lines entering into shaft shall be 25mm for CA and N2 service and shall continue up to penthouse. CO2 line entering into shaft shall be 19mm and shall connect to horizontal distribution at 4th floor ceiling level.

13. MV130 - THIRD FLOOR PLAN VENTILATION

.1 Delete Drawing MV130 and replace with MV130-X1, issued as part of this Addendum.

14. MV131 - THIRD FLOOR SOUTHWEST LARGE SCALE PLAN

.1 Delete Drawing MV131 and replace with MV131-X1, issued as part of this Addendum. Refer to revised drawing MV131-X1 for addition of fan coil units and duct system revisions.

15. MV132 - THIRD FLOOR NORTHWEST LARGE SCALE PLAN

.1 Delete Drawing MV132 and replace with MV132-X1, issued as part of this Addendum.

16. MV133 - THIRD FLOOR SOUTHEAST LARGE SCALE PLAN

.1 Delete Drawing MV133 and replace with MV133-X1, issued as part of this Addendum. Refer to revised drawing MV133-X1 for revisions to ventilation ducting.

17. MV134 - THIRD FLOOR NORTHEAST LARGE SCALE PLAN

.1 Delete Drawing MV134 and replace with MV134-X1, issued as part of this Addendum. Refer to revised drawing MV134-X1 for addition of fan coil units and duct system revisions.

18. MV141 - FOURTH FLOOR SOUTHWEST LARGE SCALE PLAN

.1 Refer to partial drawing revision MV141-R1 for addition of duct mounted silencers.

.2 Refer to partial drawing revision MV141-R2 for addition of fan coil unit.

.3 Refer to partial drawing revision MV141-R3 for revisions to exhaust ducting.

19. MV142 - FOURTH FLOOR NORTHWEST LARGE SCALE PLAN

.1 Refer to partial drawing revision MV142-R1 for revisions to washroom exhaust and additions of fan coil units.

.2 Refer to partial drawing revision MV142-R2 for miscellaneous revisions to ventilation system.

.3 Refer to partial drawing revision MV142-R3 for addition of exhaust and transfer to electrical room.

20. MV143 - FOURTH FLOOR SOUTHEAST LARGE SCALE PLAN

.1 Refer to partial drawing revision MV143-R1 for addition of air flow measuring station.

21. MV144 - FOURTH FLOOR NORTHEAST LARGE SCALE PLAN

.1 Refer to partial drawing revision MV144-R1 for revision to washroom exhaust and fan coil units.

.2 Refer to partial drawing revision MV144-R2 for revisions to ventilation ducting.

.3 Refer to partial drawing revision MV144-R3 for addition of fan coil units.

22. MV150 PENTHOUSE FLOOR PLAN - MECHANICAL

.1 Delete drawing MV150 and replace with MV150-X1, issued as part of this Addendum.

23. M160 – ROOF PLAN MECHANICAL

.1 Delete drawing M160 and replace with M160-X1, issued as part of this Addendum. Refer to revised drawing M160-X1 for new roof top units.

24. M401 – LARGE SCALE PENTHOUSE PLAN LOW LEVEL - SOUTH

.1 Delete drawing M401 and replace with M401-X1, issued as part of this Addendum.

25. M402 – LARGE SCALE PENTHOUSE PLAN HIGH LEVEL - SOUTH

.1 Delete drawing M402 and replace with M402-X1, issued as part of this Addendum.

26. M403 – LARGE SCALE PENTHOUSE PLAN LOW LEVEL - NORTH

.1 Delete drawing M403 and replace with M403-X1, issued as part of this Addendum.

27. M404 – LARGE SCALE PENTHOUSE PLAN HIGH LEVEL - NORTH

.1 Delete drawing M404 and replace with M404-X1, issued as part of this Addendum. Refer to revised drawing M404-X1 for details on ventilation for electrical and UPS rooms.

28. M501 – MECHANICAL DETAILS

.1 Refer to partial drawing revision M501-R1 for clarification of LN2 piping systems requirements.

.2 Refer to partial drawing revision M501-R2 for details of installation requirements for CO2 pressure regulators.

.3 Refer to partial drawing revision M501-R3 for clarification of RO water piping drops to laboratory bench.

.4 Refer to partial drawing revision M501-R4 for detailed requirements for steam relief valve piping.

29. M502 – MECHANICAL DETAILS

.1 Refer to partial drawing revision M502-R1 for clarification of exhaust fan construction and installation details.

.2 Refer to partial drawing revision M502-R2 for supplemental information regarding installation of air handling systems.

30. M601 – MECHANICAL SCHEDULES

.1 Delete drawing M601 and replace with M601-X1, issued as part of this Addendum. Refer to revised drawing M601-X1 for schedule revisions.

31. M602 – MECHANICAL SCHEDULES

.1 Delete drawing M602 and replace with M602-X1, issued as part of this Addendum. Refer to revised drawing M602-X1 for addition of schedules for ductless split evaporator and condensing unit schedule.

32. M603 – MECHANICAL SCHEDULES

.1 Delete drawing M603 and replace with M603-X1, issued as part of this Addendum. Refer to revised drawing M603-X1 for schedule revisions.

33. M604 – MECHANICAL SCHEDULES

.1 Delete drawing M604 and replace with M604-X1, issued as part of this Addendum. Refer to revised drawing M604-X1 for addition of schedules for condensate return units, duct silencers, roof top unit, fans.

34. M801 – MECHANICAL EQUIPMENT AIR HANDLING UNITS

.1 Refer to partial drawing revisions M801-R1 and M801-R2 for clarification of exhaust fan construction and installation details.

35. EP131 – THIRD FLOOR SOUTH WEST POWER LAYOUT

.1 Wire and connect new fan coil "FC-3-1" back to respective condensing unit on roof with #10 awg. Cu. wire in conduit. Refer to Mechanical drawings/addendum for exact location. Unit is powered from roof top condensing unit.

36. EP132 – THIRD FLOOR NORTH WEST POWER LAYOUT

.1 Wire and connect new fan coils "FC-3-4 & FC-3-5" back to respective condensing units on roof with #10 awg. Cu. wire in conduit. Refer to Mechanical drawings/addendum for exact locations. Units are powered from roof top condensing units.

.2 Wire and connect Nitrogen control panel back to Panel N32NA circuit 82 c/w #12 awg. Cu. Wire in conduit and provide 15A-1P breakers in panel. Control panel located on west wall of room A340B LN2 Fill Station.

.3 Wire and connect heat trace cabling for hot water lines back to Panel N32NA circuits 83 & 84 c/w #12 awg. Cu. Wire in conduit and provide 2x 15A-1P breakers in panel. Heat trace power junction boxes located in corridor A318 ceiling space, refer to Mechanical addendum for exact location.

37. EP133 – THIRD FLOOR SOUTH EAST POWER LAYOUT

.1 Wire and connect new fan coils "FC-3-2 & FC-3-3" back to respective condensing units on roof with #10 awg. Cu. wire in conduit. Refer to Mechanical drawings/addendum for exact locations. Units are powered from roof top condensing units.

38. EP134 – THIRD FLOOR NORTH EAST POWER LAYOUT

.1 Wire and connect new fan coil "FC-3-6" back to respective condensing unit on roof with #10 awg. Cu. Wire in conduit. Refer to Mechanical drawings/addendum for exact location. Unit is powered from roof top condensing unit.

39. EP141 – FOURTH FLOOR SOUTH WEST POWER LAYOUT

.1 Delete duplicate Type B service panel in DBP Dirty Water Room A459C near Grids 14/M.Y identified starting circuit N42NE-17.

.2 Provide circuit number N42NA-1 for three (3) blank receptacles along south wall in Air Containment room A432A.

.3 Provide circuit number N42NA-2 for one (1) blank receptacle along south wall in Material Emission Testing room A432B.

.4 Provide circuit numbers for two (2) type "A" ceiling mounted service panels in Material Emission Testing room A432B. Circuits to be noted as N42NB-81, N42NB-82, N42UB-83, N42EB-83 and N42NB-83, N42NB-84, N42UB-84, N42EB-84 respectively.

.5 Wire and connect new fan coil "FC-4-5" back to respective condensing unit on roof with #10 awg. Cu. wire in conduit. Refer to Mechanical drawings/addendum for exact location. Unit is powered from roof top condensing unit.

40. EP142 - FOURTH FLOOR NORTH WEST POWER LAYOUT

.1 Wire and connect new Fan Coils "FC-4-1, FC-4-2, FC-4-3 & FC-4-4 back to respective condensing units on roof with #10 awg. Cu. wire in conduit. Refer to Mechanical drawings/addendum for exact locations. Units are powered from roof top condensing units.

.2 Wire and connect Nitrogen control panel back to Panel N42NA circuit 82 c/w #12 awg. Cu. Wire in conduit and provide 15A-1P breakers in panel. Control panel located on west wall of room A437B LN2 Fill Station.

.3 Wire and connect heat trace cabling for hot water lines back to Panel N42NA circuits 83 & 84 c/w #12 awg. Cu. Wire in conduit and provide 2x 15A-1P breakers in panel. Heat trace power junction boxes located in corridor A423A ceiling space, refer to Mechanical addendum for exact location.

41. EP144 - FOURTH FLOOR NORTH EAST POWER LAYOUT

.1 Wire and connect new Fan Coils "FC-4-6, FC-4-7 & FC-4-8 back to respective condensing units on roof with #10 awg. Cu. wire in conduit. Refer to Mechanical drawings/addendum for exact locations. Units are powered from roof top condensing units.

42. EP150 – PENTHOUSE LIGHTING, POWER AND SYSTEMS LAYOUT

.1 Refer to Mechanical drawings/addendum for exact locations of new Nitrogen Generator NG-1, Air Compressors AC-1/AC-2, Air Dryers AD-1/AD-2 and revised pump locations.

.2 Locate new mechanical power panel "MP2EA" adjacent to south-side of MCC-C along wall (Gridline 14). Provide "U" channel support as required for mounting.

.3 Locate new transformer "TRPEB" above panel "MP2EA" in ceiling space to suit. Provide "U" channel support as required for mounting.

43. EP160 – PENTHOUSE ROOF PLAN ELECTRICAL

.1 Refer to Mechanical drawings/addendum for exact locations of new Condensing units CU-3-1 thru CU-3-6/ CU-4-1 thru CU-4-8, Roof-top Units RTU-1/RTU-2 and five (5) Heat trace cabling power connections.

44. EQ132 – THIRD FLOOR NORTH WEST EQUIPMENT POWER LAYOUT

.1 Delete Freezer FZ33D in Room A355 in its entirety.

.2 Replace one only tag number for FZ39D in Room A345A bottom corner of room with FR37D.

45. EQ133 – THIRD FLOOR SOUTH EAST EQUIPMENT POWER LAYOUT

.1 Revise location of Freezer "FZ15D" in Room "A334" to Room "A329C" instead. Refer to Architectural equipment layouts for exact location.

.2 Delete Freezer FZ16D in Room A334 in its entirety.

.3 Provide two (2) 5-20R receptacles in Room A334 for Freezer's FZ39D. Refer to Architectural equipment layouts for exact location.

46. EQ134 – THIRD FLOOR NORTH EAST EQUIPMENT POWER LAYOUT

.1 Provide one (1) junction box in Room A329F for Centrifuge CF07D. Refer to Architectural equipment layout for exact location.

.2 Delete Fridge FR20D in Room A329F in its entirety.

.3 Provide one (1) 5-20R receptacle in Room A329F for Fridge FR14D. Refer to Architectural equipment layouts for exact location.

.4 Provide one (1) 5-20R receptacle in Room A353 for Freezer FZ12D. Refer to Architectural equipment layouts for exact location.

.5 Provide one (1) 5-20R receptacle in Room A353 for Fridge FR05D. Refer to Architectural equipment layouts for exact location.

.6 Provide one (1) 5-20R receptacle in Room A354 for Incubator IN01D. Refer to Architectural equipment layouts for exact location.

.7 Refer to Architectural drawings for exact locations of equipment in room A354.

47. EQ141 – FOURTH FLOOR SOUTH WEST EQUIPMENT POWER LAYOUT

.1 Delete Freezer FZ-1D in Room A459B in its entirety.

.2 Delete one (1) only Muffle Furnace MF03D in Room A459B.

48. EQ142 – FOURTH FLOOR NORTH WEST EQUIPMENT POWER LAYOUT

.1 Flip locations of Equipment SK02D with FH03D accordingly, refer to Architectural drawing for exact location.

49. EQ144 – FOURTH FLOOR NORTH EAST EQUIPMENT POWER LAYOUT

.1 Revise room number for Analysis Pre-cleaning erroneously labelled as 409C to read 438C instead.

50. E502 – LUMINAIRE SCHEDULE

.1 With reference to luminaire types H1 and H2, Detail reference should be 3/E501.

51. E506 – ELECTRICAL MCC DETAILS

.1 Revise Detail 2 as follows:

.1 Section 1, EF-GEN-1 to read as EF-LAB-1 and 100A-3P instead of as shown.

.2 Section 2, P4/P5 to read as 3.0HP instead of as shown.

.3 Section 2, EF-GEN-2 to read as EF-LAB-2 and 100A-3P instead of as shown.

.4 Section 4, EF-GEN-3 to read as EF-LAB-3 and 100A-3P instead of as shown.

.5 Section 5, AHU-LAB-L3 to read as 100A-3P instead of as shown.

.2 Revise Detail 4 as follows:

.1 Section 2, add AC-1, 7.5HP, 20A-3P and AC-2, 7.5HP, 20A-3P.

.3 Add Note #4 – For all new motors re-use spare MCC section/starters where possible or provide new as required.

52. E600 - DISTRIBUTION SINGLE LINE DIAGRAM NORMAL (UTILITY) POWER

.1 Transformer Schedule, add the following transformer: TRPEB, 45kVA, 600V/120/208V/3ph/4W, K4, Wall mounted above Panel.

53. E601.1 – DISTRIBUTION SINGLE LINE DIAGRAM EMERGENCY (DIESEL) POWER

.1 On Single Line Diagram, add 60A-3P LSI breaker in Main Emergency Distribution "MDP6EA" for new transformer "TRPEB" and Mechanical Power Panel "MP2EA". Wire and connect transformer "TRPEB" primary with 3#6 AWG RW90 copper wire in 27mm conduit. Wire and connect transformer "TRPEB" secondary to Panel "MP2EA" with 4#2/0 AWG RW90 copper wire in 53mm conduit.

54. E604 – ELECTRICAL MOTOR SCHEDULE

.1 Item AH-LAB-L3, revise drive isolation transformer to read as 1x75kVA, OCP to 100A-3P and wire to 3#3+Grd. instead of as shown.

.2 Item AH-LAB-L4, revise HP to read as 4x20HP and drive isolation transformer to 1x118kVA instead of as shown.

.3 Items EF-LAB-1, EF-LAB-2 & EF-LAB-3, revise HP to read as 40.0HP, 41.0 amps, drive isolation transformer to 51kVA and OCP to 100A-3P instead of as shown.

.4 Items EF-RAD-1 & EF-RAD-2, revise HP to read as 1.5HP & 2.1 amps instead of as shown.

.5 Items P4 & P5, revise HP to read as 3.0HP & 3.9 amps instead of as shown.

.6 Item FP-1, revise location to read as "Lower Level Boiler Room, HP to 50.0HP, 52.0 amps, OCP to 125A-3P for emergency power and 150A-3P for normal power, wire to 3#6 MI for emergency and 3#4 for normal power instead of as shown.

.7 Item JP-1, revise location to read as "Lower Level Boiler Room, HP to 1.5HP & 2.1 amps instead of as shown. Wire & connect back to nearest available 600V/3ph power panel and provide 15A-3P breaker in panel to suit. Confirm existing panel availability on site with Departmental Representative.

.8 Add the following item to motor schedule: NG-1, Nitrogen Generator, Mechanical Penthouse, 15.0 amps, 120V/1ph, packaged unit, DDC control by Mechanical, circuit MP2NA-21, 15A-1P CB, 2#10+grd. and 21mm conduit.

.9 Add the following two (2) typical items to motor schedule: AC-1 & AC-2, Air Compressor, Mechanical Penthouse, 7.5HP, 9.0 amps, 600V/3ph, packaged unit, DDC control by Mechanical, MCC-C, 20A-3P CB, 3#12+grd. and 21mm conduit.

.10 Add the following two (2) typical items to motor schedule: AD-1 & AD-2, Air Dryer, Mechanical Penthouse, 15.0 amps, 120V/1ph, packaged unit, DDC control by Mechanical, circuits MP2NA-19 & MP2NA-20, 15A-1P CB, 2#12+grd. and 21mm conduit.

.11 Add the following typical items to motor schedule: Five (5) power JB's for Heat Trace (roof-top piping), Penthouse Roof, 20.0 amps, 120V/1ph, control by Mechanical, circuits MP2EA-1, MP2EA-2, MP2EA-3, MP2EA-4 & MP2EA-5, 20A-1P GFCI type CB, 2#10+grd. and 21mm conduit. Heat trace supplied and installed by Division 23, all control work by Division 23. Wire and connected by Division 26.

.12 Add the following typical items to motor schedule: four (4) power JB's for Heat Trace (hot water), 3rd/4th floor, 15.0 amps, 120V/1ph, control by Mechanical, circuits N32NA-83, N32NA-84, N42NA-83, N42NA-84, 15A-1P GFCI type CB, 2#12+grd. and 21mm conduit. Heat trace supplied and installed by Division 23, all control work by Division 23. Wire and connected by Division 26.

.13 Add the following typical items to motor schedule: Two (2) power JB's for Nitrogen Control Panel, 3rd/4th floor, 15.0 amps, 120V/1ph, circuits N32NA-82 & N42NA-82, 15A-1P CB, 2#12+grd. and 21mm conduit.

.14 Add the following item to motor schedule: RTU-1, Roof-top Unit, Penthouse Roof, 16.5 amps, 600V/3ph, packaged unit, DDC control by Mechanical, MCC-EB, 20A-3P CB, 3#12+grd. and 21mm conduit.

.15 Add the following item to motor schedule: RTU-2, Roof-top Unit, Penthouse Roof, 29.8 amps, 600V/3ph, packaged unit, DDC control by Mechanical, MCC-EB, 30A-3P CB, 3#10+grd. and 21mm conduit.

.16 Add the following typical items to motor schedule: CU-3-1, CU-4-3, CU-4-4, Condensing Unit, Penthouse Roof, 18.0 amps, 208V/1ph, packaged unit, DDC control by Mechanical, MP2EA-6/7, MP2EA-2/23 & MP2EA-24/25, 30A-2P CB, 2#10+grd. and 21mm conduit.

.17 Add the following typical items to motor schedule: CU-3-2, CU-3-3, CU-3-6, CU-4-5, CU-4-6 & CU-4-7, Condensing Unit, Penthouse Roof, 13.0 amps, 208V/1ph, packaged unit, DDC control by Mechanical, MP2EA-8/9, MP2EA-10/11, MP2EA-16/17, MP2EA-26/27, MP2EA-28/29 & MP2EA-30/31, 15A-2P CB, 2#10+grd. and 21mm conduit.

.18 Add the following typical items to motor schedule: CU-3-4, CU-3-5, CU-4-1, CU-4-2, CU-4-8, Condensing Unit, Penthouse Roof, 25.0 amps, 208V/1ph, packaged unit, DDC control by Mechanical, MP2EA-12/13, MP2EA-14/15 & MP2EA-18/19, MP2EA-20/21 & MP2EA-32/33, 30A-2P CB, 2#10+grd. and 21mm conduit.

.19 Add the following typical items to motor schedule: FC-3-1, FC-3-2, FC-3-3, FC-3-4, FC-3-5 & FC-3-6, Fan Coil, 3rd floor various locations, 1.0 amps, 208V/1ph, packaged unit, DDC control by Mechanical, 2#10+grd. and 21mm conduit. All fan coils are powered from respective Condensing units on roof.

.20 Add the following typical items to motor schedule: FC-4-1, FC-4-2, FC-4-3, FC-4-4, FC-4-5, FC-4-6, FC-4-7 & FC-4-8 Fan Coil, 4th floor various locations, 1.0 amps, 208V/1ph, packaged unit, DDC control by Mechanical, 2#10+grd. and 21mm conduit. All fan coils are powered from respective Condensing units on roof.

.21 Refer to Mechanical drawings and Addendum for exact location of all new equipment prior to roughing-in of all conduit and wiring.

55. E605 – ELECTRICAL EQUIPMENT SCHEDULE

.1 Equipment Tag – FZ15D, Room A334, revise room number to read "A329C" instead of "A334".

.2 Equipment Tag – FZ16D, Room A334, delete item FZ16D in its entirety.

.3 Add two Freezers to equipment schedule as follows:

.1 Tag number FZ39D, Room "A334", Quantity 2, 120V/1Ph, 5-20R, 2x 20A-1P, 2#12 + Grd. 21mm, N32EF-2, N32EF-22.

.4 Add one Centrifuge to equipment schedule as follows:

.1 Tag number CF07D, Room "A329F", Quantity 1, 208V/1Ph, Direct, 30A-2P, 2#10 + Grd. 21mm, N32NC-83,84.

.5 Add one Fridge to equipment schedule as follows:

.1 Tag number FR14D, Room "A329F", Quantity 1, 120V/1Ph, 5-20R, 20A-1P, 2#10 + Grd. 21mm, N32EF-23.

.6 Equipment Tag – FZ39D, Room A345A, revise circuit to read as N32EA-15 only instead of as shown.

.7 Add one Fridge to equipment schedule as follows:

.1 Tag number FR37D, Room "A345A", Quantity 1, 120V/1Ph, 5-20R, 20A-1P, 2#10 + Grd. 21mm, N32EA-16.

.8 Equipment Tag – FZ30D, Room 341A, revise overcurrent protection to read as 20A-1P instead of as shown.

.9 Equipment Tag – FZ31D, Room 341A, revise overcurrent protection to read as 20A-2P instead of as shown.

.10 Equipment Tag – BS02A, Room 343, revise overcurrent protection to read as 2x20A-2P instead of as shown.

.11 Equipment Tag – PP01D, Room A343, revise to read as follows: "PP01, D, 343, Plate Pourer, 1, 2x 120V/1ph & 1x 208V/1ph, 2x 5-20R & 6-20R, 2x 20A-1P & 20A-2P, 2#12+Grd., 21mm, N32NE-63, N32NE-64 and N32NE-61,62 instead of as shown.

.12 Equipment Tag – FZ37D, Room A345A, revise overcurrent protection to read as 2x20A-2P instead of as shown.

.13 Equipment Tag – FH01A, Room A346A, revise overcurrent protection to read as 2x20A-1P instead of as shown.

.14 Add one Environmental Room to equipment schedule as follows:

.1 Tag number ER01A, Room "A336B", Quantity 1, 208V/1Ph, Direct, 40A-2P, 3#8 + Grd. 35mm, N32EH-55,56.

56. E606 – ELECTRICAL EQUIPMENT SCHEDULE

.1 Equipment Tag – FZ33D, Room A355, delete item FZ33D in its entirety.

.2 Equipment Tag – FZ12D, Room A353, revise circuit number to read "N32EC-23" instead of as shown.

.3 Equipment Tag – FR05D, Room A353, revise circuit number to read "N32EC-24" instead of as shown.

.4 Equipment Tag – FH03A, Room A438A, revise to read as follows: "FH03, A, 438A, Fumehood, 1, 120V/1ph, Direct, 20A-1P, 2#12+Grd., 21mm, N42NA-43" instead of as shown.

.5 Equipment Tag – FR30D, Room A355, revise overcurrent protection to "20A-1P" instead of as shown.

.6 Equipment Tag – IN02D, Room A354, revise circuit number to read "N32EC-6 & N32EC-25" instead of as shown.

.7 Equipment Tag – FZ50D, Room A431B, revise circuit number to read "N42EC-22" instead of as shown.

.8 Equipment Tag – FR46D, Room A431B, revise overcurrent protection to read as 2x20A-1P instead of as shown.

.9 Equipment Tag – FR49A, Room A437A, revise to read as follows: "FR49, A, 437A, Ice Machine, 1, 120V/1ph, 5-20R, 20A-1P, 2#12+Grd., 21mm, N42EC-23" instead of as shown.

.10 Equipment Tag – FR49A, Room A437C, revise circuit number to read "N42EC-4" instead of as shown.

57. E606.1 – ELECTRICAL EQUIPMENT SCHEDULE

.1 Equipment Tag – FH03A, Room A438C, revise to read as follows: "FH03, A, 438C, Fumehood, 1, 120V/1ph, Direct, 20A-1P, 2#12+Grd., 21mm, N42NA-44" instead of as shown.

.2 Equipment Tag – FZ01D, Room A459B, delete item FZ01D in its entirety.

.3 Equipment Tag – MF03D, Room A459B, revise to read as follows: "MF03, D, 459B, Muffle Furnace, 1, 208V/1ph, 6-20R, 20A-2P, 2#12+Grd., 21mm, N42ND-25,26" instead of as shown.

.4 Equipment Tag – ER02A, Room A454, revise circuit number to read "N42EH-13,14" instead of as shown.

.5 Equipment Tag – GC05D, Room A461A, revise to read as follows: "GC05, D, 461A, Pump, 2, 208V/1ph, 6-20R, 2x20A-2P, 3#12+Grd., 21mm, N42UD-31,32 & N42UC-41,42" instead of as shown.

.6 Equipment Tag – GC06D, Room A461A, revise overcurrent protection to read as "2x20A-2P" and circuit number to read as "N42UD25,26 & N42UC-39,40" instead of as shown.

.7 Equipment Tag – GC07D, Room A461A, revise overcurrent protection to read as "20A-2P" instead of as shown.

.8 Equipment Tag – GC08D, Room A461A, revise overcurrent protection to read as "20A-2P" instead of as shown.

.9 Equipment Tag – BS02A, Room A461A, revise circuit number to read "N42EH-15, N42EH-16, N42EH-17 & N42EH-18" instead of as shown.

.10 Equipment Tag – BS02A, Room A461C, revise circuit number to read "N42EH-19 & N42EH-20" instead of as shown.

58. E607 - ELECTRICAL PANEL SCHEDULES NORMAL POWER

.1 Add to Panel "N32NA" circuit 82, Nitrogen Control Panel, 100W, 15A-1P and #12 wire.

.2 Add to Panel "N32NA" circuits 83 & 84, Hot Water Heat Trace, 1000W, 15A-1P GFCI type and #12 wire.

.3 Add to Panel "MP2NA" circuit 19, Air Dryer AD-2, 1000W, 15A-1P and #12 wire.

.4 Add to Panel "MP2NA" circuit 20, Air Dryer AD-1, 1000W, 15A-1P and #12 wire.

.5 Add to Panel "MP2NA" circuit 21, Nitrogen Generator NG-1, 100W, 15A-1P and #12 wire.

59. E608 – ELECTRICAL PANEL SCHEDULES NORMAL POWER

.1 Add to Panel "N32NC" circuits 83/84, Centrifuge CF07D, 3400W, 30A-2P and #10 wire.

60. E610 – ELECTRICAL PANEL SCHEDULES NORMAL POWER

.1 Add to Panel "N42NA" circuit 82, Nitrogen Control Panel, 100W, 15A-1P and #12 wire.

.2 Add to Panel "N42NA" circuits 83 & 84, Hot Water Heat Trace, 1000W, 15A-1P GFCI type and #12 wire.

.3 Add to Panel "N42NB" circuits 81,82,83,84, Ceiling Power Panel (RECx1), 600W, 4x20A-1P and #12 wire.

61. E611 - ELECTRICAL PANEL SCHEDULES NORMAL POWER

.1 Revise Panel "N42ND" circuit 27/28, description to read as "Spare" and remove wire size instead of as shown.

62. E612 - ELECTRICAL PANEL SCHEDULES EMERGENCY POWER

.1 Revise Panel "N32EA" circuit 17, description to read as "Spare" and remove wire size instead of as shown.

.2 Revise Panel “N32EA” circuit 16, description to read as “Fridge FR37D” instead of as shown.

.3 Add the following new panel schedule: Panel MP2EA, 225A, 120/208V/3ph/4w, 42 circuit single tub, surface mounted in Penthouse complete with drip hood, door & lock. Panel schedule as follows:

Circuit	Breaker	Three Phase		Breaker	Circuit
Roof-Top Heat Trace	20A GFCI	1A	22A	30A-2P	Condensing Unit CU-4-3/
Roof-Top Heat Trace	20A GFCI	2B	23B		Fan Coil FC-4-3
Roof-Top Heat Trace	20A GFCI	3C	24C	30A-2P	Condensing Unit CU-4-4/
Roof-Top Heat Trace	20A GFCI	4A	25A		Fan Coil FC-4-4
Condensing Unit CU-3-1/	30A-2P	5B	26B	15A-2P	Condensing Unit CU-4-5/
Fan Coil FC-3-1		6C	27C		Fan Coil FC-4-5
Condensing Unit CU-3-2/	15A-2P	7A	28A	15A-2P	Condensing Unit CU-4-6/
Fan Coil FC-3-2		8B	29B		Fan Coil FC-4-6
Condensing Unit CU-3-3/	15A-2P	9C	30C	15A-2P	Condensing Unit CU-4-7/
Fan Coil FC-3-3		10A	31A		Fan Coil FC-4-7
Condensing Unit CU-3-4/	30A-2P	11B	32B	30A-2P	Condensing Unit CU-4-8/
Fan Coil FC-3-4		12C	33C		Fan Coil FC-4-8
Condensing Unit CU-3-5/	30A-2P	13A	34A	15A	Spare
Fan Coil FC-3-5		14B	35B	15A	Spare
Condensing Unit CU-3-6/	15A-2P	16A	37A	15A	Spare
Fan Coil FC-3-6		17B	38B		Space
Condensing Unit CU-4-1/	30A-2P	18C	39C		Space
Fan Coil FC-4-1		19A	40A		Space
Condensing Unit CU-4-2/	30A-2P	20B	41B		Space
Fan Coil FC-4-2		21C	42C		Space

63. E613 - ELECTRICAL PANEL SCHEDULES EMERGENCY POWER

.1 Add to Panel “N32EC” circuit 23, Freezer FZ12D, 600W, 20A-1P and #12 wire.

.2 Add to Panel “N32EC” circuit 24, Fridge FR05D, 600W, 20A-1P and #12 wire.

.3 Add to Panel “N32EC” circuit 25, Incubator IN02D, 600W, 20A-1P and #12 wire.

64. E614 – ELECTRICAL PANEL SCHEDULES EMERGENCY POWER

.1 Revise Panel “N32EF” circuit 2, description to read as “Freezer FZ39D” instead of as shown.

.2 Add to Panel “N32EF” circuit 22, Freezer FZ39D, 600W, 20A-1P and #12 wire.

.3 Add to Panel “N32EF” circuit 23, Fridge FR14D, 600W, 20A-1P and #12 wire.

65. E615 – ELECTRICAL PANEL SCHEDULES EMERGENCY POWER

.1 Revise Panel “N42EA” circuit 16, description to read as “Spare” and remove wire size instead of as shown.

.2 Add to Panel “N42EB” circuits 83 & 84, Ceiling Power Panel (RECx1), 600W, 2x20A-1P and #12 wire.

66. E616 – ELECTRICAL PANEL SCHEDULES EMERGENCY POWER

.1 Add to Panel "N42EC" circuit 22, Freezer FZ50D, 1200W, 20A-1P and #12 wire.

.2 Add to Panel "N42EC" circuit 23, Freezer FR49A, 1440W, 20A-1P and #12 wire.

67. E617 - ELECTRICAL PANEL SCHEDULES EMERGENCY POWER

.1 Revise Panel "N42EH" circuit 10, description to read as "Spare" and remove wire size instead of as shown.

68. DRAWING E619 - ELECTRICAL PANEL SCHEDULES UPS POWER

.1 Add to Panel "N42UC" circuit 39/40, Pump GC06D, 1200W/1200W, 20A-2P and #12 wire.

.2 Add to Panel "N42UC" circuit 41/42, Pump GC05D, 1200W/1200W, 20A-2P and #12 wire.

.3 Add to Panel "N42UB" circuits 83 & 84, Ceiling Power Panel (RECx1), 600W, 2x20A-1P and #12 wire.

SPECIFICATIONS

1. SECTION 00 01 10 – TABLE OF CONTENTS

.1 Add new sections as follows:

.1 Division 07, Section 07 72 69 – Roof Anchors and Safety Restraints (3 pages)

.2 Division 21, Section 21 30 00 – Fire Pumps (3 pages)

.3 Division 22, as follows:

.1 Section 22 11 23 – Domestic Water Pumps (4 pages)

.2 Section 22 63 25 – Liquid Nitrogen Piping and Equipment (5 pages)

.3 Section 22 67 19 – Process Water Equipment for Laboratories (4 pages)

.4 Division 23, as follows:

.1 Section 23 22 23 – Steam Condensate Pumping Units (4 pages)

.2 Section 23 23 00 – Refrigerant Piping and Accessories (4 pages)

.3 Section 23 74 00 – Packaged Outdoor HVAC Equipment (6 pages)

.4 Section 23 81 26 – Split-Type Room Air Conditioners (3 pages)

.5 Section 23 82 36 – Finned Tube Radiation Heaters (3 pages)

.6 Section 23 82 38 – Hydronic Radiant Heating Panels (3 pages)

.7 Section 23 83 13 – Radiant Heating Electric Cables – Snow Melting (3 pages)

.5 Division 26, Section 26 29 23 – Variable Frequency Drives for HVAC (4 pages)

2. SECTION 01 00 10 – GENERAL INSTRUCTIONS

.1 Add new Article 1.11 COORDINATION AND INTERFERENCE DRAWINGS, as follows:

1.11 COORDINATION AND INTERFERENCE DRAWINGS

.1 Prepare coordination and interference drawings.

.2 Integrate and coordinate new structural systems and architectural components with new and existing mechanical and electrical systems. Integrate and coordinate new mechanical and electrical systems with existing mechanical and electrical systems. Include at a minimum Fire Suppression, Plumbing, HVAC, Integrated Automation, Electrical, Communications, Electronic Safety and Security coordination with the structural and architectural work.

.3 Coordinate placement of equipment to ensure that systems, components and service runs will be properly accommodated within spaces provided. In areas where equipment and services are exposed, organize and layout services in an organized and orderly manner. Run services parallel or at right angles to each other and the building structural and architectural components.

.4 Submit coordination and interference drawings in accordance with Section 01 33 00 - Submittal Procedures.

.5 Departmental Representative will reconfigure layout, in conjunction with the Contractor, to achieve best sight lines and aesthetics.

3. SECTION 05 50 00 – METAL FABRICATIONS

.1 Article 2.4, delete paragraph 2.4.5.2, and replace with the following:

.2 Material:

.1 Typical: Galvanized steel, zinc coating Z275 in accordance with ASTM A653M.

.2 For Specialty Gas Pipe Supports: Stainless steel to ASTM A240, Type 304. Size: 42 by 35 mm by 2.78 mm thickness, predrilled with 14 mm dia. holes at 47 mm oc, for fastening to substrates. Provide fifty 600 mm long sections for installation by Departmental Representative.

4. SECTION 07 72 69 – ROOF ANCHORS AND SAFETY RESTRAINTS

.1 Add new Section 07 72 69 – Roof Anchors and Safety Restraints, issued as part of this Addendum.

5. SECTION 11 53 00 – LABORATORY EQUIPMENT

.1 Add new article 2.3 CYLINDER STORAGE RACKS, as follows:

2.3 CYLINDER STORAGE RACKS

.1 Six-cylinder capacity per rack, three cylinders wide and two cylinders deep, constructed of 50 by 50 mm welded steel tubing, bolted together to form rigid frame, complete with dual steel chain restraints, one at 380 mm AFF and one at 760 mm AFF. Provide tube framing between each pair of cylinders. Nominal dimensions: 915 wide by 610 deep by 760 mm high. Finish: black enamel. Fasten to south wall in Rooms A325, A357, A424, and A429. Coordinate exact locations with Departmental Representative.

6. SECTION 11 53 13 – FUME HOODS

.1 Article 2.7 SAFETY ALARM CONSOLE, move paragraphs 2.7.1.3 Linear Trim Exhaust Valve, and 2.7.1.4 Paper Tissue Screen to article 2.6 ACCESSORIES, and renumber as paragraphs 2.6.4 and 2.6.5 respectively.

.2 Article 2.7 SAFETY ALARM CONSOLE, delete paragraphs 2.7.1, 2.7.1.1, and 2.7.1.2 in their entirety. Fume hood performance alarm and airflow sensor are specified in Division 25 – Integrated Automation.

.3 Article 2.3 GENERAL, add new paragraph 2.3.7 as follows:

.7 Factory prepare fume hoods with proper cutouts and brackets to accept field mounted devices specified in Division 25 – Integrated Automation.

7. SECTION 11 53 53 – BIOLOGICAL SAFETY CABINETS

.1 Article 1.4, delete paragraph 1.4.1, and replace with the following:

.1 Coordination: Coordinate mechanical, electrical and controls requirements for proper and correct installation and operation of controls, plumbing and electrical rough-in, and other affected Sections.

.2 Article 1.5, add new paragraph 1.5.3.9 as follows:

.9 Indicate how BSC complies with performance requirements specified for communication of data between BSC and building automation system.

.3 Article 2.2, add new paragraph 2.2.6 as follows:

.6 Communication between BSC and building automation system (BAS): provide by way of BACnet interface or dry contacts, communication of following data, as a minimum:

.1 BSC on/off.
.2 Normal airflow.
.3 Reduced airflow (night mode).
.4 Alarm conditions.

.4 Delete paragraphs 2.4.6.3, and 2.5.6.3 in their entirety.

8. SECTION 12 35 53 – STEEL LABORATORY CASEWORK

.1 Article 2.5, add new paragraph 2.5.1.1.3 as follows:

.3 Provide two spare gas service access holes, and two spare electrical cutouts for future services, complete with covers or plugs at each ceiling service panel.

.2 Article 2.6, add new paragraph 2.6.3 and 2.6.4 as follows:

.3 Provide two spare gas service access holes, and two spare electrical cutouts for future services, complete with covers or plugs at each vertical service chase.

.4 Where vertical service chase is located adjacent to full height partitions, provide equivalent number of services on three sides instead of four sides.

9. SECTION 21 30 00 – FIRE PUMPS

.1 Add new Section 21 30 00 – Fire Pumps, issued as part of this Addendum.

10. SECTION 22 11 23 – DOMESTIC WATER PUMPS

.1 Add new Section 22 11 23 – Domestic Water Pumps, issued as part of this Addendum.

11. SECTION 22 63 13 – GAS PIPING AND EQUIPMENT FOR LABORATORY FACILITIES

.1 Article 2.3, revise article as indicated in attached Section 22 63 13 – Gas Piping and Equipment for Laboratory Facilities.

.2 Add new Article 2.6 NITROGEN GENERATOR (UHP, 99.999% PURE), as indicated in attached Section 22 63 13 – Gas Piping and Equipment for Laboratory Facilities.

.3 Add new Article 2.7 GAS CYLINDER CABINETS, as indicated in attached Section 22 63 13 – Gas Piping and Equipment for Laboratory Facilities.

.4 Add new Article 3.2 CYLINDER REGULATORS, as indicated in attached Section 22 63 13 – Gas Piping and Equipment for Laboratory Facilities.

12. SECTION 22 63 25 – LIQUID NITROGEN PIPING AND EQUIPMENT

.1 Add new Section 22 63 25 – Liquid Nitrogen Piping and Equipment, issued as part of this Addendum.

13. SECTION 22 67 19 – PROCESS WATER EQUIPMENT FOR LABORATORIES

.1 Add new Section 22 67 19 – Process Water Equipment for Laboratories, issued as part of this Addendum.

14. SECTION 23 07 15 – THERMAL INSULATION FOR PIPING

.1 Paragraph 3.7.5, add the following to table: “Heat traced drain piping: TIAC code: A-6, all pipe sizes: 50mm thickness.”

15. SECTION 23 21 13.02 – HYDRONIC SYSTEMS: STEEL

.1 Paragraph 2.2.2, revise to the following: “NPS8 and over, Schedule 40”.

16. SECTION 23 22 13 – STEAM AND CONDENSATE HEATING PIPING

.1 Add new paragraph 2.2.2: "Stainless steel pipe: to ASTM A312/A312M: All sizes: Schedule 10."

.2 Add new paragraph 2.3.7: "Stainless steel fittings: to ANSI B36.19, Schedule 10, butt weld."

.3 Add new paragraph 3.1.2: "Stainless steel pipe and fittings shall be used on the discharge of steam-to-steam humidifiers, between the humidifier and the distributor. All other steam and condensate piping shall be Schedule 40 steel."

17. SECTION 23 22 23 – STEAM CONDENSATE PUMPING UNITS

.1 Add new Section 23 22 23 – Steam Condensate Pumping Units, issued as part of this Addendum.

18. SECTION 23 23 00 – REFRIGERANT PIPING AND ACCESSORIES

.1 Add new Section 23 23 00 – Refrigerant Piping and Accessories, issued as part of this Addendum.

19. SECTION 23 31 13 – METAL DUCTS – LOW PRESSURE TO 500 PA

.1 Article 2.4, refer to table under paragraph 2.4.1, and revise as follows:

.1 Revise "Combined General and/or Fume Hood and/or Biosafety Cabinet Exhaust" to "Lab and/or Biosafety Cabinet Exhaust", and revise pressure class to "-1500 Pa" from "-1000 Pa".

.2 Revise "General Exhaust Upstream of Air Terminal Units" to read "Lab Exhaust Upstream of Air Terminal Units".

.3 Revise pressure class for "Biosafety Cabinet Exhaust Upstream of Air Terminal Units" to "-1000 Pa" pressure class.

.4 Revise pressure class for "Biosafety Cabinet Exhaust Downstream of Air Terminal Units" to "-1500 Pa".

20. SECTION 23 37 13 – DIFFUSERS, REGISTERS AND GRILLES

.1 Add new articles 2.4 LAMINAR FLOW DIFFUSER, 2.5 RADIAL FLOW DIFFUSER, 2.6 FLUSH-FACE RADIAL FLOW DIFFUSER, 2.7 SQUARE PLAQUE DIFFUSER, 2.8 EGGCRATE GRILLE, 2.9 DOUBLE DEFLECTION SUPPLY GRILLE, AND 2.10 LOUVRED FACE RETURN GRILLE, as indicated in attached Section 23 37 13 – Diffusers, Registers and Grilles.

21. SECTION 23 44 00 – HVAC AIR FILTRATION

.1 Add new article 2.7 FILTER BANK HOUSINGS as follows:

2.7 FILTER BANK HOUSINGS

.1 Galvanized steel construction with rigid corner posts and pre-drilled standing flange for connection to other system components.

.2 Filter rack to accommodate 50mm prefilter and 300mm final filter.

.3 Galvanized steel access doors with neoprene gasket seal and positive-locking door handles.

.4 Gasketted holding frame with sealing gasket and restraining mechanism.

.5 Analog differential pressure gauge with connecting tubing to indicate pressure drop across each individual filter.

22. SECTION 23 73 13 – INDOOR AIR HANDLING UNITS - MODULAR

.1 Article 1.7, add new paragraph 1.7.12 as follows:

.12 Equipment to be delivered to site in manner which permits installation into existing facility through existing building openings and vertical transportation. Re-assembly in field following manufacturer's instructions is acceptable.

.2 Article 2.3, add new paragraph 2.3.15 as follows:

.15 Perforated interior liner for fan section and sections downstream of fan.

.3 Article 2.4, paragraph 2.4.7, add the following at the end of the paragraph: "Provide viewing windows in following sections: 1) inlet plenum; 2) humidifier; 3) cooling coil upstream of fan section; 4) access section downstream of fan section."

.4 Article 2.5, paragraph 2.5.8, revise as follows: "Provide drain pans under outside/mixed air inlet, coil,…".

.5 Article 2.6, paragraph 2.6.1, add the following at the end of the paragraph: "Fans shall be selected such the operating RPM at the design operating point is not more than 80% of maximum RPM allowed for the specific fan construction class."

.6 Article 2.6, add paragraph 2.6.12.13 "Fan motors shall be directly mounted to fan wheels."

.7 Article 2.7, add new paragraph 2.7.7 as follows:

.7 Unit shall be wired for single point connection of fan motors to the facility electrical system. Connection shall be made to a fused disconnect switch included with the air handling unit. Wiring shall include variable frequency drives for each fan to requirements of 26 29 23 – Variable Frequency Drives for HVAC, complete with individual circuit breaker protection.

.8 Article 2.9, add new paragraph 2.9.5 as follows:

.5 Fan motors shall be 1800 rpm. Motors may be over-sped up to 150% of their design RPM provided this is within design limits of motor and within terms of the motor warranty.

.9 Article 2.10, paragraph 2.10.4, revise as follows: "…centered in each fan, access, cooling coil, humidifier section and inlet plenum. Wire to…"

.10 Article 2.11, paragraph 2.11.6, replace entire paragraph with the following:

.6 Provide a flush mounted, factory installed pressure differential gauge with weatherproof cover on the drive side of the unit to measure pressure drop across each filter bank. Combination gauges not acceptable. Provide fully functional gauges complete with static pressure tips, shutoff valves and tubing.

23. SECTION 23 74 00 – PACKAGED OUTDOOR HVAC EQUIPMENT

.1 Add new Section 23 74 00 – Packaged Outdoor HVAC Equipment, issued as part of this Addendum.

24. SECTION 23 81 26 – SPLIT-TYPE ROOM AIR CONDITIONERS

.1 Add new Section 23 81 26 – Split-type Room Air Conditioners, issued as part of this Addendum.

25. SECTION 23 82 36 – FINNED TUBE RADIATION HEATERS

.1 Add new Section 23 82 36 – Finned Tube Radiation Heaters, issued as part of this Addendum.

26. SECTION 23 82 38 – HYDRONIC RADIANT HEATING PANELS

.1 Add new Section 23 82 38 – Hydronic Radiant Heating Panels, issued as part of this Addendum.

27. SECTION 23 83 13 – RADIANT HEATING ELECTRIC CABLES – SNOW MELTING

.1 Add new Section 23 83 13 – Radiant Heating Electric Cables – Snow Melting, issued as part of this Addendum.

28. SECTION 23 84 13 - HUMIDIFIERS

.1 Article 2.2, delete paragraph 2.2.2, replace entire paragraph with the following:

.2 Tank-type with stainless steel flat plate heat exchanger, automatic modulating level control, skimmer and overflow port, stand or wall bracket, automatic controls compatible with building energy management and control system (BACnet compliant).

.2 Article 2.2, delete paragraph 2.2.5, and replace entire paragraph with the following:

.5 Water fill valve: fully modulating type located within separate float chamber. Fill rate must modulate to match demand capacity.

29. SECTION 25 90 01 – EMCS: SITE REQUIREMENTS, APPLICATIONS AND SYSTEM SEQUENCES

.1 Replace Section 25 90 01 – EMCS: Site Requirements, Applications and System Sequences, with revised section included in this Addendum.

30. SECTION 26 29 23 – VARIABLE FREQUENCY DRIVES FOR HVAC

.1 Add new Section 26 29 23 – Variable Frequency Drives for HVAC, issued as part of this Addendum.

31. SECTION 26 32 13 – DIESEL ELECTRIC GENERATING UNITS (LIQUID COOLED)

.1 Article 3.6, add new paragraph 3.6.12.15 as follows:

.15 Provide wall mounted 120V, 15A ventilation exhaust fan complete with shutters for enclosure exhausting. Fan to be minimum 460 mm aluminum blade diameter within steel wire spiral guard, 2300 CFM/1500 RPM, 1/ 8HP inside wall mounted direct drive fan. Mount fan within enclosure to suit.

.2 Article 3.7, add new paragraph 3.7.8.11 as follows:

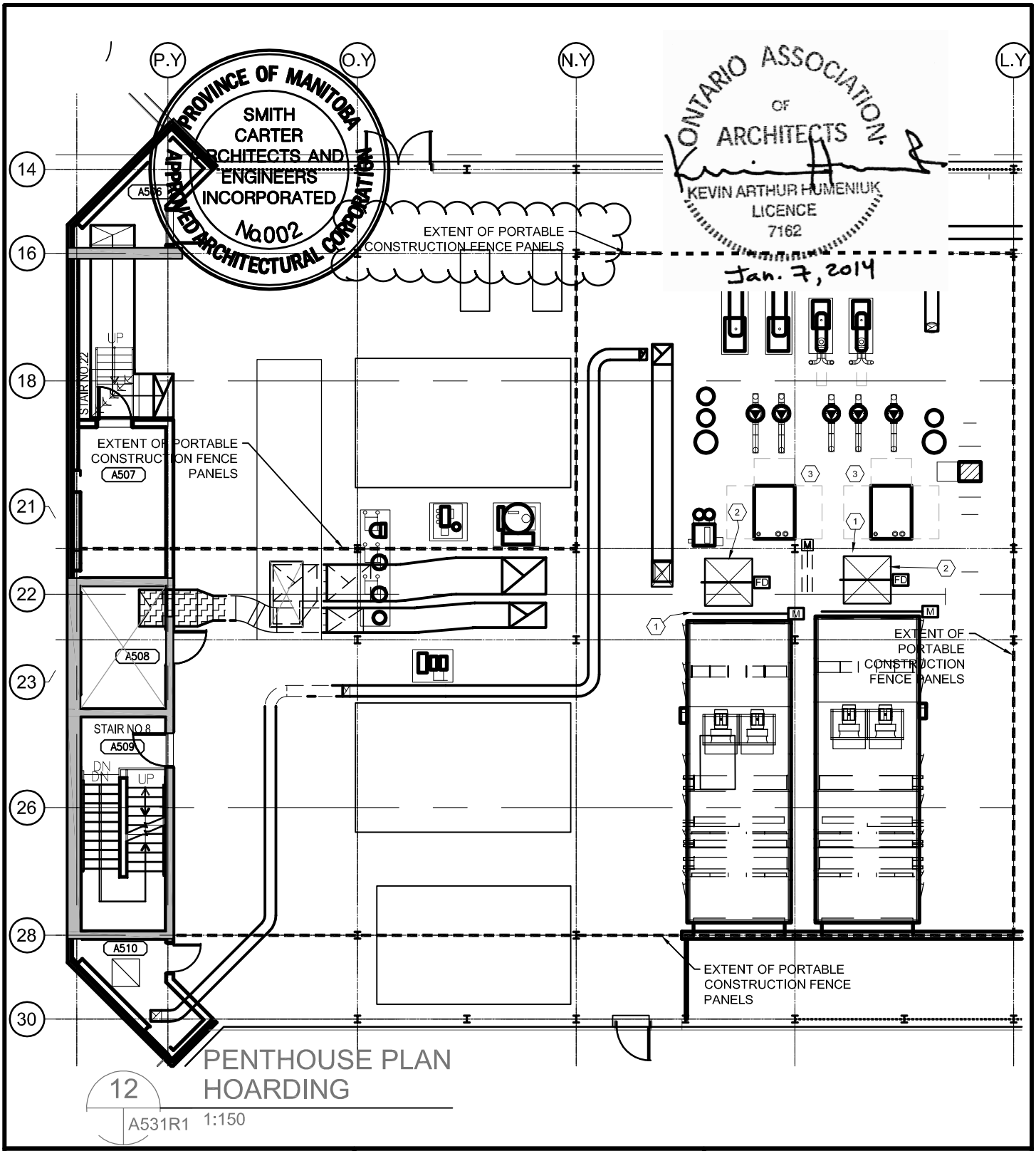
.11 Provide wall mounted 120V, 15A ventilation exhaust fan complete with shutters for enclosure exhausting. Fan to be minimum 460 mm aluminum blade diameter within steel wire spiral guard, 2300 CFM/1500 RPM, 1/8 HP inside wall mounted direct drive fan. Mount fan within enclosure to suit.

32. SECTION 26 52 00 – UNIT EQUIPMENT FOR EMERGENCY LIGHTING

.1 Article 2.1 MANUFACTURERS, add new paragraph 2.1.2.5 as follows:

.5 Lamp efficacy to be minimum 68 lumens per watt (340 lumens output) with a beam angle min./max between 30 and 35 degrees.

END OF SECTION



PROVINCE OF MANITOBA
SMITH CARTER ARCHITECTS AND ENGINEERS INCORPORATED
No.002
APPROVED ARCHITECTURAL CORPORATION

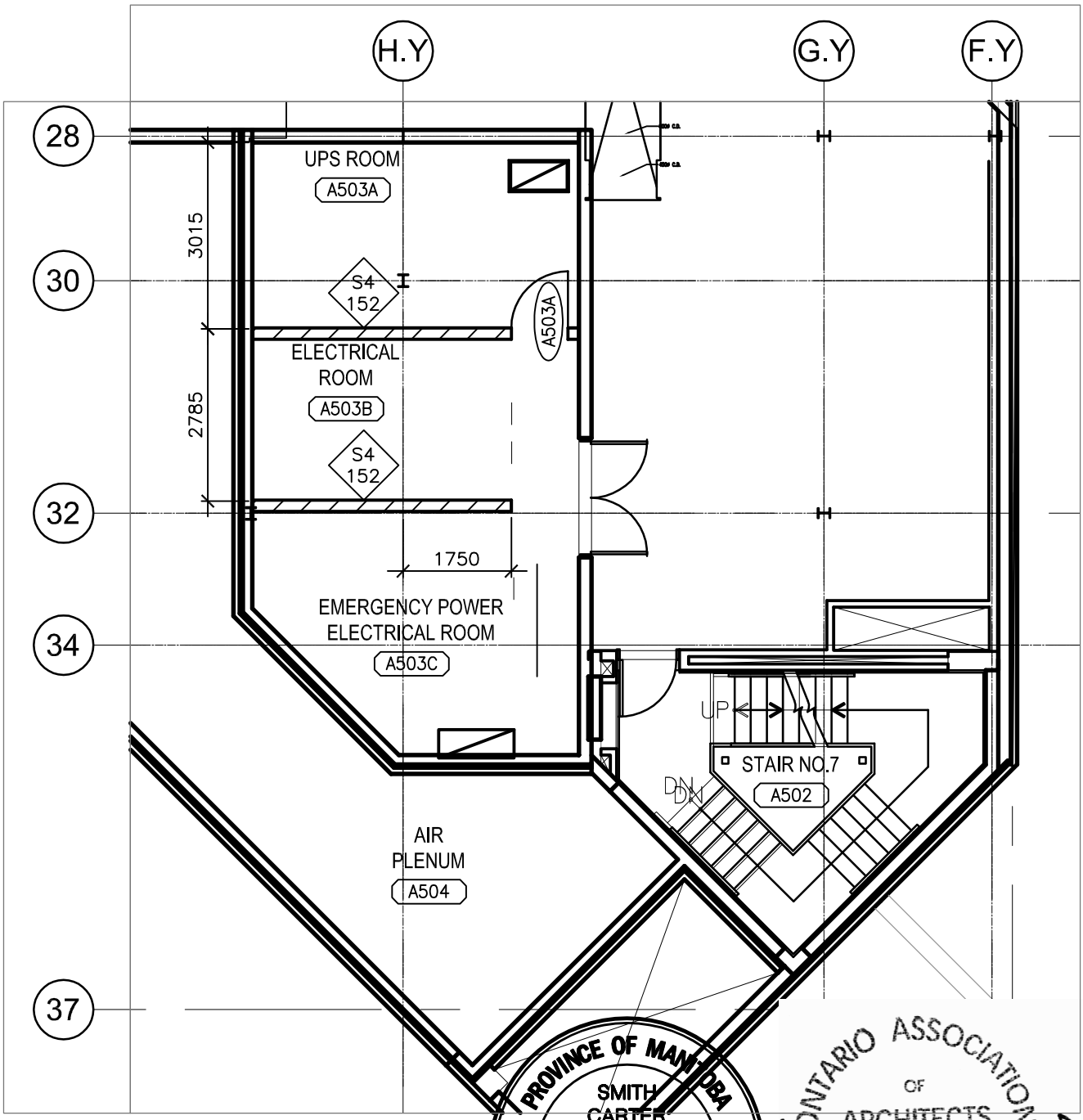
ONTARIO ASSOCIATION OF ARCHITECTS
KEVIN ARTHUR HUMENIUK
LICENCE
7162
Jan. 7, 2014

PENTHOUSE PLAN HOARDING

12 / A531R1 1:150

project / projet	SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON
drawing / dessin	PENTHOUSE FLOOR PLAN
Designed By / Conçu par	A.COPPINGER
Date (yyyy/mm/dd)	
Drawn By / Dessiné par	C.KROLL
Date (yyyy/mm/dd)	
Reviewed By / Examiné par	A.COPPINGER
Date (yyyy/mm/dd)	
Approved By / Approuvé par	A.COPPINGER
Date (yyyy/mm/dd)	
Tender / Soumission	
Project Manager / Administrateur de projets	
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada	Canada
Project no. / No. du projet	R.044033.002
Drawing no. / No. du dessin	A531R1

PWGSC 11x8.5 (215x279)



PENTHOUSE PLAN
UPS/ ELECTRICAL ROOM

13
A531R2

1:100

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ONTARIO ASSOCIATION OF ARCHITECTS
KEVIN ARTHUR HUMENIUK
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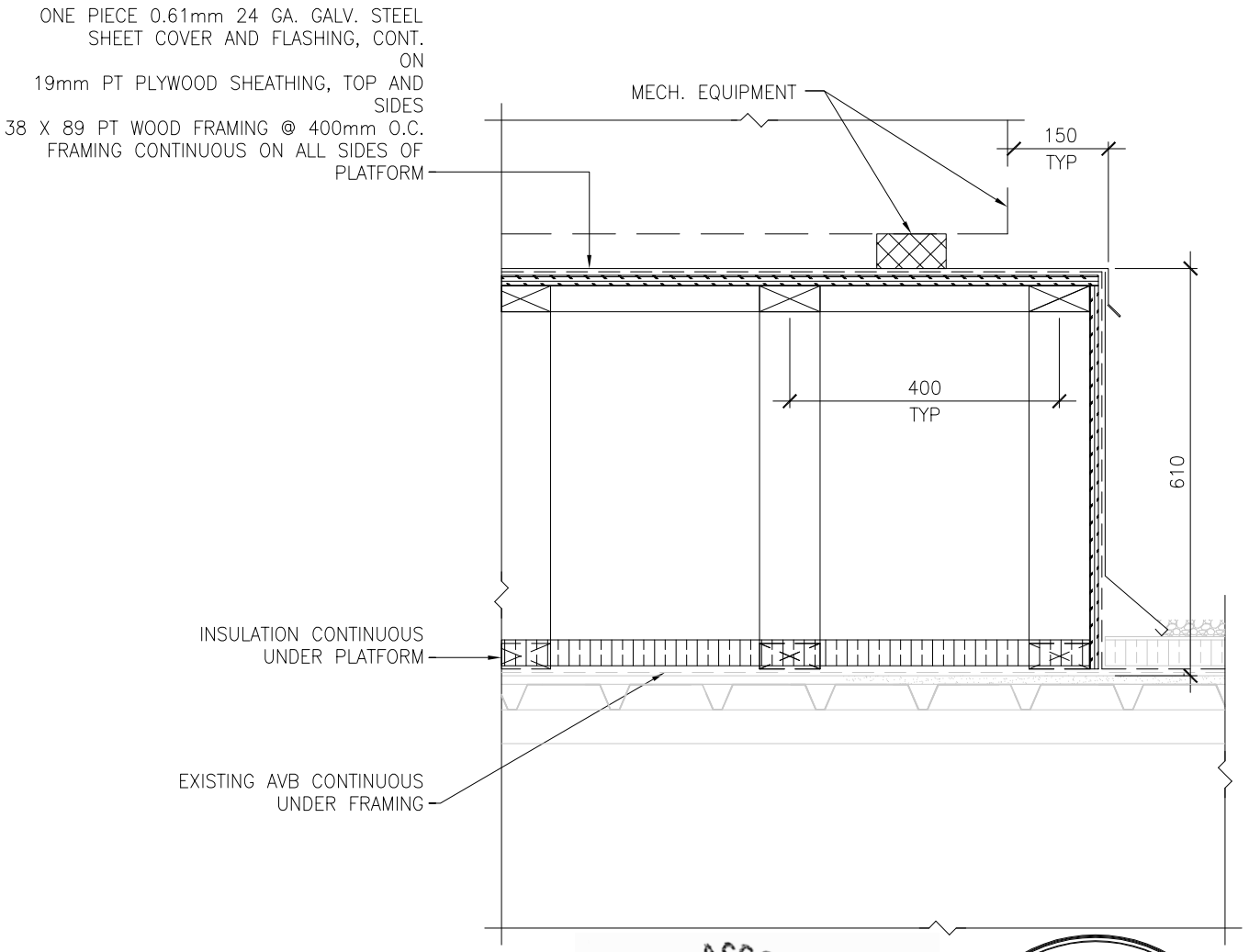
Jan. 7, 2014

project / projet	SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON
drawing / dessin	PENTHOUSE FLOOR PLAN
Designed By / Conçu par	A.COPPINGER
Date (yyyy/mm/dd)	
Drawn By / Dessiné par	C.KROLL
Date (yyyy/mm/dd)	
Reviewed By / Examiné par	A.COPPINGER
Date (yyyy/mm/dd)	
Approved By / Approuvé par	A.COPPINGER
Date (yyyy/mm/dd)	
Tender / Soumission	
Project Manager / Administrateur de projets	
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada	Canada
Project no. / No. du projet	R.044033.002
Drawing no. / No. du dessin	A531R2

PWGSC 11x8.5 (215x279)



5
A532

SECTION DETAIL
BOX CURB
1:10

ONTARIO ASSOCIATION OF ARCHITECTS
KEVIN ARTHUR HUMENIUK
LICENCE
7162
Jan. 7, 2014

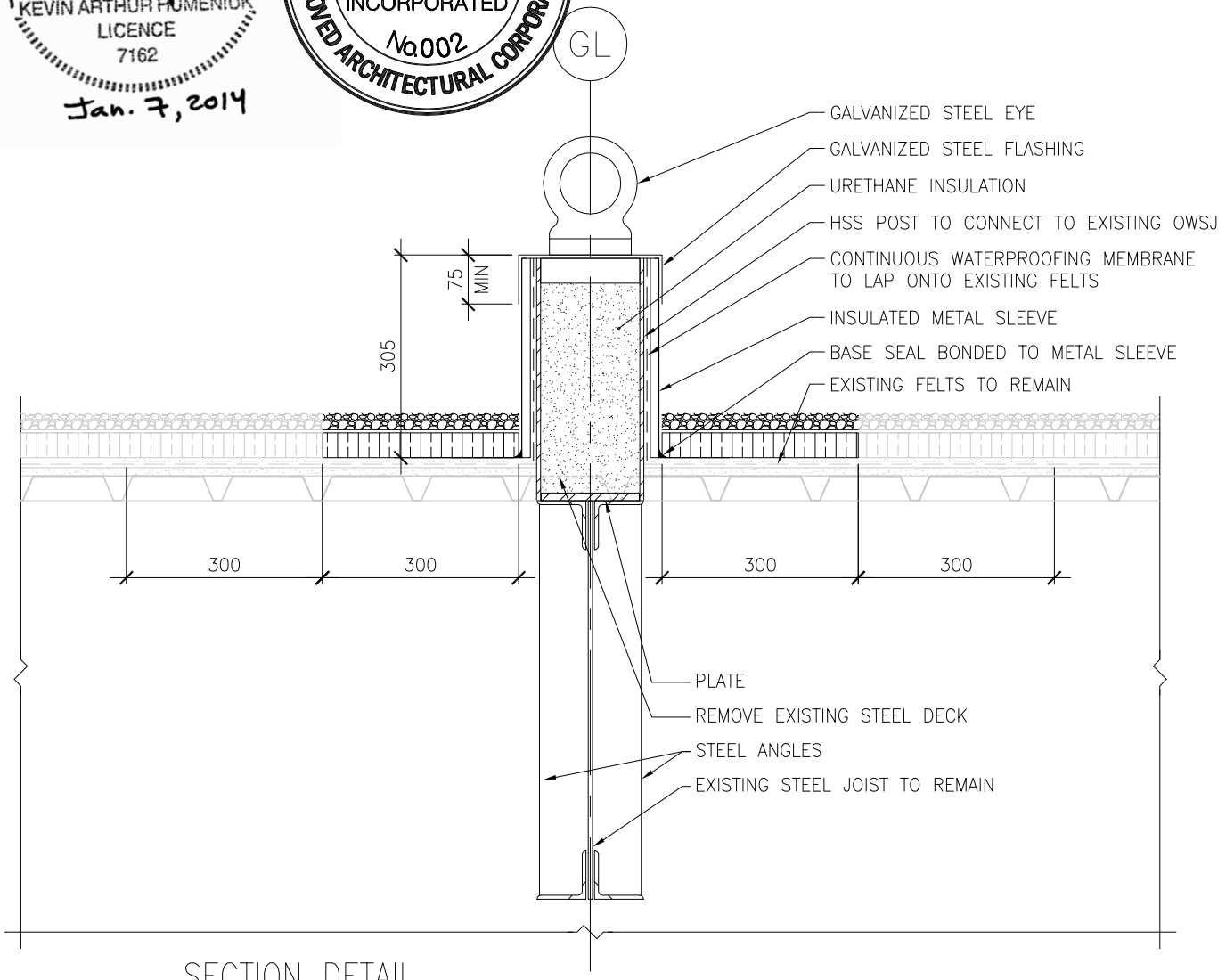
PROVINCE OF MANITOBA
SMITH CARTER ARCHITECTS AND ENGINEERS INCORPORATED
No. 002
APPROVED ARCHITECTURAL CORPORATION

project / projet	Designed By / Conçu par	A.COPPINGER	Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada
SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION	Date (yyyy/mm/dd)		Canada
251 SIR FREDERICK BANTING WAY, ON	Drawn By / Dessiné par	C.KROLL	
drawing / dessin	Date (yyyy/mm/dd)		Project no. / No. du projet
ROOF DETAILS	Reviewed By / Examiné par	A.COPPINGER	R.044033.002
	Date (yyyy/mm/dd)		
	Approved By / Approuvé par	A.COPPINGER	Drawing no. / No. du dessin
	Date (yyyy/mm/dd)		A532R1
	Tender / Soumission		
	Project Manager / Administrateur de projets		

PWGSC 11x8.5 (215x279)

ONTARIO ASSOCIATION OF ARCHITECTS
KEVIN ARTHUR HUMENIUK
LICENCE
7162
Jan. 7, 2014

PROVINCE OF MANITOBA
SMITH CARTER ARCHITECTS AND ENGINEERS INCORPORATED
No. 002
APPROVED ARCHITECTURAL CORPORATION



6
A532

SECTION DETAIL
GUY WIRE ROOF SUPPORTS

1:10

project / projet	SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON	Designed By / Conçu par	A.COPPINGER
		Date (yyyy/mm/dd)	
		Drawn By / Dessiné par	C.KROLL
		Date (yyyy/mm/dd)	
		Reviewed By / Examiné par	A.COPPINGER
		Date (yyyy/mm/dd)	
drawing / dessin	ROOF DETAILS	Approved By / Approuvé par	A.COPPINGER
		Date (yyyy/mm/dd)	
		Tender / Soumission	
		Project Manager / Administrateur de projets	

Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

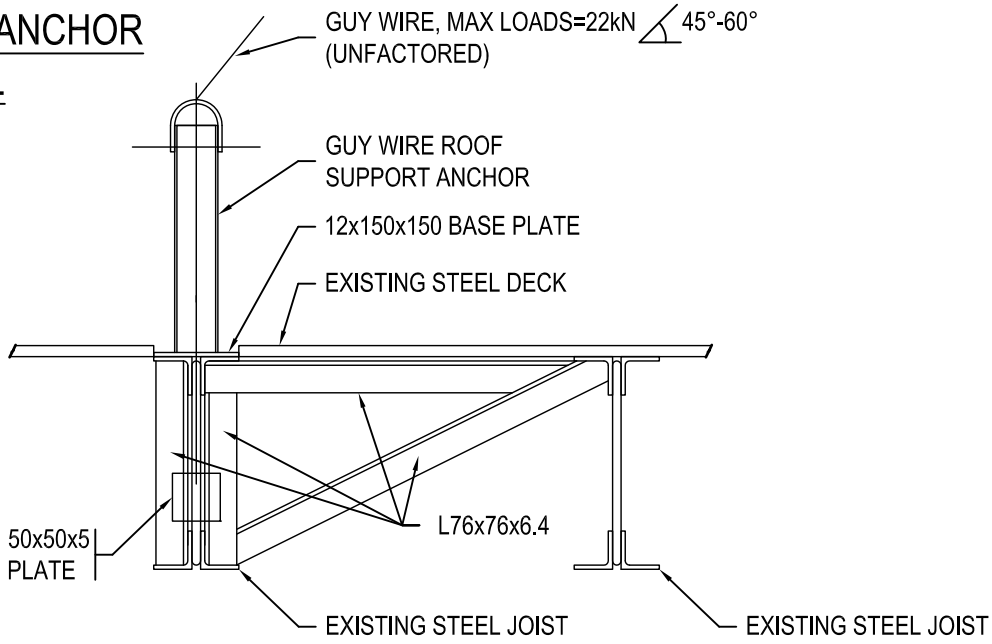
Canada

Project no. / No. du projet: R.044033.002

Drawing no. / No. du dessin: A532R2

PWGSC 11x8.5 (215x279)

ROOF ANCHOR DETAIL

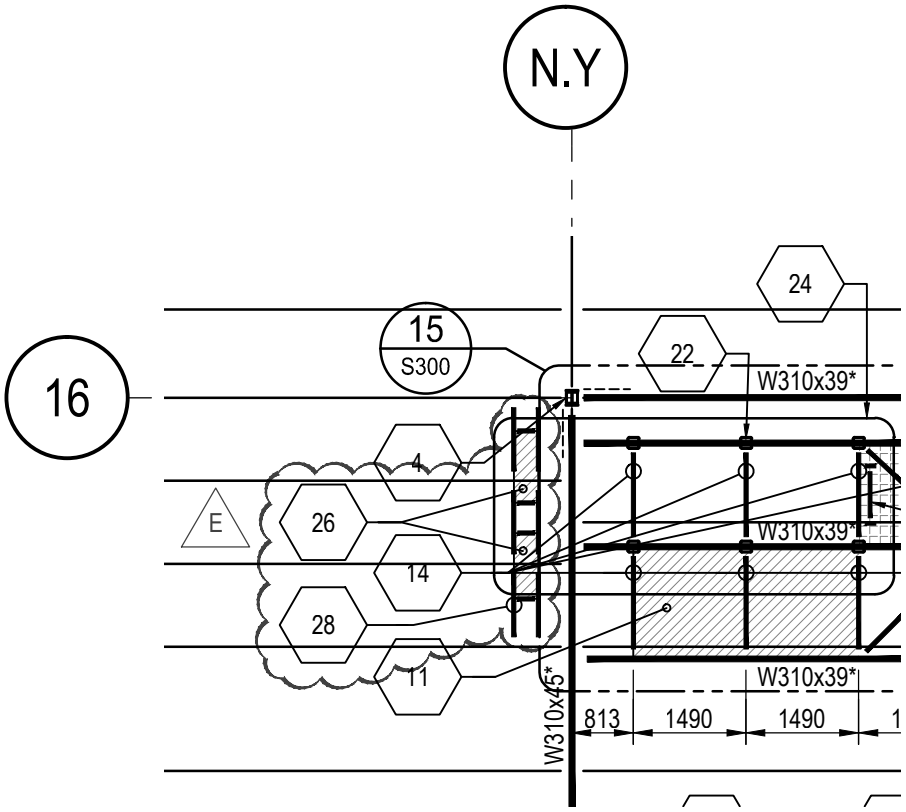


* NOTE: PLACE ANCHORS ABOVE JOIST PANEL POINTS

LICENSED PROFESSIONAL ENGINEER
D.J. MES
2013-12-04
PROVINCE OF ONTARIO

project / projet SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON	Designed By / Conçu par: A.CHEUNG Date (yyyy/mm/dd) Drawn By / Dessiné par: E.PILLON Date (yyyy/mm/dd) Reviewed By / Examiné par: A.CHEUNG Date (yyyy/mm/dd) Approved By / Approuvé par: A.CHEUNG Date (yyyy/mm/dd) Tender / Soumission Project Manager / Administrateur de projets	Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada Canada
drawing / dessin GUY WIRE ROOF SUPPORT DETAILS		Project no. / No. du projet R.044033.002 Drawing no. / No. du dessin FS-S100-01

PWGSC 11x8.5 (215x279)



DRAWING NOTES:

NO.

26. ROOF TOP UNITS
Pf=2 kN

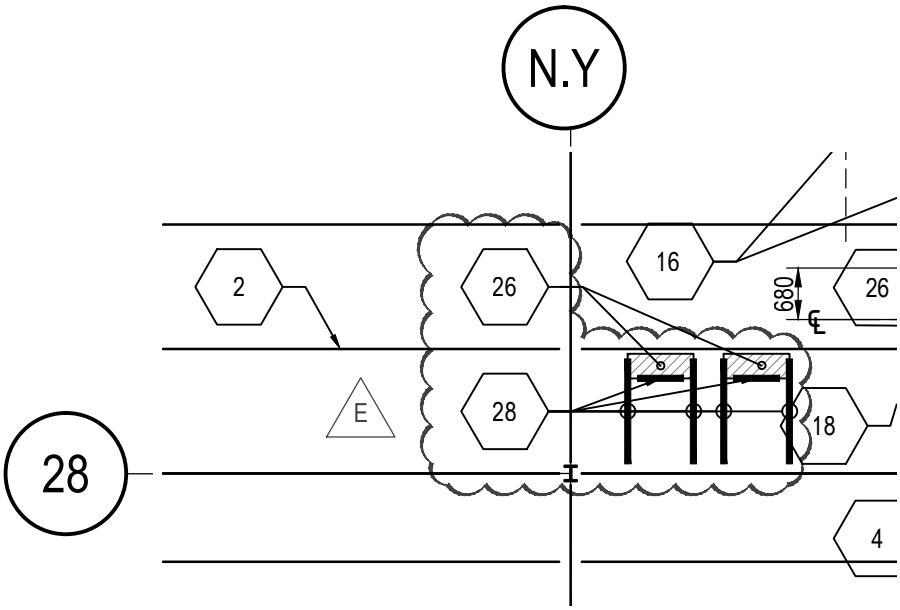
27. ROOF TOP UNITS
Pf=10 kN

28. C150x12

E

NOTES:

ALL EXTERIOR STRUCTURAL STEEL AND METAL FABRICATIONS ARE TO BE GALVANIZED.



PENTHOUSE ROOF PART PLANS

1 : 100

(yyyy/mm/dd)

LICENSED PROFESSIONAL ENGINEER
D.J. MES
2014-01-07
PROVINCE OF ONTARIO

project / projet	SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON	Designed By / Conçu par	A.CHEUNG
		Date (yyyy/mm/dd)	2013/12/20
		Drawn By / Dessiné par	E.PILLON
		Date (yyyy/mm/dd)	2013/12/20
		Reviewed By / Examiné par	A.CHEUNG
		Date (yyyy/mm/dd)	2013/12/20
drawing / dessin	RTU SUPPORT DETAILS	Approved By / Approuvé par	A.CHEUNG
		Date (yyyy/mm/dd)	2013/12/20
		Tender / Soumission	
		Project Manager / Administrateur de projets	

Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

Project no. / No. du projet: R.044033.002

Drawing no. / No. du dessin: FS-S203-01

PWGSC 11x8.5 (215x279)

DRAWING NOTES:

NO.

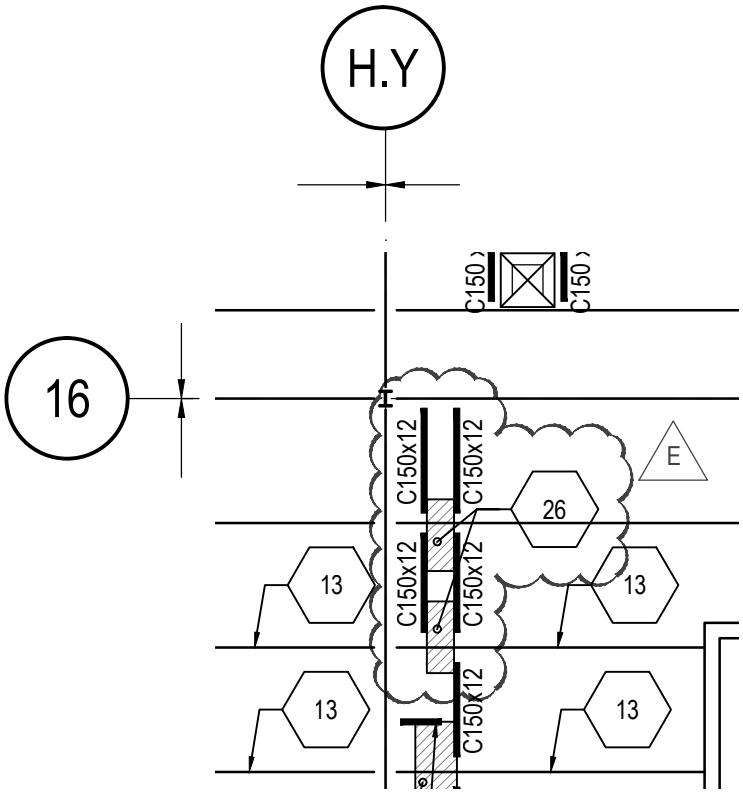
26. ROOF TOP UNITS
Pf=2 kN

27. ROOF TOP UNITS
Pf=10 kN

E

NOTES:

ALL EXTERIOR STRUCTURAL STEEL AND METAL FABRICATIONS ARE TO BE GALVANIZED.



PENTHOUSE ROOF PART PLAN

1 : 100

LICENSED PROFESSIONAL ENGINEER
D.J. MES
2014-01-07
PROVINCE OF ONTARIO

project / projet	SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON
drawing / dessin	RTU SUPPORT DETAILS

Designed By	A.CHEUNG	Conçu par
Date	2013/12/20	(yyyy/mm/dd)
Drawn By	E.PILLON	Dessiné par
Date	2013/12/20	(yyyy/mm/dd)
Reviewed By	A.CHEUNG	Examiné par
Date	2013/12/20	(yyyy/mm/dd)
Approved By	A.CHEUNG	Approuvé par
Date	2013/12/20	(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets

Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

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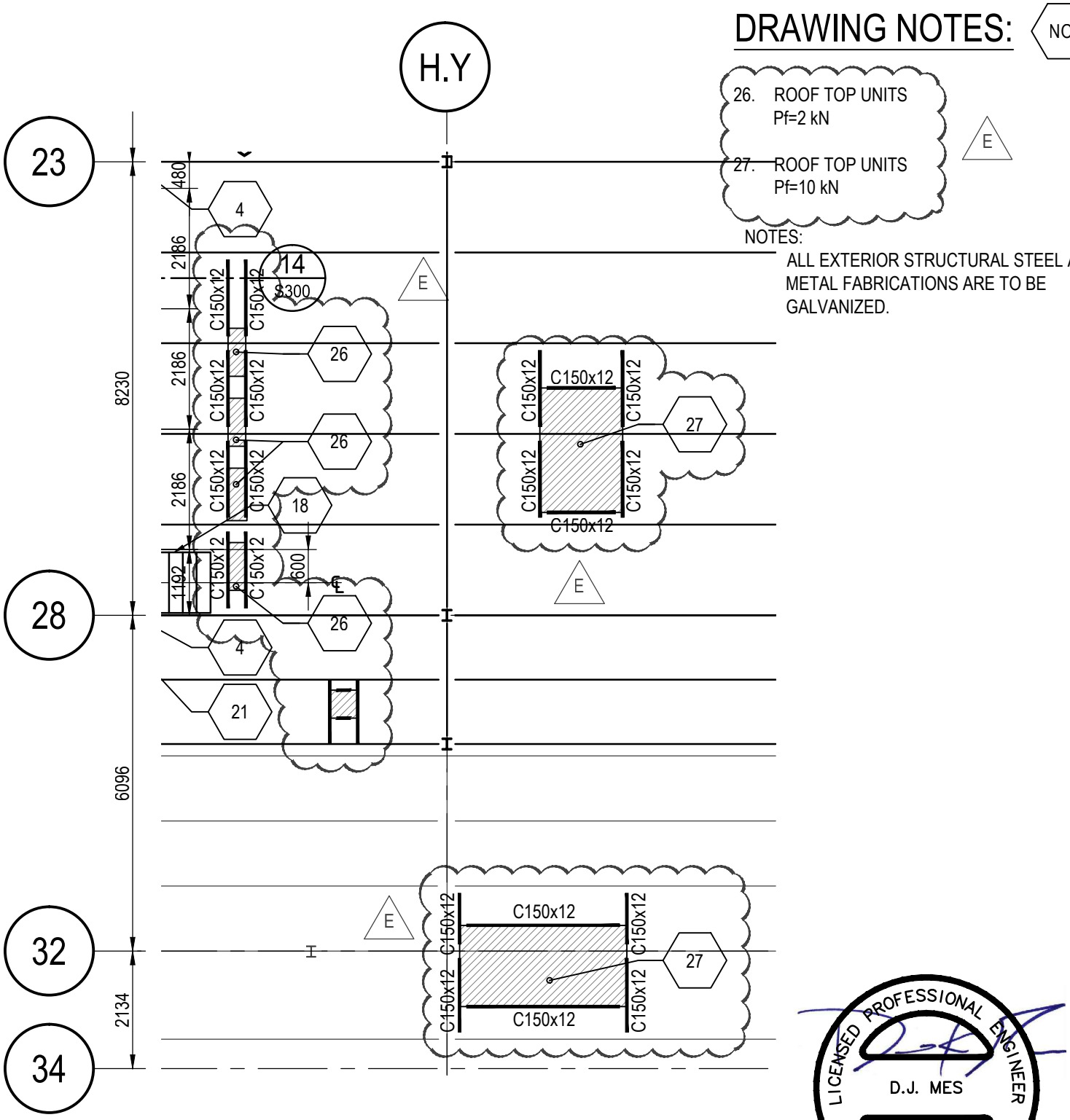
Project no. / No. du projet	R.044033.002
Drawing no. / No. du dessin	FS-S203-02

PWGSC 11x8.5 (215x279)



DRAWING NOTES:

NO.

26. ROOF TOP UNITS
Pf=2 kN

27. ROOF TOP UNITS
Pf=10 kN

E

NOTES:

ALL EXTERIOR STRUCTURAL STEEL AND METAL FABRICATIONS ARE TO BE GALVANIZED.

PENTHOUSE ROOF PART PLAN

1 : 100

LICENSED PROFESSIONAL ENGINEER
D.J. MES
2014-01-07
PROVINCE OF ONTARIO

project / projet	SIR FREDERICK BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 251 SIR FREDERICK BANTING WAY, ON
drawing / dessin	RTU SUPPORT DETAILS

Designed By / Conçu par	A.CHEUNG	
Date	2013/12/20	(yyyy/mm/dd)
Drawn By / Dessiné par	E.PILLON	
Date	2013/12/20	(yyyy/mm/dd)
Reviewed By / Examiné par	A.CHEUNG	
Date	2013/12/20	(yyyy/mm/dd)
Approved By / Approuvé par	A.CHEUNG	
Date	2013/12/20	(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		

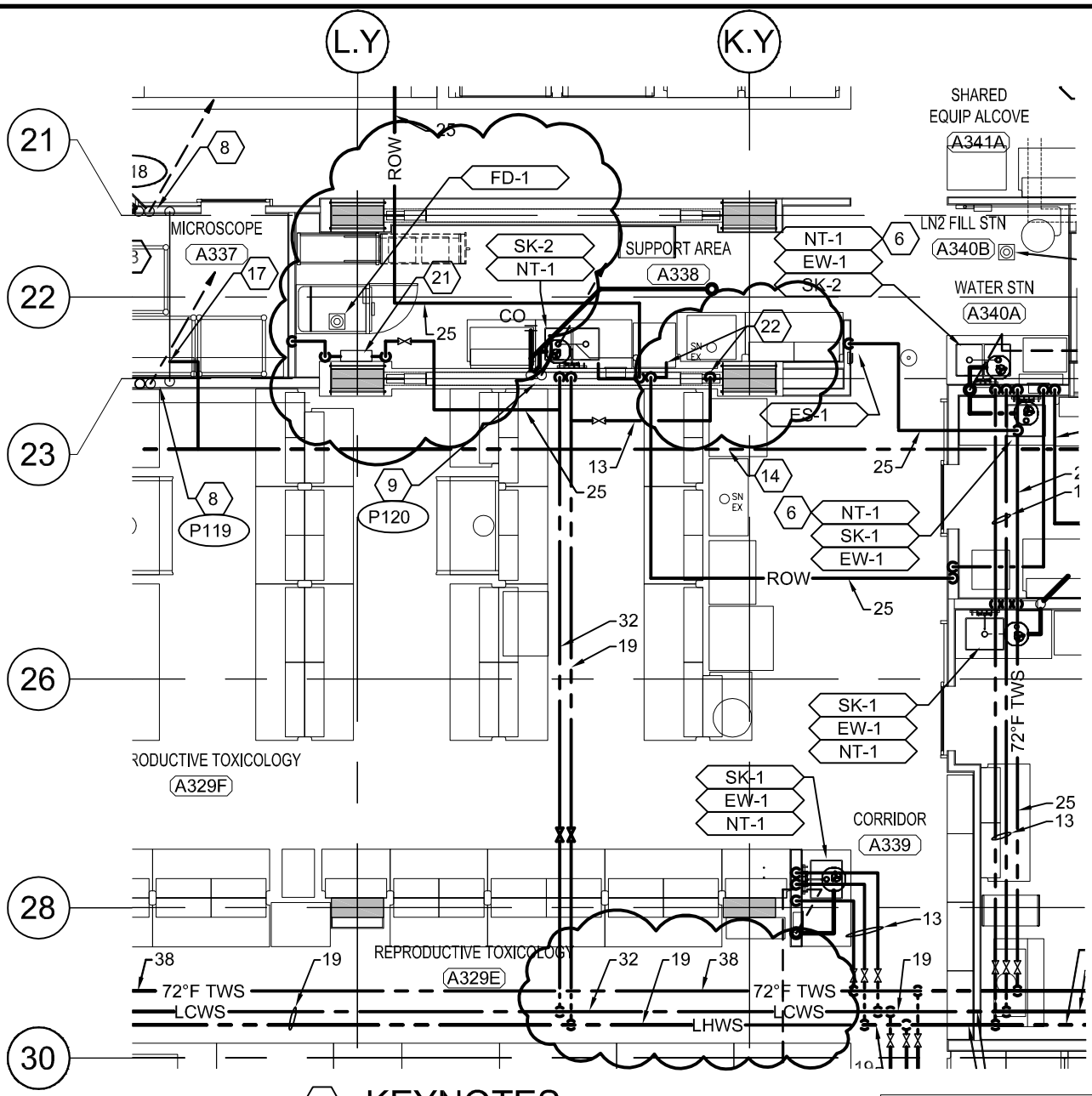
Publics Works and Government Services Canada
Travaux publics et services gouvernementaux Canada

Canada

Project no. / No. du projet: R.044033.002

Drawing no. / No. du dessin: FS-S203-03

PWGSC 11x8.5 (215x279)



KEYNOTES:

21. 25mm RPZ BACKFLOW PREVENTER ON WALL TO SERVE STERILIZER.

22. 13 LCWS AND 13 RO WATER TO GLASSWARE WASHER.

1 / MP130 — THIRD FLOOR PLAN - PLUMBING

1:100

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

project / projet
SIR FREDERIC BANTING RESEARCH CENTRE
ANIMAL TO WET LAB CONVERSION
261 SIR FREDERICK BANTING WAY, ON,

drawing / dessin
MECHANICAL DETAILS

Designed By / Conçu par	SD	
Date		(yyyy/mm/dd)
Drawn By / Dessiné par	WGC	
Date		(yyyy/mm/dd)
Reviewed By / Examiné par	SD	
Date		(yyyy/mm/dd)
Approved By / Approuvé par	SD	
Date	2013/12/20	(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		

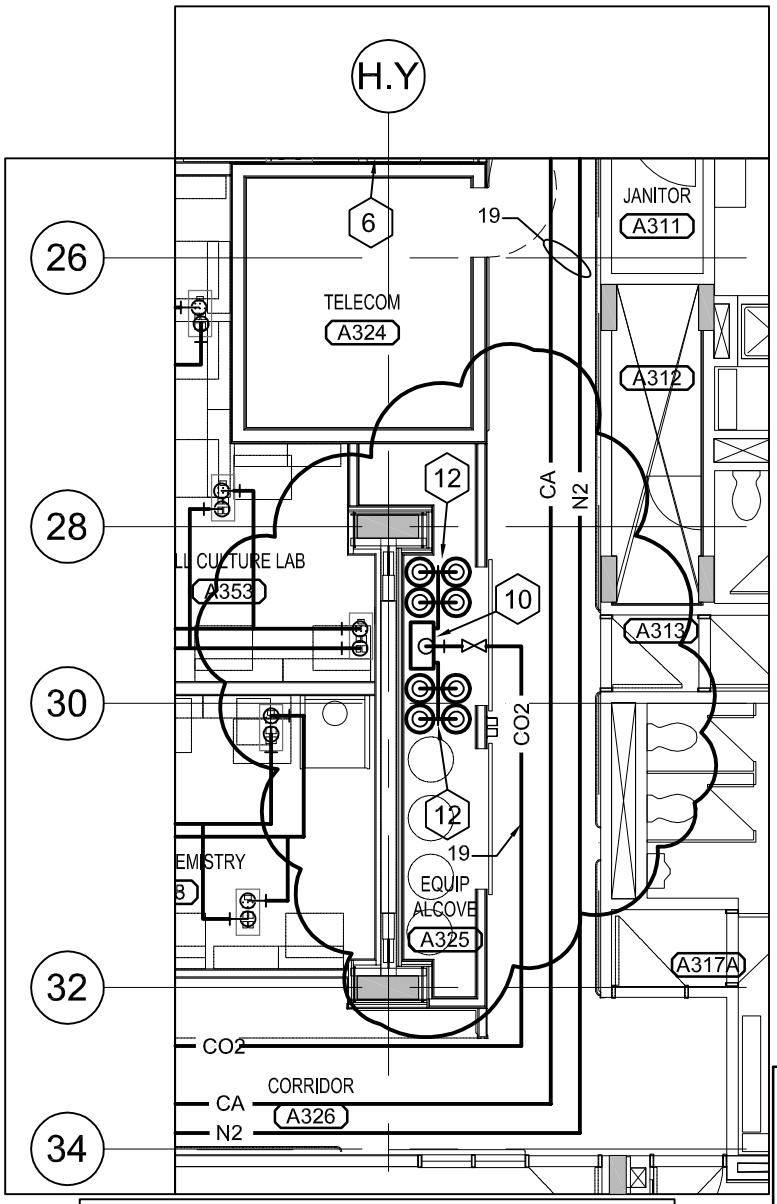
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

Project no. / No. du projet
R.044033.002

Drawing no. / No. du dessin
MP130-R1

PWGSC 11x8.5 (215x279)



KEYNOTES:

10. WALL-MOUNTED CO2 CYLINDER MANIFOLD SYSTEM.
12. GAS CYLINDERS (N.I.C.)

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

1 / MG130 THIRD FLOOR PLAN – LABORATORY GAS

1:100

project / projet
SIR FREDERIC BANTING RESEARCH CENTRE
ANIMAL TO WET LAB CONVERSION
261 SIR FREDERICK BANTING WAY, ON,

drawing / dessin
MECHANICAL DETAILS

Designed By / Conçu par	SD	
Date		(yyyy/mm/dd)
Drawn By / Dessiné par	WGC	
Date		(yyyy/mm/dd)
Reviewed By / Examiné par	SD	
Date		(yyyy/mm/dd)
Approved By / Approuvé par	SD	
Date	2013/12/20	(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		

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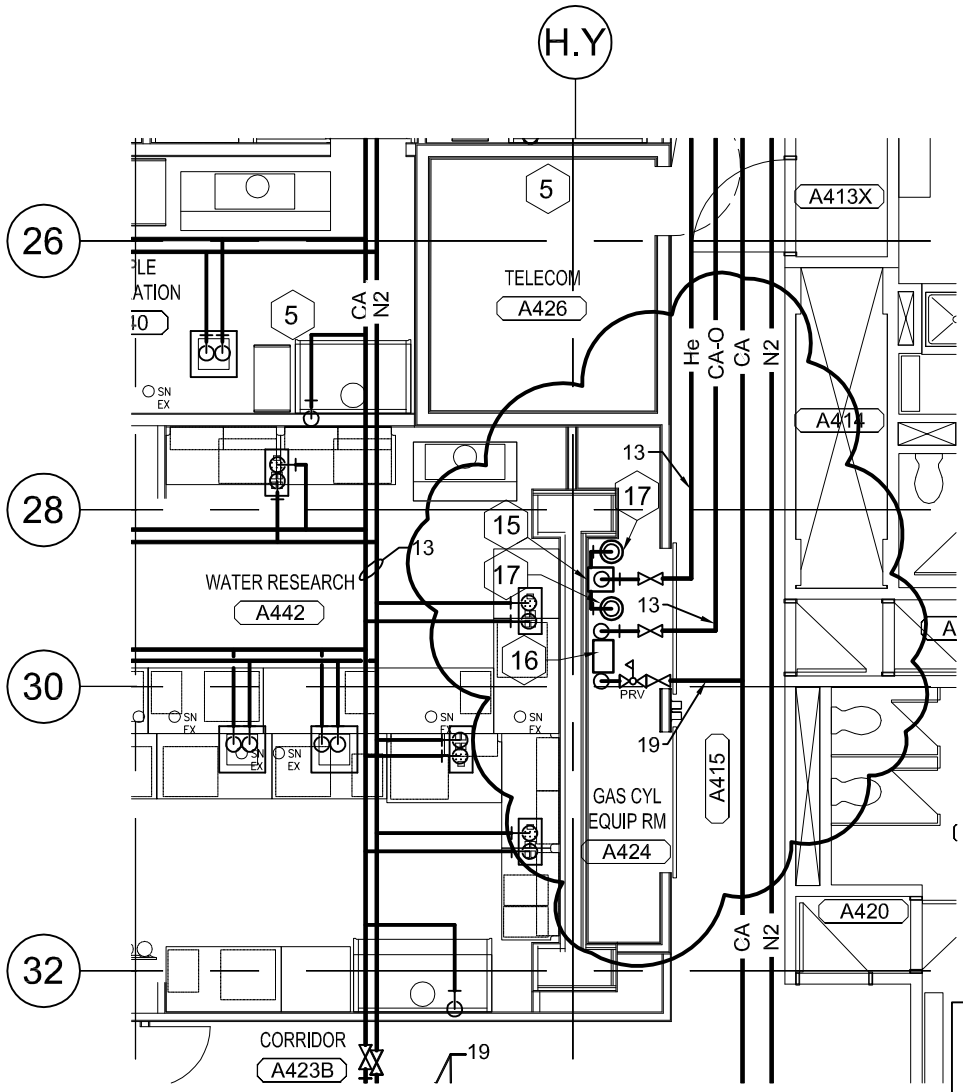
Project no. / No. du projet
R.044033.002

Drawing no. / No. du dessin
MG130-R1

PWGSC 11x8.5 (215x279)



KEYNOTES:

15. WALL MOUNTED REGULATOR ASSEMBLY.

16. PURE AIR (ZERO AIR) GENERATORS. TWO UNITS STATIONED VERTICALLY ON SEPARATE SHELVES.

17. GAS CYLINDERS (N.I.C.)

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

1 / MG140 FOURTH FLOOR PLAN – LABORATORY GAS

1:100

project / projet: SIR FREDERIC BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 261 SIR FREDERICK BANTING WAY, ON,	Designed By / Conçu par: SD Date / (yyyy/mm/dd):
drawing / dessin: MECHANICAL DETAILS	Drawn By / Dessiné par: WGC Date / (yyyy/mm/dd):
	Reviewed By / Examiné par: SD Date / (yyyy/mm/dd):
	Approved By / Approuvé par: SD Date / (yyyy/mm/dd): 2013/12/20
	Tender / Soumission Project Manager / Administrateur de projets

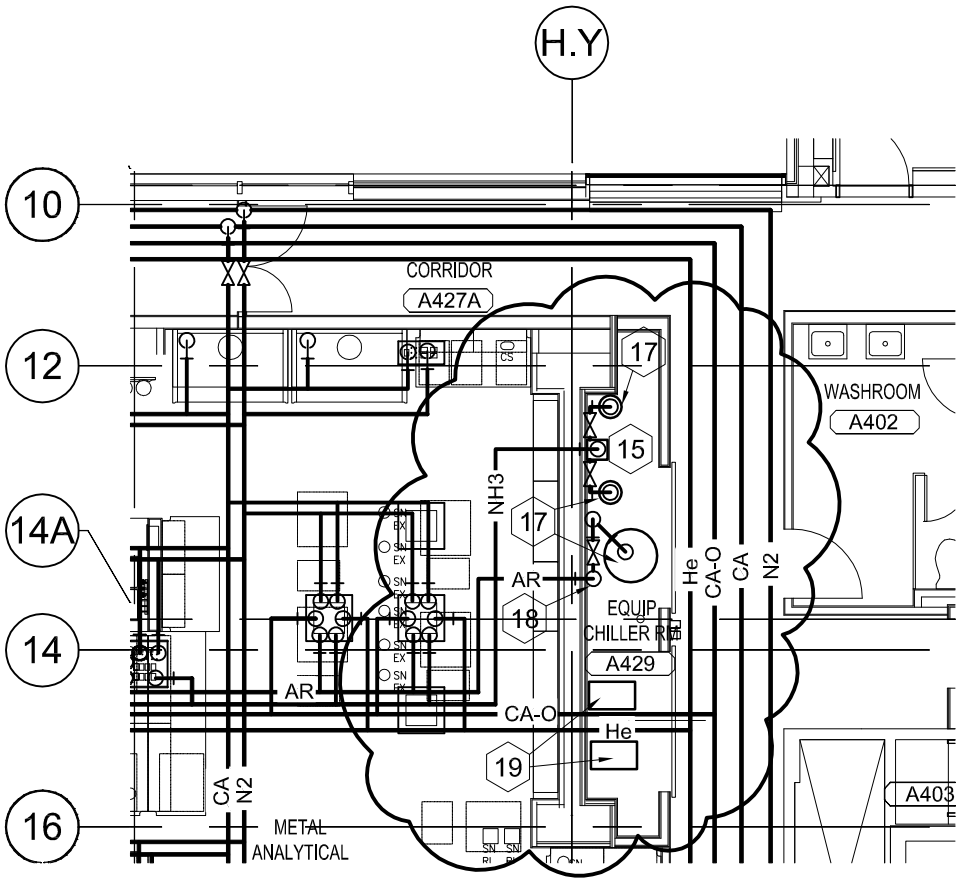
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

Project no. / No. du projet: R.044033.002

Drawing no. / No. du dessin: MG140-R1

PWGSC 11x8.5 (215x279)



KEYNOTES:

15. WALL MOUNTED REGULATOR ASSEMBLY.
17. GAS CYLINDERS (N.I.C.)
18. ARGON REGULATOR ASSEMBLY
19. PROCESS CHILLERS (N.I.C.) ON FIELD-FABRICATED RACK.

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

1 / MG140 FOURTH FLOOR PLAN – LABORATORY GAS
1:100

project / projet
SIR FREDERIC BANTING RESEARCH CENTRE
ANIMAL TO WET LAB CONVERSION
261 SIR FREDERICK BANTING WAY, ON,

drawing / dessin
MECHANICAL DETAILS

Designed By	SD	Conçu par
Date		(yyyy/mm/dd)
Drawn By	WGC	Dessiné par
Date		(yyyy/mm/dd)
Reviewed By	SD	Examiné par
Date	2013/12/20	(yyyy/mm/dd)
Approved By	SD	Approuvé par
Date		(yyyy/mm/dd)
Tender		Soumission
Project Manager		Administrateur de projets

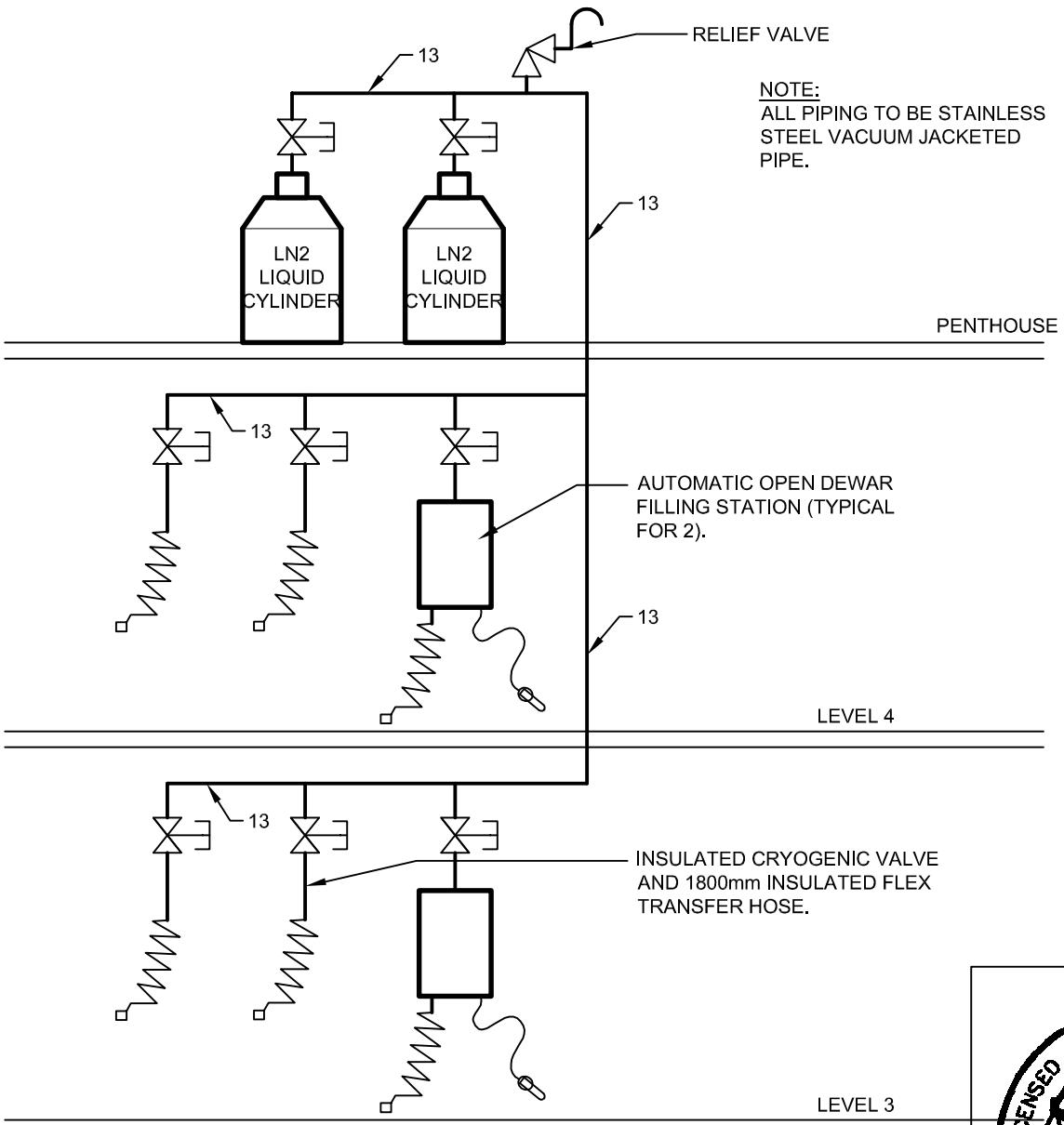
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

Project no. / No. du projet
R.044033.002

Drawing no. / No. du dessin
MG140-R2

PWGSC 11x8.5 (215x279)



3
M501

LIQUID NITROGEN SUPPLY AND FILLING STATION SCHEMATIC

NOT TO SCALE

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

project / projet
SIR FREDERIC BANTING RESEARCH CENTRE
ANIMAL TO WET LAB CONVERSION
261 SIR FREDERICK BANTING WAY, ON,

drawing / dessin
MECHANICAL DETAILS

Designed By / Conçu par	SD	
Date		(yyyy/mm/dd)
Drawn By / Dessiné par	WGC	
Date		(yyyy/mm/dd)
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Date		(yyyy/mm/dd)
Approved By / Approuvé par	SD	
Date	2013/12/20	(yyyy/mm/dd)
Tender / Soumission		
Project Manager / Administrateur de projets		

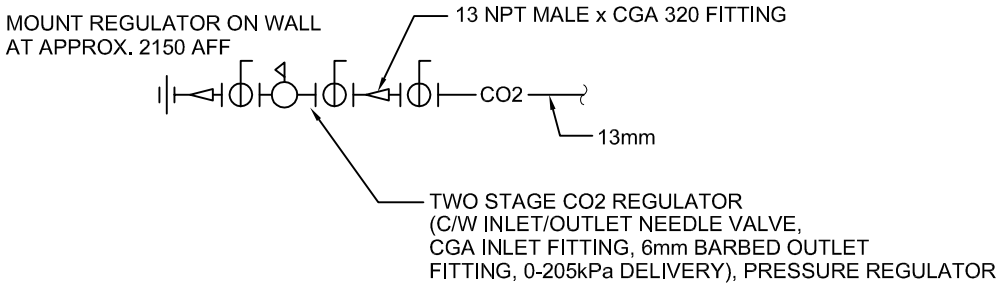
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada

Canada

Project no. / No. du projet
R.044033.002

Drawing no. / No. du dessin
M501-R1

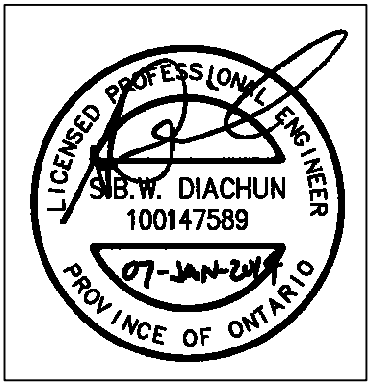
PWGSC 11x8.5 (215x279)



4 / M501

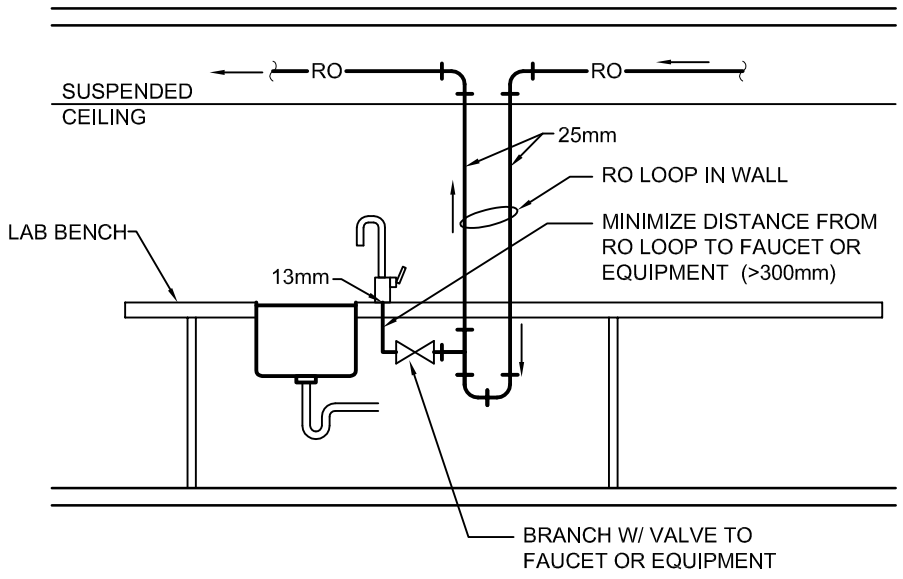
CARBON DIOXIDE DROPS TO INCUBATORS

NOT TO SCALE



project / projet: SIR FREDERIC BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 261 SIR FREDERICK BANTING WAY, ON,	Designed By / Conçu par: SD Date (yyyy/mm/dd):	Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada Canada
drawing / dessin: MECHANICAL DETAILS	Drawn By / Dessiné par: WGC Date (yyyy/mm/dd):	
	Reviewed By / Examiné par: SD Date (yyyy/mm/dd):	
	Approved By / Approuvé par: SD Date (yyyy/mm/dd): 2013/12/20	Project no. / No. du projet: R.044033.002
	Tender / Soumission: Project Manager / Administrateur de projets:	Drawing no. / No. du dessin: M501-R2

PWGSC 11x8.5 (215x279)



5
M501

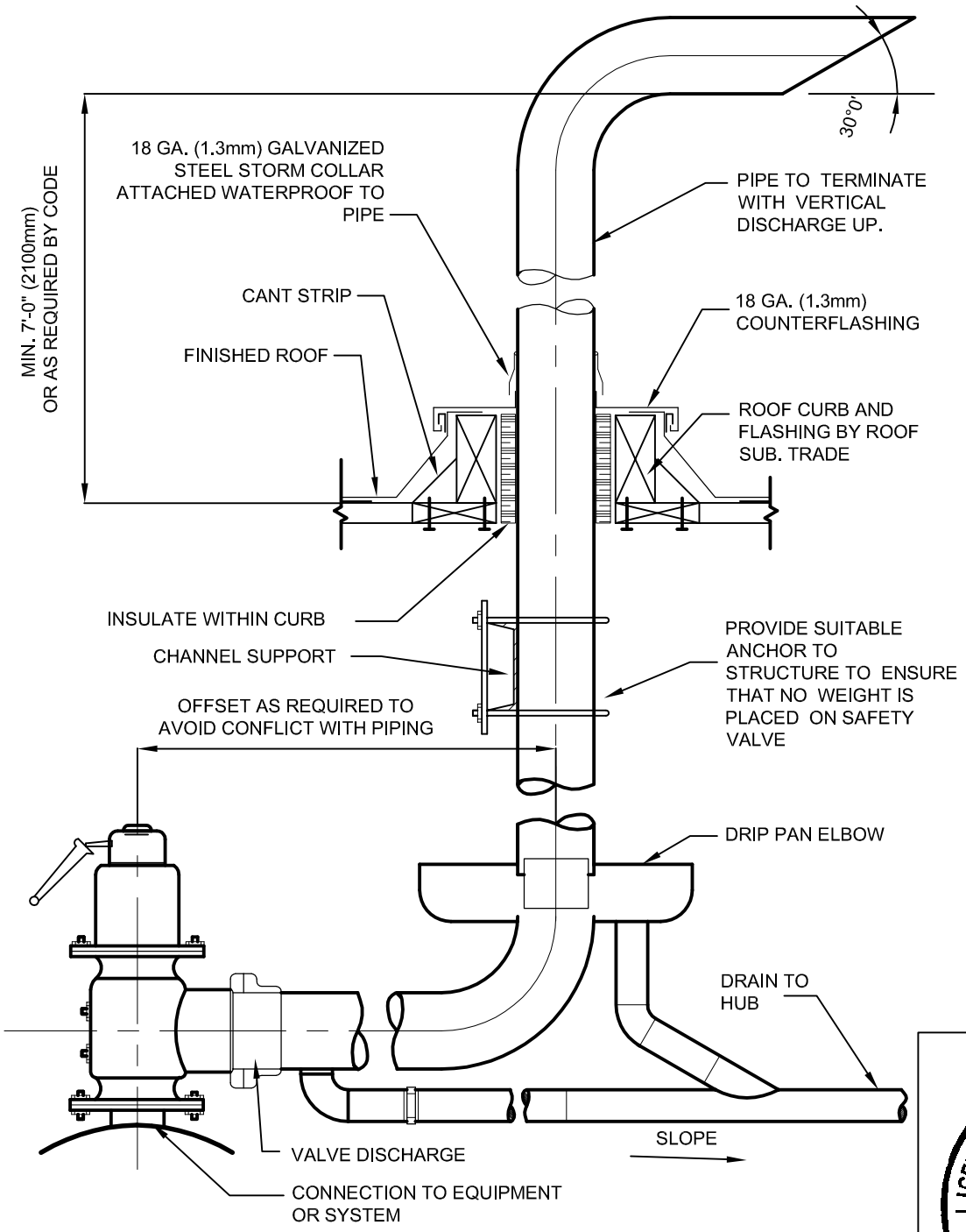
RO WATER DISTRIBUTION TO BENCH

NOT TO SCALE

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

project / projet: SIR FREDERIC BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 261 SIR FREDERICK BANTING WAY, ON,	Designed By / Conçu par: SD Date / (yyyy/mm/dd):	Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada Canada	
drawing / dessin: MECHANICAL DETAILS	Drawn By / Dessiné par: WGC Date / (yyyy/mm/dd):		
	Reviewed By / Examiné par: SD Date / (yyyy/mm/dd):	Project no. / No. du projet: R.044033.002	
	Approved By / Approuvé par: SD Date / (yyyy/mm/dd): 2013/12/20		
	Tender / Soumission: Project Manager / Administrateur de projets:	Drawing no. / No. du dessin: M501-R3	

PWGSC 11x8.5 (215x279)



6 M501

STEAM RELIEF VALVE PIPING

NOT TO SCALE

LICENSED PROFESSIONAL ENGINEER
S.B.W. DIACHUN
100147589
07-JAN-2014
PROVINCE OF ONTARIO

project / projet	SIR FREDERIC BANTING RESEARCH CENTRE ANIMAL TO WET LAB CONVERSION 261 SIR FREDERICK BANTING WAY, ON,
drawing / dessin	MECHANICAL DETAILS
Designed By / Conçu par	SD
Date (yyyy/mm/dd)	
Drawn By / Dessiné par	WGC
Date (yyyy/mm/dd)	
Reviewed By / Examiné par	SD
Date (yyyy/mm/dd)	
Approved By / Approuvé par	SD
Date (yyyy/mm/dd)	2013/12/20
Tender / Soumission	
Project Manager / Administrateur de projets	
Publics Works and Government Services Canada / Travaux publics et services gouvernementaux Canada	Canada
Project no. / No. du projet	R.044033.002
Drawing no. / No. du dessin	M501-R4

PWGSC 11x8.5 (215x279)

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel

.2 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel

.3 CSA W55.3-08, Certification of Companies for Resistance Welding of Steel and Aluminum

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 guy wire roof supports, 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.

.1 Indicate component profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.

.2 Indicate welded connections using standard welding symbols include net weld lengths.

.2 Submit Test Reports and substantiating engineering data and test results of previous tests by independent laboratory which purport to meet performance criteria, and other supportive data.

.3 Delegated-Design Submittal: For installed products to comply with performance requirements and design criteria, including structural calculations, analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

.4 Certificate of compliance.

1.3 QUALITY ASSURANCE

.1 Design structural support framing components and site inspect installation under direct supervision of professional structural engineer experienced in design of this Work and licensed in the Province of Ontario.

.2 Qualifications:

.1 Welder's qualifications: welders certification to CSA W55.3

.1 Employ qualified and licensed welders possessing certificates for each procedure to be performed.

.2 Each welder to possess identification symbol issued by authority having jurisdiction.

.2 Welding company certification: certified for fusion welding of steel structures to CSA W47.1

Part 2 Products

2.1 DESIGN AND PERFORMANCE REQUIREMENTS

.1 Guy Wire Roof Supports: Design to withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

.2 Locate supports to suit mechanical stack spacing, roof edge condition, and similar items.

.3 Maintenance-free design.

2.2 GUY WIRE ROOF SUPPORTS

.1 Guy Wire Roof Supports: consisting of epoxy-coated, urethane insulated, galvanized hollow structural steel support, including appropriate fastening to structural roof deck, and steel ring with galvanized eye and stainless steel cap for affixing guy wire. Provide urethane insulated Type 304 stainless steel flashing, and EPDM base seal, and deck flange suitable for use embedding in roofing membrane.

.1 Support pipe: 356 mm high, by diameter and thickness based on loads.

.2 Size of eye bolt: based on loads.

.3 Size of base plate and securement method: 305 by 305 mm by thickness based on loads, for welded securement.

.4 Allow for four supports per stack.

2.3 MATERIALS

.1 Steel sections and plates: CSA G40.20M/G40.21.

.2 Steel rings: galvanized steel, ring thickness determined by imposed loads.

.3 Bolts, nuts, and washers for stainless steel: stainless steel, matte finish.

.4 Welding materials: CSA-W47.1 for materials being welded.

2.4 FABRICATION

.1 Fabricate items with joints tightly fitted and secured.

.2 Continuously seal joined members by intermittent welds and plastic filler.

.3 Grind exposed joints flush and smooth with adjacent finish surface.

.1 Make exposed joints butt tight, flush, and hairline.

.2 Ease exposed edges to small uniform radius.

.4 Exposed Mechanical Fastenings: screws or bolts; consistent with design of component.

.5 Furnish and install components required for anchorage of fabrications.

.6 Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.5 FABRICATION TOLERANCES

.1 Squareness: 3 mm maximum difference in diagonal measurements.

.2 Maximum Deviation From Plane: 1.5 mm from 1 m.

Part 3 Execution

3.1 EXAMINATION

.1 Verify dimensions, tolerances, and method of attachment with other work.

3.2 PREPARATION

.1 Supply and install steel items required to be attached to steel framing as clean uncoated metal, with setting templates to appropriate sections.

3.3 INSTALLATION

.1 Install guy wire roof supports in accordance with manufacturer's printed instructions, shop drawings and as specified.

.2 Install work under direct supervision of a professional engineer.

.3 Install items plumb and level, accurately fitted, free from distortion or defects.

.4 Where necessary, provide protection against deterioration due to contact of dissimilar materials.

.5 Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

.6 Field weld components as indicated on shop drawings.

.7 Place flashing sleeve over base and seal to roof membrane in accordance with manufacturer's instructions. Flash in deck flange with two overlapping layers of membrane and seal with asphalt sealer.

.8 Obtain approval from Departmental Representative prior to site cutting or making adjustments not scheduled.

3.4 ERECTION TOLERANCES

.1 Maximum Variation from Plumb: 3 mm.

3.5 ADJUSTING AND FINAL INSPECTION

.1 Verify manufactured units have been installed in accordance with specifications and details, and function as intended.

.2 Provide necessary documentation certifying system is acceptable for service.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by roof anchors and safety restraint installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 21 05 05 - Common Work Results for Fire Protection.

1.2 REFERENCES

.1 National Fire Protection Association (ANSI/NFPA)

.1 NFPA 20-2011, Standard for the Installation of Stationary Fire Protection.

.2 Underwriters' Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for fire pump control and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate:

.1 Method of anchorage

.2 Number of anchors.

.3 Supports.

.4 Reinforcement.

.5 Assembly details.

.6 Accessories.

.7 Indicate hydraulic and electrical characteristics including Net Positive Suction Head (NPSH) required, make and model number.

.2 Provide power and control diagrams.

1.4 CLOSEOUT SUBMITTALS

.1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and in accordance with ANSI/NFPA 20.

1.5 MAINTENANCE MATERIALS SUBMITTALS

.1 Extra Materials:

.1 Furnish spare parts for each pump in accordance with Section 01 78 00 - Closeout Submittals and as follows:

.1 One set of packing.

.2 One casing joint gasket.

1.6 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

.1 Test reports:

.1 Submit certified test reports for packaged fire pumps from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

.2 Test each pump/driver package at factory to provide detailed performance data and to demonstrate compliance with NFPA and specification. Submit certified test curves for approval of Departmental Representative.

.3 Test hydrostatically to meet requirements of fire protection system to which it will be connected.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Instructions: submit manufacturer's installation instructions.

.4 Manufacturer's Field Reports: manufacturer's field reports specified.

1.7 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 Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Water supply:

.1 Results of water flow test conducted on 4th of October 2013 indicate flow rate of 40 L/s and residual pressure of 503 kPa at hydrant outside front of the facility. This information forms basis of current equipment selections indicted in the documents.

.2 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for basis of design including NPSH available, and in accordance with NFPA 20.

2.2 FIRE PUMPS

.1 Packaged, ULC, CSA listed and labelled vertical inline fire pumps and controllers. System to consist of one fire pump, one controller and one transfer switch.

.2 Driver: electric open drip-proof motor.

.3 Mounting: install pump and driver on common base.

.4 Materials and construction: to NFPA 20.

.5 Capacity: as scheduled.

.6 Accessories to NFPA 20 requirements and in addition:

.1 Fire pump bypass fitted with shut off valves and check valves.

.2 Audible and visual suction side alarm.

.3 OS&Y valves on suction and shut off valves on discharge, electrically supervised.

.7 Anchor bolts and templates:

.1 Supply for installation by others.

2.3 PRESSURE MAINTENANCE (JOCKEY) PUMP

.1 General: horizontal, close-couple, electrically driven positive displacement pump and controller.

.2 Capacity: to satisfy fire protection system requirements and NFPA: Refer also to schedule.

.3 Accessories: to NFPA 20.

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 Install in accordance with ULC listing, NFPA 20, manufacturer's instructions and reviewed shop drawings.

.2 Align pump and motor shafts to within manufacturer's recommended clearances prior to start-up.

.3 Install wiring in accordance with manufacturer's instructions and applicable codes.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide 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 site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.2 Site Tests:

.1 Field test each fire pump, driver and controllers in accordance with NFPA 20. Testing to include:

.1 Verification of proper installation and system initiation.

.2 Verification of the sequence of operations and alarm systems.

.2 Testing to be witnessed by authority having jurisdiction.

.3 Develop, with Departmental Representative assistance, detailed instructions for O & M installation.

3.4 CLEANING

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

.2 Clean installed products in accordance to manufacturer's recommendation.

.3 Waste Management: in accordance with Section 01 74 21 - Construction Waste Management and Disposal and 01 35 21 - LEED Requirements.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 22 05 00 - Common Work Results for Plumbing.

1.2 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 for domestic water booster pumps.

.3 Shop Drawings:

.1 Submit shop drawings to indicate project layout and dimensions; indicate:

.1 Equipment, piping, and connections, together with valves, strainers, control assemblies, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system.

.4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Instructions: submit manufacturer's installation instructions.

.7 Manufacturer's Field Reports: manufacturer's field reports specified.

.8 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include data as follows:

.1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.

.2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

Part 2 Products

2.1 DOMESTIC WATER PRESSURE BOOSTER SYSTEM

.1 General requirements:

.1 Skid mounted packaged duplex system, factory assembled, tested and adjusted, ready for external field piping and electrical connections.

.2 Pumps: stainless steel, close-coupled, horizontal end-suction design with mechanical seal suitable for potable water applications.

.3 Pipe headers: type L copper pipe

.1 Rated for 860 kPa (125 psig).

.2 Connection to match connecting piping shown on drawings.

.3 Pressure transmitter mounted on discharge header and wired to controller to indicate process variable.

.4 Valves:

.1 NPS 2 and under: Ball valve, stainless steel body, ball and stem.

.2 NPS 2-1/2 and greater: Butterfly valve, epoxy coated ductile iron, stainless steel disc and stem, EPDM seat liner.

.3 Isolation valves on suction and discharge of each pump.

.4 Check valve on discharge of each pump.

.5 Supports: install complete package on factory fabricated structural steelwork

.6 Control panel: solid-state in NEMA 1 enclosure, with the following features or functions:

.1 Designed for mounting on package frame.

.2 CUL listed, CE marked.

.3 Single point power connection with manually operated fused door interlock disconnect switch.

.4 Local-Off-Remote switch.

.5 Adjustable frequency drive (AFD) with line and load reactors for each pump with HOA selector switch. NEMA 3-R enclosure.

.6 Motor overload protection.

.7 Microprocessor-based pump logic controller with the following features:

.1 Loss of suction protection.

.2 Lack of NPSHa.

.3 Dead-head protection.

.4 Low flow, over pressure and pressure sensor error shut-down.

.5 Dry contacts for remote monitoring of common alarm output.

.8 Pressure and suction gauges, 90 mm nominal diameter, with range suitable to the application.

.9 Sensors and transmitters:

.1 Pressure transmitter mounted in discharge header.

.2 Flow sensor.

.2 Features and performance:

.1 As scheduled. Scheduled characteristics govern where the conflict with the general requirements specified herein.

.3 Anchor bolts and templates:

.1 Supply for installation by other Divisions.

.4 Operation:

.1 System will operate under own controls.

.2 Each transmitter/sensor to send 4-20mA signal to controller for process control.

.3 Lead pump shall operate to meet the pressure set point and continue to operate at constant speed to meet demand.

.4 Lag pumps shall start automatically to meet demand.

.5 Lag pump shall shut down when demand is satisfied, subject to time delay or other strategy to avoid short cycling of pumps.

.6 Lead pump to operate during demand.

.7 When system is satisfied, lead pump shall be shut-down for low flow/no flow condition.

.8 Failure of single pump, VFD or sensor shall not cause the system to shut down.

Part 3 Execution

3.1 INSTALLATION

.1 Provide concrete foundation pad for domestic water pressure booster system in accordance with manufacturers' recommendations and as indicated on drawings.

.2 Disassemble and reassemble pump package as required to install system in location indicated, following manufacturer's recommendations. This includes piping and electrical connections.

.3 Make piping and electrical connections to pump and motor assembly and controls.

.4 Provide flexible connections at the suction and discharge headers of domestic water pressure booster system.

.5 Maintain clearances as recommended by manufacturer for service and as required by code.

.6 Ensure pump and motor assembly do not support piping.

.7 Adjust setpoint of pressure booster systems on site to suit to satisfy building requirements.

3.2 FIELD QUALITY CONTROL

.1 Start-up in accordance with manufacturers' recommendations. Check for proper and safe operation.

.2 For pressure booster system, provide factory-trained representative to start-up and commission system. Submit report to Departmental Representative.

.3 Check settings and operation of hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 22 05 00 - Common Work Results for Plumbing.

1.2 RELATED REQUIREMENTS

.1 Section 22 05 00 - Common Work Results for Plumbing

.2 Section 23 05 05 - Installation of Pipework

1.3 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.9 – 2011, Building Services Piping

.2 ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings

.2 ASTM International (ASTM)

.1 ASTM F1387-99(2012), Standard Specification for the Performance of Mechanical Attached Fittings

.2 ASTM B819-00(2011), Standard Specification for Seamless Copper Tube for Medical Gas Systems

.3 ASTM A269-10, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

.3 Canadian Standards Association (CSA)

.1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

.2 CSA Z7396.1-09 - Medical gas pipeline systems - Part 1: Pipelines for medical gases and vacuum

.4 Health Canada/workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS)

.5 Compressed Gas Association (CGA):

.1 Pamphlet G-4.1, “Cleaning Equipment for Oxygen Service”

1.4 SUBMITTALS

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

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 35 21 - LEED Requirements.

.3 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

.1 Submit Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.4 Shop Drawings:

.1 Submit shop drawings to indicate project layout including layout, dimensions and extent of piping system.

.1 Vertical and horizontal piping locations and elevations and connections details.

.2 Other details including: manifold configuration, dimensions.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.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.

1.5 CLOSEOUT SUBMITTALS

.1 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include data as follows:

1.6 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 PIPING

.1 Piping:

.1 Stainless steel:

.1 316/316L stainless steel instrumentation grade tubing to ASTM A169-10.

.2 Copper:

.1 Type ‘L’ copper to ASTM B189.

.2 Fittings:

.1 Stainless steel:

.1 Butt or socket weld fittings suitable for orbital welding.

.2 Two-ferrule tube fitting, to ASTM F1387.

.2 Copper:

.1 Wrought copper, brass or bronze pressure fittings, designed for silver brazed connections to ASME B16.50.

.3 Joints:

.1 Stainless steel:

.1 Orbital weld.

.2 Mechanical coupling at valves and connection to equipment.

.2 Copper:

.1 NPS2 and smaller: silver brazed.

2.2 BALL VALVES

.1 Stainless steel:

.1 ¼" (6mm): One piece design, straight pattern.

.1 Stainless steel body, ball, stem, disc and ring. PFTE packing. Ferruled fitting at both ends. Rated to 2500 PSI at 37C.

.2 ½" (13mm): 3-piece design, straight pattern:

.1 Stainless steel body, ball, stem, disc and ring. UHMW polyethylene packing. Ferruled fittings at both ends. Rated to 2500 PSI at 37C.

.2 Copper:

.1 Three piece design or top entry for ease of in-line maintenance.

.1 To MSS SP-100, bronze body, screwed ends, chrome plated ball, 600 WOG.

2.3 CHANGE-OVER CYLINDER REGULATORS

.1 Dual Stainless steel, dual stage regulators for cylinder mounting complete with auto change over mechanism.

.1 Regulators

.1 316 stainless steel body, diaphragm, nozzle, poppet.

.2 CGA gas fitting appropriate to service.

.3 Outlet pressure range: 4-80 psig.

.4 Maximum inlet pressure: 3000 psig.

.5 Pressure gauge, dual scale, 0-50 psig and 0-3450 kPa.

.2 Change over mechanism:

.1 Automatic change over with low pressure alarm switch and change over alarm outputs.

.2 Manual cylinder switch-override.

2.4 INLINE REGULATORS

.1 Stainless steel, single stage regulator for cylinder mounting.

.1 316 stainless steel body, diaphragm, nozzle, poppet.

.2 Threaded inlet and outlet.

.3 Outlet pressure range: 4-80 psig.

.4 Maximum inlet pressure: 3000 psig.

.5 Pressure gauge, inlet and outlet shut off valve, 6mm barbed hose fitting.

2.5 AUTOMATIC GAS MANIFOLD ASSEMBLY

.1 Fully automatic, digital manifold, factory assembled and tested, and cleaned for oxygen service. CSA or CUL Certified.

.1 Designed to alternate cylinder banks automatically by used of solenoid valves and digital controls.

.2 Piping components:

.1 Two primary regulators designed for 345 kPa discharge pressure.

.2 Two pressure transmitters

.3 Two inlet check valves

.4 Heavy-duty normally open brass solenoid valve

.5 Isolation ball valves

.6 Three externally mounted, ASME certified pressure relief valves.

.3 Manifold to accommodate two (2) banks of two, with 4cylinders each, arranged in standard configuration with 250mm centres.

.1 Header bars: brass pipe and fittings, silver soldered. Labelled for intended gas, complete with gas specific inlet connectors with integral check valve.

.2 Pigtails: CGA inlet and outlet nut and nipple fittings, 600mm long Teflon lined stainless steel tube.

.4 Cabinet:

.1 Painted steel cabinet to house piping components and electronics.

.5 Display:

.1 Digital display and control unit with following features:

.1 LED indication of cylinder bank status (“Service”, “Ready”, “Empty”)

.2 Digital display of each cylinder bank pressure and main supply pressure.

2.6 NITROGEN GENERATOR (UHP, 99.999% PURE)

.1 General:

.1 Tag: “NG-1” (refer to drawings)

.2 Cabinet-style nitrogen generator using PSA (pressure swing absorption) technology to generate a continuous flow of minimum 10 litres per minute of 99.999% pure nitrogen at 550 kPag (80 psig) using compressed air.

.2 Technical requirements:

.1 Inlet: Clean, dry compressed air at 825 kPa (120 psig) from laboratory compressed air system. Maximum inlet flow rate of 20 litres per minute.

.2 Outlet: Analytical grade nitrogen, minimum of 99.999% pure at minimum outlet pressure of 550 kPag (80 psig).

.3 Operating temperature range: 5-35 C (41-95F)

.3 Construction:

.1 Cabinet style generator with all internal components concealed behind cabinet walls.

.2 Integral control panel with pressure gauges, operating pilot lights, trouble/alarm/service light.

.3 Designed for indoor mounting.

.4 Electrical: 120 V, 1ph.

2.7 GAS CYLINDER CABINETS

.1 Floor mounted cylinder cabinet with hinged door. Constructed from cold-rolled steel, minimum 2.5mm thick, with polyurethane paint finish inside and out. Galvanized steel floor. Gasketted, painted steel door with 6mm wire-glass viewing window, positive latching mechanism, inlet louvre in bottom portion of door.

.2 Top duct connection for exhaust ventilation: minimum 100 mm diameter with 25mm collar. Internal support channels for cylinder restraint and gas regulator mounting.

.3 Refer to drawings of quantity and locations.

Part 3 Execution

3.1 MATERIAL APPLICATION

.1 The following materials, as specified above, shall be used for gas piping systems for the specific gas:

Gas	Material
High purity helium (He)	Stainless steel
Carbon Dioxide (CO2)	Copper
High purity Nitrogen (N2)	Stainless steel
Zero Air (high purity)	Stainless steel
Argon	Stainless steel

3.2 CYLINDER REGULATORS

.1 Change over regulators: Ammonia (1), helium (1).

.2 Automatic gas manifold assembly: Carbon dioxide.

.3 Automatic dewar regulator: Argon.

GAS PIPING CONNECTIONS AND INSTALLATION

.1 In accordance with requirements of ASME B31.9, CSA B51.9, CSA Z7396.1 and as specified.

.2 Installer to be experienced in the installation of laboratory gas piping using the materials specified.

.3 Install piping in strict accordance with manufacturers' instructions.

.4 Install shut-off valves at outlets, major branch lines and elsewhere as indicated.

.5 Changes in direction to be accomplished using fittings.

.6 Cleaning:

.1 Piping and fittings to be kept clean, and sealed in package until time of installation.

.2 Inspect and clean any pipe and fittings following procedures for cleaning for oxygen service to CGA Pamphlet G-41.

.7 Testing:

.1 Pressure test in accordance with requirements of Section 23 05 05 - Installation of Pipework, for 4 h minimum, to 1034 kPa, with outlets closed. Pressure drop not to exceed 10 kPa.

.8 Install inline regulator at each CO2 system drop, as located on the drawings.

.9 Review termination points and methods, routing of pipe and general installation with Departmental Representative prior to start of installation.

3.4 CLEANING

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 22 05 00 - Common Work Results for Plumbing.

1.2 REFERENCES

.1 National Fire Protection Association (NFPA)

.1 NFPA 55 – Compressed Gases and Cryogenic Fluids Code

.2 Compressed Gas Association (CGA)

.1 Pamphlet 8.1 – Safe Handling of Compressed Gases

.3 American Society for Mechanical Engineering (ASME)

.1 ASME B31.3 – Process Piping (Normal Fluid Service)

.4 Transport Canada (TC)

.1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.3 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, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide complete design and drawings of the system including:

.1 Isometric drawings showing all components.

.2 Plan drawings showing lengths of assemblies, method of joining and location of valve and relief vents.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Packaging Waste Management: in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

.2 Place materials defined as hazardous or toxic in designated containers.

.3 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.

Part 2 Products

2.1 GENERAL

.1 Following components are part of a complete engineered nitrogen storage and delivery system.

2.2 PIPING – VACUUM JACKETTED

.1 Piping: vacuum insulated and be designed for transferring of liquid nitrogen.

.2 Construction:

.1 Construct in accordance with ASME B31.3.

.3 Inner liner:

.1 Material: 304 Stainless Steel ASTM A312 pipe, or A269 Tube (welded).

.2 Internal working pressure: 1034 kPa

.3 Internal or External expansion joints shall be installed at the factory at recommended intervals to compensate for thermal contraction when the pipe is in service. (See Appendix A)

.4 Inner line size and jacket size shall be specified on drawings. (See Appendix A)

.5 Spool connections shall be identified and located on the approval drawings and as specified in section five (5).

.4 Vacuum Jacket

.1 Design and construction: To ASME Section VIII, designed for internal vacuum ad external atmospheric pressure.

.2 Material: 304 Stainless Steel ASTM A312 pipe, or A269 Tube (welded).

.3 Outer jacket shall be evacuated at the factory and sealed.

.5 Vacuum Annulus

.1 Inner carrier: Designed to support liner and absorb thermal and pressure loading.

Insulation: alternating layers of fibreglass and aluminum foil.

.6 Joints:

.1 Field Connections:

.1 Field connections shall be accomplished using bayonet-style connections.

.2 Bayonet connection shall include sealing gasket or O-ring, and outer clamping band.

.3 Clamping bands to be secured via bolted flange or threaded nut.

.4 Welded field connections shall only be used where approved by the Departmental Representative.

2.3 FLEXIBLE CRYOGENIC HOSE

.1 Construction:

.1 Inner liner: corrugated type 304 stainless steel, 1034 kPa working pressure.

.2 Outer jacket: corrugate type 304 stainless steel.

.3 Insulation: multi-layer reflective insulation in annular space, evacuated at the factory and sealed.

.4 Connections: CGA connection, male or female. Confirm with Departmental Representative.

.5 Length: as indicated.

2.4 VACUUM JACKET GATE VALVES

.1 Globe valve:

.1 Construction:

.1 Body: type 304 or 316 stainless steel

.1 Configuration: straight or angle suitable to application.

.2 Purge port.

.2 Stem: stainless steel.

.3 Plug: Brass.

.4 Bonnet: Brass.

.5 Outer jacket: stainless steel.

.6 Annular space between inner liner and outer jacket held at vacuum.

.2 Performance:

.1 Working pressure: 2068 kPa.

.2 Bubble tight seat seal to 1034 kPa.

2.5 AUTOMATIC DEWAR FILLING STATION

.1 Electronically controlled filling station intended for filling of open dewars (non pressurized).

.1 Configuration: Wall mounted control panel, CSA certified.

.2 Sensor: thermistor.

.3 Alarms: Local visual and audible. Output for connection to EMCS.

.4 Operation:

.1 Upon activation of the fill cycle, flow of liquid nitrogen will begin and continue until presence of liquid is detected at the thermistor sensor. Thermistor sensor to be positioned by user at the desired fill level by the operator prior to start of fill cycle.

2.6 NITROGEN STORAGE - LIQUID CYLINDER

.1 Liquid cylinder for the storage and dispensing of nitrogen in the liquid phase.

.2 Construction:

- .1 Stainless steel inner chamber and outer jacket.
- .2 Non-conducting annular spacer. Annual space evacuated and sealed at the factory.
- .3 Connections:
  - .1 Fill port.
  - .2 Liquid outlet port.
  - .3 Vent valve.
  - .4 Pressure gauge.
  - .5 Pressure building regulator.
  - .6 Pressure relief valve and rupture disk.
  - .7 Liquid level gauge.
- .4 Heavy duty base with stainless steel casters and handle.
- .5 Capacity: 230 L liquid nitrogen.
- .6 Quantity: Two (2).
- .7 Performance: Maximum NER= 1.8% per day.

2.7 ACCESSORIES

.1 Relief valves:

- .1 Pressure activated valve designed to prevent excess pressure in lines due to evaporation of liquid nitrogen.

.2 Keep-cold device:

- .1 Automatic device designed to keep lines full of liquid by bleeding off gas. Keep cold device shall be float type design and shall not require electrical power for operation.

.3 Phase separator:

- .1 Device designed to reduce splashing and streamline transfer on manual transfer hoses.

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 DESIGN AND INSTALLATION

.1 Install in accordance with Provincial and Federal regulations and Authority Having Jurisdiction.

.2 Provide a complete engineered system containing all components for safe and fully functioning nitrogen storage and transfer system. Drawings and details indicated convey design intent but do not show all components and devices that may be required to ensure safe and proper installation.

3.3 VALVES

.1 Provide valves at connections to tanks, equipment and at fill locations.

3.4 ACCESSORIES

.1 Relief valves: Install in sections of the system where piping may be isolated and contain liquid, such as between isolation valve and equipment.

.2 Keep-cold devices: Install on long runs of pipe to ensure flow of liquid nitrogen.

3.5 FLEXIBLE HOSE

.1 Install between liquid cylinders and piping systems, and downstream of valves at fill connections.

.2 Install phase separator on one end of manual transfer hoses at fill stations.

3.6 PRE-START-UP INSPECTIONS

.1 Systems to be complete, prior to flushing, testing and start-up.

3.7 CLEANING

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

.2 Waste Management: in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 22 05 00 - Common Work Results for Plumbing.

1.2 REFERENCES

.1 ASTM International (ASTM)

.1 ASTM D2657 Standard specification for Reagent Grade Water

.2 International Organization for Standardization (ISO)

.1 ISO 3696: Water for Analytical Laboratory Use: Specification and Test Methods

1.3 SUBMITTALS

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

.1 Indicate, for central water equipment:

.1 Dimensions, construction details, roughing-in dimensions.

.2 Electrical data and connection type.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 Details of operation, servicing, maintenance.

.2 List of recommended spare parts including contact information.

Part 2 Products

2.1 PACKAGED REVERSE OSMOSIS WATER SYSTEM

.1 Complete packaged unit, factory assembled, wired and tested.

.2 Unit to include following:

.1 Painted steel mounting frame

.2 Stainless steel circulating pump

.3 Single pass reverse osmosis filter unit

.1 Stainless steel housing

.2 Polyamide thin-film composite membrane

.4 Inlet, outlet and component interconnecting piping

.5 Single point electrical connection

.6 Pressure gauges

.7 Flow indicators

.3 Unit to be complete with application specific solid-state controller and accessories with the following minimum features:

.1 NEMA 4X enclosure

.2 Warning and shutdown alarms

.3 Status indicator lights

.4 Run time indicator

.4 Performance: Generate 1.7 m^3/hr Type III water to ASTM D1193-06(2011).

2.2 WATER SOFTENER

.1 Corrosion resistant polyethylene shell reinforced with fibreglass fibres. Vessel to designed to allow loading of media and connection of multiport valve. Unit to be complete with seven day cycle timer.

.2 Unit to be supplied with high capacity cation exchange resin with gravel support bed, complete with inlet diffuser and lower hub.

.3 Five-cycle multi-port control valve to permit backwash, brining, slow and fast rinse, and refill cycles. Valve to be complete with flow regulators.

.4 Corrosion resistant brine tank to be supplied as part of system. Tank to be complete with auto air eliminator safety valve.

.5 Two (2) softeners to be provided in parallel configuration, with common brine tank.

.6 General specifications (each softener):

.1 Ion exchange media: 85 L

.2 Resin capacity: 90 kgrains

.3 Nominal flow rating: 35 lpm

2.3 CARBON FILTER

.1 Corrosion resistant polyethylene shell reinforced with fibreglass fibres. Top of vessel to incorporate connection of multiport valve. Unit to be complete with seven day cycle timer.

.2 Unit to be supplied with high quality activated carbon with gravel support bed, complete with inlet diffuser and lower hub.

.3 Five-cycle multi-port control valve to permit backwash and fast rinse cycles.

.4 Simplex filter configuration.

.5 General specifications:

.1 Max pressure rating: 689 kPa.
.2 Organics: < 5.0 mg/L as O2 consumed
.3 Chlorine: < 5.0 mg/L
.4 Inlet connections: threaded brass

2.4 PIPING ANCILLIARIES

.1 RO water storage tank:

.1 Polypropylene tank with cone bottom and lid. Fabricate steel stand.
.2 Top inlet and bottom outlet connections.
.3 Capacity: 470 litre

.2 Storage tank inlet nozzle:

.1 Stainless steel body with polypropylene nozzle ball.
.2 Designed to provide 360 degree distribution pattern.

.3 Backpressure valve:

.1 PVDF body, stainless steel springs. Designed for 20 to 410 kPa.
.2 Diaphragm: Polytetrafluoroethylene bonded EPDM.
.3 Pressure gauge.

.4 Self-regulating flow control valve:

.1 Type 316 stainless steel body with type 304 stainless steel cartridge and spring.

2.5 UV WATER STERILIZER

.1 Packaged UV sterilizer complete with operating controls and monitoring.

.2 Flanged inlet and outlet of type 316 stainless steel. Light traps to prevent degradation of external piping.

.3 UV lamp generating ultraviolet light with wavelength of 185 nm.

.4 Controls: run-time meter, lamp out alert circuit with contacts for remote monitoring.

.5 Capacity:

.1 Flow: 4.5 m^3/hr @99% UVT
.2 UV dosage: 30,000 microwatt-seconds/cm^2.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions and contract documents.

.2 Install level and with adequate access to allow for servicing, at minimum to manufacturer's directions or as required to properly service and maintain the equipment.

.3 Provide interconnecting piping, valves and fittings between pieces of equipment and make connections to form complete working system.

.4 Manufacturer's to start up and verify systems operation. Test water sample for compliance to specifications.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC.

1.2 REFERENCES

.1 Canada Green Building Council (CaGBC)

.1 LEED Canada-CI, Green Building Rating System for Commercial Interiors, Version 1.0, February 2007

1.3 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 units and pumps, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide the following information:

.1 Pump curves with point of operation.

.2 Required NPSH at specified maximum condensate temperature.

.3 Tank capacity.

.4 Manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.

.2 Indicate control equipment, piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

.4 Sustainable Design Submittals:

.1 LEED Submittals: in accordance with Section 01 35 21 - LEED Requirements.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.5 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 Waste Management and Disposal.

Part 2 Products

2.1 PACKAGED CONDENSATE UNIT, TANK MOUNTED PUMPS

.1 Suitable for service up to 99 deg C.

.2 General: duplex unit with pumps mounted directly on tank.

.3 Pumps:

.1 Volute: cast iron, radially split, screwed discharge connection.

.2 Impeller: cast bronze, secured to shaft by key and lock nut.

.3 Shaft: stainless steel.

.4 Seals: carbon/ceramic mechanical type rated for 121 deg C.

.5 Motor: open drip-proof fan cooled.

.6 Tank: close-grained cast iron construction complete with pump openings, inlet, vent, and overflow connections, openings for accessories and controls.

.7 Accessories:

.1 One externally adjustable 2-pole float switches

.2 One dial pressure gauges for pump discharge

.3 One dial thermometer

.4 Gauge glass with guard and shutoff valves

.5 Bronze fitted inlet isolation valve

.6 Two lifting eye bolts, and one cast iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.

.4 Controls:

.1 Duplex automatic: supplied as package by pump manufacturer complete with:

.1 Level operated controls.

.2 Controller in NEMA 2 enclosure complete with:

.1 Numbered terminal strip.

.2 Combination magnetic contactor with adjustable thermal overload protection with fused disconnect and cover interlock for each motor.

.3 Electrical alternator.

.4 Hand-Off-Auto selector switch.

.5 Fuser control circuit transformer.

.6 Pump running pilot light(s).

.2 Float switches: quick double break type with silver contacts. Seamless stainless steel float with stainless steel rod and packed stuffing box.

.3 Wiring between pumps and controls run in liquid tight rigid conduit installed with standoffs to permit insulation of tank.

.4 ULC listed.

.5 Unit configuration and wiring shall permit installation of insulation on receiver to a minimum of 38mm thickness.

.6 Capacities: As scheduled.

Part 3 Execution

3.1 INSTALLATION

.1 Place level, shim unit and grout.

.2 Pipe up to system as indicated.

.3 Run tank vent separately to exterior of building in location as indicated.

.4 Run drain line and overflow to terminate over floor drain.

.5 Check rotation prior to start-up.

.6 Check bearings for oil level and lubrication.

3.2 SYSTEM START-UP AND PERFORMANCE VERIFICATION (PV)

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements, supplemented as specified herein.

.2 Start-up:

.1 Check strainers and clean as often as necessary until system is clean.

.2 Tighten as necessary glands of valves, pumps.

.3 Check lubrication and add as necessary.

.4 Determine source of loss and rectify deficiencies.

.3 Performance Verification (PV):

.1 Test unit for capacity, NPSH at design temperatures.

.2 Discharge condensate to sewer until system is clean.

.4 Reports:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements, supplemented as specified herein.

.2 Include:

.1 Report forms as specified Section 01 91 13 - General Commissioning (Cx) Requirements.

3.3 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 Waste Management and Disposal and 01 35 21 - LEED Requirements.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.22, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.

.2 ASME B16.24, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.

.3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5, Refrigeration Piping.

.2 ASTM International (ASTM)

.1 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 ASTM B280, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA)

.1 CSA B52, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

.1 EPS 1/RA/1, Environmental Code of Practice for the Reduction of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.3 SUBMITTALS

.1 Shop Drawings: Indicate layout of refrigeration piping system, including equipment, valves, specialties, critical dimensions, and sizes with supporting calculations.

.2 Product Data:

.1 Piping: Submit data on pipe materials, fittings, and accessories.

.2 Valves: Submit manufacturers catalog information with valve data and ratings for each service.

.3 Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for each type.

.3 Design Data: Indicate pipe sizes based on installed configuration and equipment capacities. Sizes indicated on drawings are for tendering assistance only.

.4 Test Reports: Indicate results of refrigerant leak test.

.5 Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

.6 Welding Certificates.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

.1 Hard copper: to ASTM B280, type ACR.

.2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure and temperature to suit R-410a refrigerant.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ASME B16.24, suitable for service.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

.2 Ensure copper tubing does not contact steel sleeve.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 MPa, globe or angle non-directional type, diaphragm, pack-less type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 500, 3.5 MPa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

Part 3 Execution

3.1 GENERAL

.1 Install in accordance with CSA B52, EPS 1/RA/1 and ASME B31.5.

.2 Provide piping systems for all split type refrigeration equipment.

3.2 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.3 PIPING INSTALLATION

.1 General:

- .1 Soft annealed copper tubing: bend without crimping or constriction
- .2 Hard drawn copper tubing: do not bend. Minimize use of fittings.

.2 Hot gas lines:

- .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
- .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
- .3 Provide inverted deep trap at top of risers.
- .4 Provide double risers for compressors having capacity modulation.
  - .1 Large riser: install traps as specified above.
  - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

.3 Evaporator coil liquid line accessories: provide solenoid valve, sight glass/moisture indicator, and thermostatic expansion valve with external equalizer line for coil connection.

3.4 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation.

.3 Test Procedure: Build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.5 DEHYDRATION AND CHARGING

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:

- .1 Twice to 14 Pa absolute and hold for 4 h.
- .2 Break vacuum with refrigerant to 14 kPa.
- .3 Final to 5 Pa absolute and hold for at least 12 h.
- .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
- .5 Submit test results to Departmental Representative.

.7 Charging:

- .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
- .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
- .3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

- .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
- .2 Record and report measurements to Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC.

1.2 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC

1.3 REFERENCES:

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE Standard 70-2006(RA 2011), Method of Testing the Performance of Air Outlets and Air Inlets.

1.4 SUBMITTALS

.1 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.

.2 Indicate following:

.1 Type and model number.

.2 Capacity.

.3 Throw and terminal velocity.

.4 Noise criteria.

.5 Pressure drop.

.6 Neck velocity.

.2 Samples:

.1 Submit when requested by the Departmental Representative in accordance with Section 01 33 00 - Submittal Procedure.

.3 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.

.4 Catalogued or published ratings shall be those obtained from tests in adherence to ASHRAE Standard 70.

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 Waste Management and Disposal: in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 21 - LEED Requirements.

2.2 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests signifying adherence to codes and standards.

2.3 DIFFUSERS, GRILLES AND REGISTERS

.1 General Requirements:

.1 To meet the features, capacity, pressure drop, terminal velocity, throw, noise level, and neck velocity of the Acceptable Material scheduled.

.2 Frames:

.1 Appropriate to surrounding construction material.

.2 Plaster frames where set into plaster or gypsum board and where otherwise specified.

.3 Full perimeter gaskets.

.4 Concealed fasteners.

.3 Concealed manual volume control damper operators to be supplied with diffuser or grille where indicated.

.4 Flow Equalizing Grids: provide in the neck of all ceiling diffusers.

.5 Colour: baked off-white polyester powder coat unless otherwise directed by the Departmental Representative.

.2 Features and performance: as scheduled.

.3 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 LAMINAR FLOW DIFFUSER

.1 Non-aspirating, unidirectional laminar flow diffuser consisting of a dual chamber design. Plenum shall be divided into an upper and lower chamber utilizing an internal pressure equalization baffle to promote consistent airflow and face velocity.

.1 Designed to produce plug of air down from ceiling.

.2 Construction:

.1 Plenum: aluminum construction with integral hanging tabs. Full-flow style volume control damper.

.2 Diffuser face: perforated aluminum diffusion plate secured with ¼ turn fasteners.

.3 White powder coat finish, baked-on in factory.

.3 Where specified, provide HEPA filter with unit. Diffuser shall be designed to provide knife-edge seal in HEPA filter with perimeter gel gasket. HEPA filter shall be removable from face of diffuser. Unit shall be compete with filter monitoring system, including face mounted indicator light and output to the EMCS.

2.5 RADIAL FLOW DIFFUSER

.1 Multi-angular perforated face that extends below the ceiling, with integral plenum.

.1 Designed to produce airflow in radial pattern from center of diffuser.

.2 One or two way airflow pattern as schedule.

.2 Construction:

.1 Aluminum construction, powder coated finish. Diffuser hinged to plenum with external fastening to allow access for cleaning.

2.6 FLUSH-FACE RADIAL FLOW DIFFUSER

.1 Deflector blades located below a perforated equalization baffle, with entire face of diffuser even with below the ceiling line.

.1 Designed to produce airflow in radial pattern from center of diffuser.

.2 One or two way airflow pattern as schedule.

.2 Construction:

.1 Aluminum construction, powder coated finish.

.2 Removable diffuser face via face mounted quarter turn fasteners.

2.7 SQUARE PLAQUE DIFFUSER

.1 Steel diffuser with flat face plate, and die-formed steel back cone. Powder coat finish.

2.8 EGGCRATE GRILLE

.1 Aluminum cubical grid and retaining frame. Frame to have counter-sunk screw holes for surface mounting.

2.9 DOUBLE DEFLECTION SUPPLY GRILLE

.1 Steel supply grille with horizontal and vertical blades in grid pattern. Individually adjustable blades for control over air pattern. Frame with border and counter sunk screw holes. Powder coat finish.

2.10 LOUVRED FACE RETURN GRILLE

.1 Steel return grille with fixed angled steel blades in a retaining frame with border. Powder coat finish.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Adjust locations of air inlets and outlets to conform to architectural features, symmetry and lighting arrangement. Obtain approval of Departmental Representative prior to installation.

.3 Install with flat or oval head screws in countersunk holes where fastenings are visible.

.4 Install air inlets and outlets to ductwork with air-tight connections. Attach round neck diffusers to ductwork using drawbands.

.5 Linear Diffusers: provide continuous length plenums. Provide sealant in receptacle of mounting frame and attach mounting frame to plenum using sheet metal screws 150 mm on centres.

.6 Paint ductwork visible behind air inlets and outlets 'Matte Black'.

.1 Maximum VOC Content: 50g/L – Flat; 150 g/L Non-Flat Paint (less water)

3.2 CLEANING

.1 Proceed in accordance with Section 01 74 11 – Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)

.1 ANSI/ARI 210/240-03, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

.2 ARI 270-95, Sound Rating of Outdoor Unitary Equipment.

.2 ANSI/UL 1995 B-1998, Standard for Heating and Cooling Equipment.

.3 Canadian Standards Association (CSA International)

.1 CSA B52-05, Mechanical Refrigeration Code.

.2 CSA C22.1 HB-[02], Canadian Electrical Code Handbook.

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

.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association

.1 NFPA 90A-2012, Standard for the Installation of Air Conditioning and Ventilating Systems.

1.3 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 for packaged rooftop HVAC units.

.3 Shop Drawings:

.1 Submit shop drawings to indicate project layout and dimensions; indicate:

.1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.

.2 Piping, valves, fitting shipped loose showing final location in assembly.

.3 Control equipment shipped loose, showing final location in assembly.

.4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

.5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.

.6 Fan performance curves.

.7 Details of vibration isolation.

.8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.

.9 Type of refrigerant used.

.4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Instructions: submit manufacturer's installation instructions.

.7 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 CLOSEOUT SUBMITTALS

.1 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include data as follows:

.1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.

.2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.5 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Construction requirements: in accordance with Section 01 35 31 – LEED Requirements.

.3 Verification: contractor's verification in accordance with Section 01 35 31 – LEED Requirements

1.6 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.7 WARRANTY

.1 Contractor hereby warrants that packaged rooftop refrigeration compressors will function and operate for 60 months.

Part 2 Products

2.1 GENERAL

.1 Roof mounted, self-contained single zone unit with DX refrigeration and bear label of CSA.

.2 Units to consist of cabinet and frame, supply fan, packaged controls, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, motorized return damper, gravity relief damper.

.3 Prefabricated roof curb to conform to requirements of National Roofing Contractors Association (NRCA), minimum height 450 mm.

.4 Conform to ANSI/ARI 210/240, ANSI Z21.47 and UL 1995/CAN/CSA No. 236- M90.

2.2 CABINET

.1 Cabinets: weatherproofing tested and certified to AGA rain test standards.

.2 Framing and supports: minimum 2 mm thick welded steel, galvanized after manufacture, with full perimeter base rail.

.3 Outer casing: weather tight galvanized steel with baked enamel finish.

.4 Access: hinged doors with gasket seals and tool-less access fasteners.

.5 Insulation: neoprene coated glass fiber on surfaces where conditioned air is handled, minimum 25 mm thick, 32 kg/m^3density.

2.3 FANS

.1 Centrifugal, forward curved impellers, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley. Fan and motor assembly shall be isolated from the unit with rubber isolators, and mounted on slide-out base.

2.4 AIR FILTERS

.1 50 mm thick, minimum MERV 7 efficiency, pleated.

.2 To meet NFPA 90A, air filter requirements, type Class 1.

2.5 MIXED AIR DAMPER SECTION (ECONOMIZER)

.1 Motorized outside air and return air dampers with spring return actuators and control package to automatically vary outside air quantity. Outside air damper shall be normally closed and return air damper normally open.

.1 Tight fitting opposed blade dampers with neoprene or suitable gaskets, synthetic bushings and 1% maximum leakage.

.2 Damper operators: weather-proof if located outside unit, and suitable for use in minus 25 degrees C environment.

.2 Direct drive power exhaust fan complete with low leakage gravity backdraft damper and weather hood.

2.6 REFRIGERATION

.1 Conform to CSA B52 and ANSI/UL 1995 requirements.

.2 Compressor/Condenser Section:

.1 Hermetic compressor(s), vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch and crankcase heater. Two independent refrigeration circuits, equally split in 50% capacity increments.

.2 Fan: propeller type with single piece spun venturi outlets and zinc plated guards. Motor: sequenced for head pressure control.

.3 Electrical system: complete with operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof disconnect.

.4 Include refrigerant piping with automatic hot gas bypass, sight glass, filter/drier/strainer and valves.

.5 Condenser: Micro-channelled with aluminium tubes and aluminium fins.

.6 Capacity reduction: compressor staging.

.7 Refrigerant: R-410a.

.3 Evaporator:

.1 Rated to ANSI/ARI 210/240.

.2 Thermostatic expansion valve.

.3 Coil: staggered seamless copper tubes expanded into aluminum fins.

.4 Corrosion resistant construction, slide out design, internally sloped to avoid standing water. Conforms to ASHRAE 62.1-2007.

2.7 CONTROLS

.1 Terminal block for interface with EMCS to permit following control functions: unit start/stop, compressor staging, economizer/mixed air damper control. Include adjustable low ambient compressor lockout.

.2 Provide freeze-protection on evaporator coil.

.3 Single Zone Cooling Control:

.1 Zone sensor to activate cooling relay in control circuit cycling compressors. Provide safeties and pressure controls. Condenser fans to operate in sequence.

.4 Mixed Air Single Zone Unit:

.1 Motorized outside, return and gravity relief dampers with spring return actuators and control package to automatically vary outside quantity. Outside air and exhaust air dampers, normally closed.

.2 Tight fitting opposed blade dampers with neoprene or silicone gaskets, synthetic bushings and 2% maximum leakage.

.3 Damper operation: low voltage, spring return actuator with gear train sealed in oil and heater for operation under minus 18 degrees C. Controlled from EMCS via a 2 – 10 VDC input signal. Adjustable auxiliary end-switch to energize/de-energize the power exhaust fan.

.4 Potentiometer on outside air actuator for adjustment of minimum outside airflow rate.

.5 Scheduled minimum outside airflow rate above DX cooling changeover set point.

2.8 CAPACITY

.1 As scheduled.

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 INSTALLATION

.1 Install as per manufacturers' instructions on roof curbs provided by manufacturer.

.2 Manufacturer to certify installation, supervise start-up and commission unit.

3.3 FIELD QUALITY CONTROL

.1 Performance Verification:

.2 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.

.3 Verify accessibility, cleanability, drainage of drain pans for coils, humidifiers.

.4 Performance Verification:

.1 Rooftop Air Handling Units:

.1 Set outside air and return air dampers for minimum outside air.

.2 Check for smooth, vibration less correct rotation of supply fan impeller.

.3 Measure supply fan capacity.

.4 Adjust impeller speed as necessary and repeat measurement of fan capacity.

.5 Set outside air and return air dampers for the % of outside air required by design and repeat measurements of fan capacity.

.6 OAD: verify for proper stroking, interlock with RAD.

.7 Measure DBT, WBT of SA, RA, EA.

.8 Measure air cooled condenser discharge DBT.

.9 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.

.10 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.

.11 Verify operating control strategies.

.12 Check capacity of heating unit.

.13 Measure DX refrigeration system performance.

.14 Refer to other sections of these specifications for PV procedures for other components.

.2 Start-Up:

.1 General: in accordance with manufacturer's instructions.

.3 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.

.4 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

.5 Commissioning Reports:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

3.4 CLEANING

.1 Perform cleaning operations as specified in Section 01 74 11 – Cleaning, and in accordance with manufacturer's recommendations.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA B52, Mechanical Refrigeration Code.

.2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.

.2 Environment Canada, (EC)/Environmental Protection Services (EPS)

.1 EPS 1/RA/2 Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

.2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.

1.3 ADDITIONAL SUBMITTALS

.1 Shop drawing submissions shall include the following additional information:

.1 Indicate major components and accessories including sound power levels of units.

.2 Type of refrigerant used.

.3 Accessories.

1.4 WARRANTY

.1 Provide 5-year warranty including material and labour on compressors.

Part 2 Products

2.1 WALL MOUNTED AIR CONDITIONING UNIT

.1 Split direct-expansion cooling system, with indoor evaporator unit and remote condensing unit.

.2 Refrigerant: R-410A.

.3 Indoor Evaporator Unit:

.1 Heavy duty ABS plastic cabinet, with separate back plate designed for wall mounting.

.2 Cooling coil with aluminum fins and copper tubes.

.3 Three-speed direct drive fan with DC motor.

.4 Return air inlet with washable filter.

.5 Air diffusion system with manually adjustable louvers and motorized vane.

.6 Condensate drain pump.

.7 Factory assembled, wired, and tested.

.4 Outdoor Condensing Unit:

.1 Steel cabinet with acrylic paint finish.

.2 Condenser coil with aluminum fins and copper tubes.

.3 Direct drive fan with DC motor.

.4 Inverter controlled hermetic scroll compressor.

.5 Integral high pressure and overcurrent protection.

.6 Minimum power factor of 0.98.

.7 Rated for operation to minus 40 degrees C outdoor ambient.

.5 Controls:

.1 Microprocessor-based.

.2 Remote panel complete with liquid crystal display for current room temperature, set point, and system input adjustments.

.3 Capable of automatic restart when power is restored after interruption.

.4 Provides system error diagnostic and operation data.

.5 Remote on/off control capability.

.6 DDC interface controller for monitoring and control from building EMCS, complete with the following I/O points:

.1 Inputs:

.1 On/off (binary).

.2 Temperature set point (analog, 0-10Vdc).

.3 Operating mode (analog, 0-10Vdc).

.4 Fan speed (analog, 0-10Vdc).

.2 Outputs:

.1 On/off (binary).

.2 Fault (binary).

.3 Compressor on/off (binary).

.4 Operating mode (binary).

.6 Features and Performance:

.1 As scheduled. Scheduled characteristics govern where they conflict with the general descriptions herein.

Part 3 Execution

3.1 GENERAL

.1 Manufacturer to certify installation.

.2 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.

.3 Install air conditioning system in accordance with manufacturer's installation instructions.

.4 Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

3.2 ELECTRICAL WIRING

.1 Install electrical devices furnished by manufacturer but not specified to be factory mounted, in accordance with requirements of Division 26.

.2 Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

3.3 PIPING CONNECTIONS

.1 Install and connect devices furnished by manufacturer but not specified to be factory mounted.

.2 Connect refrigeration piping and condensate drain to the evaporator unit. Pitch and trap drain in accordance with manufacturer's instructions and prevailing codes/regulations.

.3 Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

3.4 CONTROLS

.1 Install control devices furnished by manufacturer but not specified to be factory mounted.

.2 Furnish copy of manufacturer's controls connection diagram submittal to the electrical contractor.

.3 All control wiring to be run in conduit.

.4 Provide services of manufacturer's field representative to set and adjust equipment for operation as specified.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC

1.2 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

.2 Hydronic Institute of Boiler and Radiator Manufacturers (IBR)

1.3 SUBMITTALS

.1 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate:

.1 Equipment, capacity, piping, and connections.

.2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

.3 Special enclosures.

1.4 CLOSEOUT SUBMITTALS

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

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 Waste Management and Disposal:

.1 Construction Waste Management and Disposal: in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 FINNED TUBE RADIATION

.1 Heating elements: seamless copper tubing with 1.2 mm minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, suitable for sweat fittings. Tube diameter, fin size and spacing as scheduled.

.2 Element hangers: ball bearings or plastic lined cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm centres maximum.

.3 Standard enclosures: 1.6 mm thick steel complete with components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners as indicated. Provide full length channel and sealer strip at top of wall edge. Height as scheduled. Joints and filler pieces flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Provide access doors for vents. Finish cabinet with factory applied powder coat or baked enamel finish.

.4 Special enclosures: as indicated.

.5 Dimensions for enclosures: measure site conditions. Do not scale from drawing.

.6 Provide for noiseless expansion of components.

.7 Expansion compensators: by manufacturer, as recommended to suit design and site conditions.

.8 Capacity and configuration: as scheduled.

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 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Install in accordance with piping layout and reviewed shop drawings.

.3 Provide for pipe movement during normal operation.

.4 Maintain sufficient clearance to permit performance of service maintenance.

.5 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.

.6 Valves:

.1 Locate in crawlspace.

.2 Refer to details for valve requirements and piping details.

.7 Venting:

.1 Install automatic air vent on continuous finned tube radiation.

.8 Clean finned tubes and comb straight.

.9 Install flexible expansion compensators as recommended by manufacturer.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 11 – Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC

1.2 REFERENCES

.1 Deutsches Institut für Normung (DIN)

.1 DIN 14037 EN - Ceiling-mounted radiant panels supplied with water at a temperature below 120C - Part 1: Technical specifications and requirements

1.3 SUBMITTALS

.1 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.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate:

.1 Equipment, capacity, piping, and connections.

.2 Dimensions, internal and external construction details, recommended method of installation.

.3 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

1.4 CLOSEOUT SUBMITTALS

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

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 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 CAPACITY

.1 As scheduled.

2.2 LINEAR RADIANT CEILING PANELS

.1 Radiant ceiling panels:

.1 Radiant linear ceiling panels for mounting in ceiling.

.2 Extruded aluminum plank, minimum 1.2 mm thick with linear pattern on face.

.3 Exposed surfaces shall be powder coated with high emissivity finish.

.4 Aluminum heat sinks on panel back. Copper tubing complete with high-conductivity heat transfer paste shall be installed in serpentine pattern on the panel back.

.5 Panels shall be suitable for installation within lay-in tile ceiling grid frame.

.6 Panel capacity shall be tested and certified in accordance with DIN 14037.

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 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Install in accordance with piping layout and approve shop drawings.

.3 Provide for expansion using loops following installation instructions.

.4 Maintain sufficient clearance to permit performance of service maintenance.

.5 Insulate back panel with 50mm fibreglass batt insulation laid on back of panel.

.6 Valves:

.1 Install isolating ball valves on inlet and calibrated balancing valves on outlet of each unit.

3.3 CLEANING

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

.2 Remove all visible dirt from panel face.

.3 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 RELATED REQUIREMENTS

.1 Refer to the following sections for specifications necessary to complete the work specified in this Division

.1 Section 23 05 00 - Common Work Results for HVAC

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.2 No. 130-03, Requirements for Electrical Resistance Heating Cables and Heating Device Sets.

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

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 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.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for heating cable in accordance with Section 01 78 00 - Closeout Submittals.

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 Waste Management and Disposal:

.1 Construction Waste Management and Disposal: in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Heating cables: to CAN/CSA C22.2 No. 130-03.

2.2 DOMESTIC/LABORATORY HOT WATER TEMPERATURE MAINTENANCE CABLES

.1 Thermoplastic insulated copper conductors with conductive, self-regulating polymer core. Outer jacket complete with tinned copper stranded braid.

.2 Designed to maintain domestic hot water lines at minimum of 52 deg C when insulated with 25mm of fibreglass insulation, with hot water supply temperature of 60 deg C.

.3 Electrical characteristics compatible with power supply under Division 26.

2.3 HEAT TRACE CABLES FOR FREEZE PROTECTION

.1 Thermoplastic insulated copper conductors with conductive, self-regulating polymer core. Outer jacket complete with tinned copper stranded braid.

.2 Designed to maintain plumbing and drain lines at minimum above freezing when insulated with 25mm of fibreglass insulation, subjected to outdoor temperatures of minus 27 deg C.

.3 Electrical characteristics compatible with power supply under Division 26.

2.4 ACCESSORIES

.1 Heat resistant plastic or metal straps for holding the cable in place on the pipe.

.2 Splice and termination kits specific to the system.

2.5 CONTROLS

.1 Temperature maintenance:

.1 Strap-on type sensor located near end of each run of pipe, connected to adjustable thermostat.

.2 Freeze-protection:

.1 Adjustable thermostat with ambient temperature sensor designed to turn heat trace system on when outdoor temperature is below setpoint.

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 INSTALLATION

.1 Install cables in accordance with manufacturer's instructions. Follow manufacturer specific details at fittings, valves and other changes in pipe condition or configuration.

.2 Make power and control connections.

.3 All lines that are heat traced shall be insulated.

3.3 APPLICATION

.1 Domestic/laboratory hot water temperature maintenance cable:

.1 Apply to entire length of lines.

.2 Heat trace cables for freeze protection:

.1 Apply to drain lines from equipment located outside building envelope, to point 1000 mm inside building.

3.4 FIELD QUALITY CONTROL

.1 Tests:

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Test lines before and after installation. Repair or replace defective lines or devices prior to insulating.

3.5 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 GENERAL

.1 The following sequences shall be controlled through the EMCS, unless otherwise approved by the Departmental Representative.

.2 Provide all points required to execute the sequences specified, operate the equipment safely, for protection and alarms when failures occur, indicate system performance, assist in problem diagnosis, and for good energy management.

.3 Provide alarms with logic, auto adjustment, automatic seasonal override and time delays required to eliminate false alarms.

.4 PID control shall be available for all control loops, and implemented where appropriate, unless it can be demonstrated that PI control will provide stable and satisfactory control for the specific application.

.5 All control loop design, scheduling and sequencing shall be reviewed and approved by Departmental Representative prior to implementation.

1.2 REFERENCES

.1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.

.1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.3 SYSTEM CONTROL SEQUENCES – GENERAL

.1 Present sequences of operation for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.

.2 The following sequences outline the system requirements. Also refer to mechanical equipment specifications and schedules.

.3 Provide all controls required for complete working systems including features specified. Include devices and points as required to allow sequence of operation to be achieved as specified, even if not explicitly included in points list.

.4 Ensure all controls are compatible, including those provided by others. Show the detailed interfaces on the control shop drawings (i.e. packaged equipment wiring diagrams).

.5 All set points shown are suggested initial values only, to be adjusted as required during commissioning.

.6 All set points shall be user-adjustable at the operator workstation. Restrict set point adjustment by user access level (lowest access level = no adjustment, highest access level = all set points can be adjusted). Confirm set point adjustment access level restrictions with Departmental Representative. Allow for 3 user access levels.

.7 Abbreviations:

AHU	- air handling unit	HWR	- hot water return
AI	- analog input	HWS	- hot water supply
AO	- analog output	LPS	- low pressure steam
CAV	- constant air volume	MA	- mixed air
CCV	- cooling control valve	OA	- outside air
CSR*	- current sensing relay	OAT	- OA temperature
CWR	- chilled water return	OWS	- operator workstation (system terminal)
CWS	- chilled water supply	PRV	- pressure reducing valve
DI	- digital input	RA	- return air
DO	- digital output	RF	- return fan
DX	- direct expansion	RH	- relative humidity
EA	- exhaust air	SA	- supply air
EMCS	- Energy Monitoring and Control System	SF	- supply fan
		SP	- static pressure
EF	- exhaust fan	TD	- time delay
HCV	- heating control valve	VAV	- variable air volume
HGR	- hot glycol return	VFD	- variable frequency drive
HGS	- hot glycol supply		

* Or CT (current transducer) as appropriate to application.

.8 All sequences shall provide for safe and effective start and stop routines, including:

.1 TD on fan shutdown with electric heating coils

.2 ramp starts

.3 dampers on exhaust fans and 100% OA air handling units 100% open before fan start

.4 interlocks with TD as appropriate to suit transient conditions.

.9 Provide airflow proving switches on air handling systems to enable normal control sequences.

.10 Monitor all motor driven equipment for status using current sensing relays, unless current variation is insufficient, where other means approved by the Departmental Representative shall be employed.

.11 Design all systems required to activate on fire alarm for fail safe operation, such that loss of signal from the fire alarm interconnection shall initiate sequence.

.12 Accuracy to be ±0.5℃ for all temperature controls. Control space temperature ±1℃, and space humidity ±5% RH, unless otherwise specified.

.13 Temperature reset sequences shall be designed such that they are stable and minimize overshoot and hunting. Loops shall be self-tuning and provide the operator with the ability to fine tune their operation.

.14 Sequences shall utilize common outside air sensor and common outside air humidity sensor as required to achieve control functions, unless otherwise specified.

.15 Monitor position of shut-off/isolation dampers using end switch independent of the actuator and report to the EMCS.

1.4 EMCS SOFTWARE APPLICATION – GENERAL

.1 Implement following control strategies and techniques within EMCS software developed for all systems controlled by EMCS controllers, unless otherwise specified. Control set points shall be as described in individual system sequences of operation specified in this section. They shall be obtained and/or adjusted at the OWS.

.2 Minimum OA control (systems with OA flow measuring stations) – maintain minimum OA flow rate measured directly by airflow measuring station located in OA intake duct. If SA temperature falls more than 2ºC below set point, minimum OA shall be reduced to provide largest minimum OA possible while SA temperature set point is maintained. Initiate alarm at OWS.

.3 Supply air volume control (variable volume systems) – modulate SF speed to maintain SA duct static pressure set point, subject to duct high limit static pressure set point.

.4 Return/exhaust air volume control (variable volume systems) – modulate RF/EF speed to maintain RA/EA duct static pressure set point, subject to duct low limit duct static pressure set point.

.5 Building pressure relief dampers shall be controlled from space static pressure referenced to outdoors.

.6 Supply air temperature control – modulate, when applicable, OA and RA dampers, heating and cooling equipment in sequence to maintain SA temperature set point. SA temperature control shall interact with minimum OA control and system shall revert to minimum OA flow rate on signal from comparative enthalpy economizer changeover controls specified in individual sequences of operation in this section. SA temperature set point shall be automatically reset where noted in individual sequences of operation in this section.

.7 Ramp functions – apply where control loops are subject to rapid load changes (i.e. SF volume control on system start-up, OA damper control on system start-up, MA and discharge air temperature control when systems are manually switched to 100% OA mode of operation, etc.). Ramp functions shall be implemented to prevent system overshoot, cycling and nuisance tripping of low limit protection devices.

.8 Reset Schedules – where control loops have reset schedules associated with them (i.e. HWS temperature reset based on OAT), high and low temperature alarm indication shall also be on sliding schedule. For example, if alarm limits are set at ±2ºC from set point, alarm will be generated only if the sensed temperature is above or below present set point by 2ºC (i.e. if present set point is 85ºC then alarm limits are 83ºC and 87ºC). Indication available to operator shall include low end point of reset schedule, high end point of reset schedule, present set point, present high and low alarm limits, and sensed temperatures.

.9 Alarms shall be inhibited from reporting when the associated HVAC system is normally inactive (either seasonally, or on a time basis); e.g. supply air temperature outside normal limits when unit is shut down at night.

.10 Provide the ability to disable and/or limit the range of manual set point adjustment of zone temperature sensors. Confirm adjustment ranges with Departmental Representative during commissioning.

.11 Allow for mapping and display of 6 BACnet objects from each piece of equipment connected to the EMCS network via a BACnet interface. Points shall be confirmed with Departmental Representative during review of preliminary shop drawing submittal.

1.5 FAN SYSTEM CONTROLS – GENERAL

.1 Following control sequences shall apply to all supply fan systems whether specifically noted in sequence of operation or not.

.2 Provide interlocks to ensure system controls energize and associated RFs and/or EFs run when associated SFs run.

.3 Provide interlocks to ensure auxiliary equipment such as humidifiers, humidifier valves, OA dampers, relief air dampers, etc., are shut off and/or closed when supply fan is off.

.4 Where steam, hot water or glycol heating coils are utilized, a coil discharge air temperature controller shall modulate media flow through coil when supply fan is off in order to prevent overheating/overcooling condition within system plenum and/or ductwork.

.5 Where hot water or glycol heating coils have coil circulating pumps and 3-way valves associated with them, provide interlocks to ensure that circulating pump shall run automatically when OAT is below 12.8 deg C.

.6 Provide all fan systems that introduce OA with low limit control in discharge air to shut down supply fan and alarm on the EMCS when discharge air temperature drops below 5 deg C. Locate low limit in manner that shall protect heating and cooling coils, and not be subject to nuisance tripping. Low limit shall be manual reset and hard-wired to fan starter or VFD.

.7 Where relief air dampers are not directly ducted to supply/return fans, provide modulating back-draft temperature controller to prevent back-draft condition from occurring.

.8 On systems with duct static pressure control of fan speed, static pressure sensor shall be located at the end of the longest duct run. Confirm with Departmental Representative prior to installation. Provide second independent static pressure sensor located in supply fan discharge or exhaust/return fan inlet to function as high limit and override control of fan volume device to prevent over-pressurization of system.

.9 On 100% OA systems provide end switch on OA damper to ensure OA damper is fully open prior to starting fan. End switch shall be independent of damper actuator, and shall prove damper is open, not actuator stroke.

.10 On exhaust systems provide end switch on EA damper to ensure EA damper is fully open prior to starting fan, unless otherwise specified. End switch shall be independent of damper actuator, and shall prove damper is open, not actuator stroke.

1.6 ALARMS

.1 Selectable as to local (at the problem), panel (at the control panel), remote (elsewhere on site), off site (contact monitored at off site location) or any combination of these. "Local" is required only when the equipment is remote from the panel, or specifically indicated.

.2 Capable of individually being disabled.

.3 Silence audible easily.

.4 Audible alarm of subsequent alarms.

.5 Annunciation where effective.

.6 Audible to be distinct from fire alarm and other alarms.

.7 Provide alarming as follows:

.1 Analog inputs: Provide user-adjustable alarm limits above and below set point. Alarm when set point is out of range.

.2 Binary inputs: Provide alarming of all binary inputs when current state is opposite to desired state. Desired state for alarming shall be user selectable.

.3 Seasonal and scheduled states (i.e. different alarm set points for winter/summer modes, day/night, etc.).

.4 Complete with time delays or sliding scales where appropriate and as directed by Departmental Representative.

.8 Off-site alarm notification:

.1 Make provision for off-site notification via EMCS pager system.

.2 Each alarm shall have a unique descriptor. Confirm descriptor format with Departmental Representative during commissioning.

.9 Non-critical alarms: similar to critical, but different visual signal without audible.

PART 2 Products

.1 Not Used.

PART 3 Sequences of Operation

3.1 GENERAL

.1 For additional information, refer to manufacturer's descriptions.

3.2 POWER FAILURE

.1 Provide safe automatic re-start following power failure and clearing of fire alarms, except where manual reset is requested by the Departmental Representative or safe re-start is not possible. Include a time delay to limit starts on multiple 'bumps' and to avoid simultaneous re-start with lights, etc. Control system shall be designed to discriminate between loss of power and other failures to ensure proper restart of systems. Provide relays, sensor and other devices as necessary to positively determine status of normal and emergency power to allow the EMCS to react appropriately. Provide details with shop drawing submission and review with Departmental Representative.

3.3 THIRD FLOOR AIR HANDLING SYSTEM

.1 Equipment:

.1 Modular air handling unit (AH-LAB-L3) complete with OA inlet plenum with isolation damper, summer pre-filters, glycol heat reclaim coil, glycol heating coil, winter pre-filters, humidifier steam distribution grid, chilled water cooling coil, 2 x 2 variable speed supply fan array with individual airflow measuring stations, final filters, and SA discharge plenum.

.2 Variable speed heating coil pump (P-4).

.3 Variable speed cooling coil pump (P-6).

.4 Humidifier H-2 complete with packaged controller.

.5 VFDs for supply fans and coil pumps (x6).

.6 Duct mounted main SA riser isolation damper.

.7 Duct mounted lab air handling systems emergency bypass damper.

.8 Duct mounted carbon filter module (FP-5-1).

.9 Supply air CAV and VAV terminal units with hot water reheat coils.

.2 Points list:

.1 Analog inputs:

.1 Outdoor air temperature (common).
.2 Outdoor air relative humidity (common).
.3 Outdoor air CO_2 concentration (common).
.4 Heat reclaim coil leaving air temperature.
.5 Heating coil leaving air temperature.
.6 Supply air temperature (downstream of supply fans).
.7 Supply air relative humidity (between supply fans and final filters).
.8 Heating coil entering glycol temperature.
.9 Heating coil leaving glycol temperature.
.10 Cooling coil entering chilled water temperature.
.11 Cooling coil leaving chilled water temperature.
.12 Pre-filter pressure drop (x2).
.13 Final filter pressure drop.
.14 Carbon filter module pre-filter pressure drop.
.15 Carbon filter module carbon filter pressure drop.
.16 Carbon filter module entering air ozone concentration.
.17 Carbon filter module leaving air ozone concentration.
.18 Supply fan VFD speed (x4).
.19 Supply fan airflow measuring station (x4).
.20 SA duct SP.
.21 SA discharge plenum SP.
.22 Third floor lab exhaust temperature (x2).
.23 Third floor lab exhaust relative humidity (x2).

.2 Analog outputs:

.1 Heat reclaim demand.
.2 HCV control.
.3 CCV control.
.4 Lab exhaust air RH demand.
.5 Supply air RH high limit.
.6 Supply fan VFD control signal (x4).
.7 Heating coil pump VFD control signal.
.8 Cooling coil pump VFD control signal.

.3 Binary inputs:

.1 Supply fan status (x4).
.2 Heating coil pump status.
.3 Cooling coil pump status.
.4 Supply fan VFD trouble/fault (x4).
.5 Heating coil pump VFD trouble/fault.
.6 Cooling coil pump VFD trouble/fault.

.7 Supply air temperature low limit switch.

.8 OA inlet plenum isolation damper end switch position.

.9 SA discharge plenum isolation damper end switch position.

.10 Lab air handling systems emergency bypass damper end switch position (common).

.11 Humidifier fault.

.4 Binary outputs:

.1 Supply fan VFD start/stop (x4).

.2 Heating coil pump VFD start/stop.

.3 Cooling coil pump VFD start/stop.

.4 Humidifier enable/disable.

.5 OA inlet plenum isolation damper open/close.

.6 SA discharge plenum isolation damper open/close.

.7 Lab air handling systems emergency bypass damper open/close (common).

.3 Control Loops:

.1 Time:

.1 AH-LAB-L3 runs continuously.

.2 Heat Reclaim:

.1 Refer to 3.5 Lab Exhaust Heat Reclaim System.

.3 Heating:

.1 SA temperature set point = 12.8ºC.

.2 Modulate HCV and heating coil pump speed in sequence with the heat reclaim system as follows to maintain SA temperature set point:

.1 Maximize heat reclaim. Modulate the lab exhaust heat reclaim coil control valve in conjunction with AH-LAB-L4 such that the SA temperature of each AHU does not exceed their respective set points.

.2 Start/run coil pump at minimum speed.

.3 Modulate HCV from 0 – 100%.

.4 Modulate pump speed from minimum to maximum.

.4 Cooling:

.1 Modulate CCV and cooling coil pump in sequence as follows to maintain the SA temperature set point:

.1 Start/run coil pump at minimum speed.

.2 Modulate CCV from 0 – 100%.

.3 Modulate pump speed from minimum to maximum.

.5 Damper Control:

.1 Isolation dampers:

.1 OA inlet damper is 100% open when any SF is running and fully closed when all SFs are not running.

.2 SA discharge damper is 100% open when any SF is running and fully closed when all SFs are not running.

.3 Lab air handling systems emergency bypass damper – provide a manual software open/close switch on the system graphic display to control the damper. Alarm if the damper is set in the 'open' position and both AH-LAB-L3 and AH-LAB-L4 are running.

.6 Humidification:

.1 Provide an analog signal, based on inputs from sensors in both third floor lab exhaust main ducts, to the packaged humidifier controls that shall modulate the steam control valve to maintain EA RH set point of 30%.

.2 Limit supply air RH to 90% maximum. Refer to 'Safeties'.

.7 Fans:

.1 Occupied:

.1 AH-LAB-L3 runs continuously.

.2 Modulate SF speed and number of active SFs to minimize SF energy consumption while maintaining SA duct SP set point, subject to SA discharge plenum high limit SP = +1,000 Pa. Reset set point so that at least one SA CAV or VAV terminal unit damper is approximately 95% open, and all associated SA terminal unit airflow rates are at or above minimum airflow set point. Confirm initial duct SP set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 All active fans shall operate at the same speed.

.8 CAV and VAV SA terminal units: refer to 3.10 Room Control for sequences.

.9 Power Failure:

.1 System transitions to operation on emergency power, except for cooling coil pump and humidifier. Follow normal start-up of these items upon restoration of power.

.10 Fire Alarm:

.1 System shuts down when smoke is detected in SA.

.11 Additional Interlocks:

.1 AH-LAB-L3 with EF-LAB-1/2/3:

.1 EFs start before SFs.

.2 On AH-LAB-L3 failure EF-LAB-1/2/3 continues to run to maintain safe fume hood and biological safety cabinet conditions.

.2 SFs with end switch positions of corresponding isolation dampers.

.3 Controls with supply airflow.

.12 Safeties:

.1 Low SA temperature: alarm and shut down SFs. Provide manual reset low limit switch set at 5°C and hardwired to SF VFDs.

.2 High SA RH: alarm and reduce RH set point until SA humidity drops below alarm threshold. If this is ineffective then disable humidifier.

.3 High SA discharge plenum SP: alarm and shut down SFs. Hardwire to SF VFDs.

.4 Program SF VFDs to prevent operation above maximum rated fan speed.

.5 Program pump VFDs to prevent operation above rated motor speed.

.6 Program all VFDs to prevent operation above maximum rated motor capacity.

3.4 FOURTH FLOOR AIR HANDLING SYSTEM

.1 Equipment:

.1 Modular air handling unit (AH-LAB-L4) complete with OA inlet plenum with isolation damper, summer pre-filters, glycol heat reclaim coil, glycol heating coil, winter pre-filters, humidifier steam distribution grid, chilled water cooling coil, 2 x 2 variable speed supply fan array with individual airflow measuring stations, final filters, and SA discharge plenum.

.2 Variable speed heating coil pump (P-5).

.3 Variable speed cooling coil pump (P-7).

.4 Humidifier H-1 complete with packaged controller.

.5 VFDs for supply fans and coil pumps (x6).

.6 Duct mounted main SA riser isolation damper.

.7 Duct mounted lab air handling systems emergency bypass damper.

.8 Supply air CAV and VAV terminal units with hot water reheat coils.

.2 Points list:

.1 Analog inputs:

.1 Outdoor air temperature (common).

.2 Outdoor air relative humidity (common).

.3 Outdoor air CO_2 concentration (common).

.4 Heat reclaim coil leaving air temperature.

.5 Heating coil leaving air temperature.

.6 Supply air temperature (downstream of supply fans).

.7 Supply air relative humidity (between supply fans and final filters).

.8 Heating coil entering glycol temperature.

.9 Heating coil leaving glycol temperature.

.10 Cooling coil entering chilled water temperature.

.11 Cooling coil leaving chilled water temperature.

.12 Pre-filter pressure drop (x2).

.13 Final filter pressure drop.

.14 Supply fan VFD speed (x4).
.15 Supply fan airflow measuring station (x4).
.16 SA duct SP.
.17 SA discharge plenum SP.
.18 Fourth floor lab exhaust temperature.
.19 Fourth floor lab exhaust relative humidity.

.2 Analog outputs:
.1 Heat reclaim demand.
.2 HCV control.
.3 CCV control.
.4 Lab exhaust air RH demand.
.5 Supply air RH high limit.
.6 Supply fan VFD control signal (x4).
.7 Heating coil pump VFD control signal.
.8 Cooling coil pump VFD control signal.

.3 Binary inputs:
.1 Supply fan status (x4).
.2 Heating coil pump status.
.3 Cooling coil pump status.
.4 Supply fan VFD trouble/fault (x4).
.5 Heating coil pump VFD trouble/fault.
.6 Cooling coil pump VFD trouble/fault.
.7 Supply air temperature low limit switch.
.8 OA inlet plenum isolation damper end switch position.
.9 SA discharge plenum isolation damper end switch position.
.10 Lab air handling systems emergency bypass damper end switch position (common).
.11 Humidifier fault.

.4 Binary outputs:
.1 Supply fan VFD start/stop (x4).
.2 Heating coil pump VFD start/stop.
.3 Cooling coil pump VFD start/stop.
.4 Humidifier enable/disable.
.5 OA inlet plenum isolation damper open/close.
.6 SA discharge plenum isolation damper open/close.
.7 Lab air handling systems emergency bypass damper open/close (common).

.3 Control Loops:

.1 Time:

.1 AH-LAB-L4 runs continuously.

.2 Heat Reclaim:

.1 Refer to 3.5 Lab Exhaust Heat Reclaim System.

.3 Heating:

.1 SA temperature set point = 12.8ºC.

.2 Modulate HCV and heating coil pump speed in sequence with the heat reclaim system as follows to maintain SA temperature set point:

.1 Maximize heat reclaim. Modulate the lab exhaust heat reclaim coil control valve in conjunction with AH-LAB-L3 such that the SA temperature of each AHU does not exceed their respective set points.

.2 Start/run coil pump at minimum speed.

.3 Modulate HCV from 0 – 100%.

.4 Modulate pump speed from minimum to maximum.

.4 Cooling:

.1 SA temperature set point = 12.8ºC.

.2 Modulate CCV and cooling coil pump in sequence as follows to maintain the SA temperature set point:

.1 Start/run coil pump at minimum speed.

.2 Modulate CCV from 0 – 100%.

.3 Modulate pump speed from minimum to maximum.

.5 Damper Control:

.1 Isolation dampers:

.1 OA inlet damper is 100% open when any SF is running and fully closed when all SFs are not running.

.2 SA discharge damper is 100% open when any SF is running and fully closed when all SFs are not running.

.3 Lab air handling systems emergency bypass damper – provide a manual software open/close switch on the system graphic display to control the damper. Alarm if the damper is set in the ‘open’ position and both AH-LAB-L3 and AH-LAB-L4 are running.

.6 Humidification:

.1 Provide an analog signal, based on inputs from sensor in fourth floor lab exhaust main duct, to the packaged humidifier controls that shall modulate the steam control valve to maintain EA RH set point of 30%.

.2 Limit supply air RH to 90% maximum. Refer to ‘Safeties’.

.7 Fans:

.1 Occupied:

.1 AH-LAB-L4 runs continuously.

.2 Modulate SF speed and number of active SFs to minimize SF energy consumption while maintaining SA duct SP set point, subject to SA discharge plenum high limit SP = +1,000 Pa. Reset set point so that at least one SA CAV or VAV terminal unit damper is approximately 95% open, and all associated SA terminal unit airflow rates are at or above minimum airflow set point. Confirm initial duct SP set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 All active fans shall operate at the same speed.

.8 CAV and VAV SA terminal units: refer to 3.10 Room Control for sequences.

.9 Power Failure:

.1 System transitions to operation on emergency power, except for cooling coil pump and humidifier. Follow normal start-up of these items upon restoration of power.

.10 Fire Alarm:

.1 System shuts down when smoke is detected in SA.

.11 Additional Interlocks:

.1 AH-LAB-L4 with EF-LAB-1/2/3:

.1 EFs start before SFs.

.2 On AH-LAB-L4 failure EF-LAB-1/2/3 continues to run to maintain safe fume hood and biological safety cabinet conditions.

.2 SFs with end switch positions of corresponding isolation dampers.

.3 Controls with supply airflow.

.12 Safeties:

.1 Low SA temperature: alarm and shut down SFs. Provide manual reset low limit switch set at 5°C and hardwired to SF VFDs.

.2 High SA RH: alarm and reduce RH set point until SA humidity drops below alarm threshold. If this is ineffective then disable humidifier.

.3 High SA discharge plenum SP: alarm and shut down SFs. Hardwire to SF VFDs.

.4 Program SF VFDs to prevent operation above maximum rated fan speed.

.5 Program pump VFDs to prevent operation above rated motor speed.

.6 Program all VFDs to prevent operation above maximum rated motor capacity.

3.5 LABORATORY EXHAUST HEAT RECLAIM SYSTEM

.1 Equipment:

- .1 Exhaust heat reclaim air handling unit module (GRC-6-1) complete with inlet plenum, filters, glycol heat reclaim coil, and outlet plenum.
- .2 AH-LAB-L3 OA glycol heat reclaim coil.
- .3 AH-LAB-L4 OA glycol heat reclaim coil.
- .4 Glycol heat reclaim pump (P-3).
- .5 Packaged heat transfer fluid make-up system (GFP-2).
- .6 Duct mounted GRC-6-1 EA inlet and outlet isolation dampers.
- .7 Duct mounted GRC-6-1 EA bypass damper.

.2 Points list:

- .1 Analog inputs:
  - .1 Outdoor air temperature (common).
  - .2 Lab exhaust heat reclaim coil entering air temperature.
  - .3 Lab exhaust heat reclaim coil entering air relative humidity.
  - .4 Lab exhaust heat reclaim coil leaving air temperature.
  - .5 Lab exhaust heat reclaim coil leaving air relative humidity.
  - .6 Lab exhaust heat reclaim coil entering glycol temperature.
  - .7 Lab exhaust heat reclaim coil leaving glycol temperature.
  - .8 AH-LAB-L3 heat reclaim coil leaving glycol temperature.
  - .9 AH-LAB-L4 heat reclaim coil leaving glycol temperature.
  - .10 AH-LAB-L3 supply air temperature.
  - .11 AH-LAB-L3 supply air temperature set point.
  - .12 AH-LAB-L3 heat reclaim demand signal.
  - .13 AH-LAB-L4 supply air temperature.
  - .14 AH-LAB-L4 supply air temperature set point.
  - .15 AH-LAB-L4 heat reclaim demand signal.
  - .16 Lab exhaust heat reclaim coil pressure drop.
  - .17 Lab exhaust air filter pressure drop.
  - .18 Laboratory exhaust airflow rate (common).
- .2 Analog outputs:
  - .1 Heat reclaim control valve.
- .3 Binary inputs:
  - .1 Heat reclaim pump status.
  - .2 EA inlet duct isolation damper end switch position.
  - .3 EA outlet duct isolation damper end switch position.
  - .4 Bypass damper end switch position.
  - .5 Heat transfer fluid make-up system storage tank ‘low level’.

.4 Binary outputs:

.1 Heat reclaim pump start/stop.

.2 EA inlet duct isolation damper open/close.

.3 EA outlet duct isolation damper open/close.

.4 EA bypass duct isolation damper open/close.

.3 Control Loops:

.1 Heat Reclaim:

.1 Heat reclaim system shall run continuously unless OA conditions are suitable for free cooling.

.2 When OAT < SA temperature set point modulate the lab exhaust heat reclaim coil control valve based on feedback from AH-LAB-L3 and AH-LAB-L4 SA heat reclaim demand signals such that the SA temperatures of AH-LAB-L3 and AH-LAB-L4 do not exceed their respective set points, subject to a lab exhaust reclaim coil entering glycol low limit temperature set point of -1 ºC (to prevent frost formation).

.3 Heat reclaim system shall shut down when OAT $\geq$ (SA temperature set point - adjustable offset) and OAT $\leq$ (EA temperature entering lab exhaust reclaim coil + adjustable offset).

.4 Heat reclaim system shall operate at full capacity when OAT > (EA temperature entering general exhaust reclaim coil + adjustable offset).

.5 When the heat reclaim 3-way control valve is in the full bypass position the heat reclaim pump shall shut off.

.2 Damper Control:

.1 Isolation dampers: EA inlet and outlet duct dampers are normally 100% open.

.2 Bypass damper: EA bypass damper is 100% open when the heat reclaim system pump is off and fully closed when the pump is running.

.3 Provide manual software ‘maintenance mode’ switch on the system graphic display to open the bypass damper (first) and then close both isolation dampers.

.4 Both isolation dampers or the bypass damper shall be 100% open whenever the lab exhaust system is in operation.

.3 Power Failure:

.1 Pump shuts down. Follow normal start-up on restoration of power.

.4 Fire Alarm:

.1 System continues to operate.

.5 Additional Interlocks:

.1 Operation of either AH-LAB-L3 or AH-LAB-L4.

.6 Safeties:

.1 Low lab exhaust reclaim coil entering glycol temperature: alarm and modulate control valve to bypass OA heat reclaim coils until exhaust heat reclaim coil leaving air temperature rises above alarm threshold. If this is ineffective then shut down reclaim pump.

.2 High lab exhaust heat reclaim coil air pressure drop (coil ice formation): alarm and modulate control valve to bypass OA heat reclaim coils until exhaust heat reclaim coil pressure drop falls below alarm threshold. If this is ineffective then shut down reclaim pump. Lab exhaust heat reclaim coil pressure drop alarm threshold shall be 50 Pa above a wet coil condition relative to the current lab exhaust airflow rate. Determine coil pressure drop with exhaust heat reclaim air handling unit module supplier.

.7 Additional Alarms:

.1 Heat transfer fluid make-up system storage tank ‘low level’.

3.6 LABORATORY COMBINED EXHAUST SYSTEM

.1 Equipment:

.1 Laboratory exhaust fan system (EF-LAB-1/2/3) consisting of an EA inlet plenum with three variable speed exhaust fans, each complete with an airflow measuring station, isolation damper, and bypass damper.

.2 VFDs for exhaust fans (x3).

.3 Duct mounted laboratory exhaust airflow measuring station.

.4 Chemical fume hoods. Refer to drawings for quantities.

.5 Face velocity control system for each chemical fume hood.

.6 Biological safety cabinets (Class II, Type A2); each complete with outputs for monitoring on/off status, normal airflow, reduced airflow (night mode), and alarm. Refer to drawings for quantities.

.7 General exhaust VAV terminal units. Refer to drawings for quantities.

.8 Chemical fume hood exhaust VAV terminal units. Refer to drawings for quantities.

.9 Biological safety cabinet exhaust VAV terminal units. Refer to drawings for quantities.

.2 Points list:

.1 Analog inputs:

.1 Exhaust fan VFD speed (x3).

.2 Exhaust fan airflow measuring station (x3).

.3 Exhaust duct SP (x2).

.4 EA inlet plenum SP.

.5 Laboratory exhaust airflow rate (common).

.2 Analog outputs:

.1 Exhaust fan VFD control signal (x3).

.2 Bypass damper control signal (x3).

.3 Binary inputs:

.1 Exhaust fan status (x3).

.2 Exhaust fan VFD trouble/fault (x3).

.3 EF isolation damper end switch position (x3).

.4 EF bypass damper end switch position (x3).

.5 Chemical fume hood face velocity monitor alarm (multiple, refer to drawings).

.6 Biological safety cabinet alarm (multiple, refer to drawings).

.4 Binary outputs:

.1 Exhaust fan VFD start/stop (x3).

.2 EF isolation damper open/close (x3).

.3 Control Loops:

.1 Time: EF-LAB-1/2/3 system runs continuously.

.2 Damper Control:

.1 Isolation dampers: damper is 100% open when the corresponding EF is running and fully closed when the EF is off. Damper operation shall be simultaneous with fan during start-up and shut down to minimize backflow through fan. Confirm proposed start-up and shutdown sequences with fan manufacturer prior to preliminary shop drawing submittal.

.2 Bypass dampers:

.1 Bypass damper modulates to maintain the corresponding EF design airflow rate (14,160 L/s).

.2 Bypass damper is fully closed when the corresponding EF is off.

.3 Confirm recommended actuator speed(s) with fan manufacturer prior to preliminary shop drawing submittal.

.3 Fans:

.1 EF-LAB-1/2/3: fans shall operate in a lead/lag/standby arrangement complete with automatic alternation to exercise the standby unit. On failure of the lead or lag fan the standby fan shall automatically start.

.2 Lag fan on/off staging shall be based on the position of the bypass dampers on active fans.

.1 When only the lead fan is running the lag fan shall be switched on when the lead fan bypass damper is 90% open.

.2 With lead and lag fans running the lag fan shall be switched off when the average bypass damper position is 10% open.

.3 Confirm proposed sequences with fan manufacturer

.3 Modulate fan speed to maintain exhaust duct SP set point, subject to EA inlet plenum SP high limit = 1,500 Pa (absolute value). Confirm initial duct SP set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.4 All active fans shall operate at the same speed.

.5 Provide two SP sensors for reliability. Locate sensors in main EA duct, upstream of laboratory exhaust heat reclaim air handling unit inlet isolation damper.

.4 Exhaust VAV Terminal Unit Control:

.1 General exhaust: modulate damper to maintain airflow rate set point based on input from the associated lab zone controller.

.2 Fume hood exhaust: modulate damper to maintain airflow rate set point based on input from the associated face velocity controller.

.3 Biological safety cabinet (BSC) exhaust: modulate damper to maintain airflow rate set point based on input (off/normal airflow/reduced airflow) from the associated BSC controls.

.4 Refer also to 3.10 Room Control for integration with other terminal units.

.5 Power Failure:

.1 System transitions to operation on emergency power.

.6 Fire Alarm:

.1 System continues to operate.

.7 Additional Interlocks:

.1 EFs with corresponding isolation damper end switch position.

.2 100% open position of either of the following conditions:

.1 Laboratory exhaust heat reclaim air handling unit inlet and outlet isolation dampers.

.2 Laboratory exhaust heat reclaim air handling unit bypass damper.

.8 Safeties:

.1 Low fume hood face velocity: local and OWS alarms, and modulate associated VAV terminal unit damper open until airflow rate rises above alarm threshold.

.2 Low biological safety cabinet airflow: alarm and modulate associated VAV terminal unit open until airflow rate rises above alarm threshold.

.3 High EA inlet plenum SP: alarm and shut down EFs. Hardwire to EF VFDs.

.4 Program EF VFDs to prevent operation above maximum rated fan speed.

.5 Program EF VFDs to prevent operation above maximum rated motor capacity.

3.7 BIOLOGICAL SAFETY CABINET EXHAUST SYSTEM

.1 Equipment:

.1 Biological safety cabinet (BSC) exhaust fan system (EF-BSC-1/2) consisting of an EA inlet plenum with two variable speed exhaust fans, each complete with an airflow measuring station, isolation damper, and bypass damper.

.2 VFDs for exhaust fans (x2).

.3 Duct mounted BSC system third floor exhaust airflow measuring station.

.4 Duct mounted BSC system fourth floor exhaust airflow measuring station.

.5 Biological safety cabinets (Class II, Type B2); each complete with outputs for monitoring on/off status, normal airflow, reduced airflow (night mode), and alarm. Refer to drawings for quantities.

.6 Biological safety cabinet exhaust VAV terminal units. Refer to drawings for quantities.

.2 Points list:

.1 Analog inputs:

.1 Exhaust fan VFD speed (x2).

.2 Exhaust fan airflow measuring station (x2).

.3 Exhaust duct SP (x2).

.4 EA inlet plenum SP.

.5 BSC system third floor exhaust airflow rate.

.6 BSC system fourth floor exhaust airflow rate.

.2 Analog outputs:

.1 Exhaust fan VFD control signal (x2).

.2 Bypass damper control signal (x2).

.3 Binary inputs:

.1 Exhaust fan status (x2).

.2 Exhaust fan VFD trouble/fault (x2).

.3 EF isolation damper end switch position (x2).

.4 EF bypass damper end switch position (x2).

.5 Biological safety cabinet alarm (multiple, refer to drawings).

.4 Binary outputs:

.1 Exhaust fan VFD start/stop (x2).

.2 EF isolation damper open/close (x2).

.3 Control Loops:

.1 Time: EF-BSC-1/2 system runs provided at least one associated biological safety cabinet is switched ‘on’.

.2 Damper Control:

.1 Isolation dampers: damper is 100% open when the corresponding EF is running and fully closed when the EF is off. Damper operation shall be simultaneous with fan during start-up and shut down to minimize backflow through fan. Confirm proposed start-up and shutdown sequences with fan manufacturer prior to preliminary shop drawing submittal.

.2 Bypass dampers:

.1 Bypass damper modulates to maintain the corresponding EF design airflow rate (2,266 L/s).

.2 Bypass damper is fully closed when the corresponding EF is off.

.3 Confirm recommended actuator speed(s) with fan manufacturer prior to preliminary shop drawing submittal.

.3 Fans:

.1 EF-BSC-1/2: both fans shall operate continuously with excess bypass air for quick response to failure of a single fan. On failure of one fan the other fan shall continue to operate and the associated bypass damper shall modulate towards closed to compensate.

.2 Modulate fan speed to maintain exhaust duct SP set point, subject to EA inlet plenum SP high limit = 1,500 Pa (absolute value). Confirm initial duct SP set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 All active fans shall operate at the same speed.

.4 Provide two SP sensors for reliability. Locate sensors in main BSC EA duct on the third floor.

.4 Exhaust VAV Terminal Unit Control:

.1 Biological safety cabinet (BSC) exhaust: modulate damper to maintain airflow rate set point based on input (off/normal airflow/reduced airflow) from the associated BSC controls.

.2 Refer also to 3.10 Room Control for integration with other terminal units.

.5 Power Failure:

.1 System transitions to operation on emergency power.

.6 Fire Alarm:

.1 System continues to operate.

.7 Additional Interlocks:

.1 EFs with corresponding isolation damper end switch position.

.8 Safeties:

.1 Low biological safety cabinet airflow: alarm and modulate associated VAV terminal unit open until airflow rate rises above alarm threshold.

.2 High EA inlet plenum SP: alarm and shut down EFs. Hardwire to EF VFDs.

.3 Program EF VFDs to prevent operation above maximum rated fan speed.

.4 Program EF VFDs to prevent operation above maximum rated motor capacity.

3.8 HYDROFLOURIC ACID FUME HOOD EXHAUST SYSTEM

.1 Equipment:

.1 Hydroflouric acid fume hood exhaust fans (EF-HFA-1/2),

.2 VFDs for exhaust fans (x2).

.3 Duct mounted EF isolation dampers.

.4 Hydroflouric acid (‘acid digestion’) fume hoods. Refer to drawings for quantities.

.5 Face velocity control system for each hydroflouric acid fume hood.

.6 Fume hood exhaust CAV terminal units. Refer to drawings for quantities.

.2 Points list:

.1 Analog inputs:

.1 Exhaust fan VFD speed (x2).

.2 Exhaust duct SP (x2).

.3 Rooftop EA inlet header duct SP.

.2 Analog outputs:

.1 Exhaust fan VFD control signal (x2).

.3 Binary inputs:

.1 Exhaust fan status (x2).

.2 Exhaust fan VFD trouble/fault (x2).

.3 EF isolation damper end switch position (x2).

.4 Hydroflouric acid fume hood face velocity monitor alarm (multiple, refer to drawings).

.4 Binary outputs:

.1 Exhaust fan VFD start/stop (x2).

.2 EF isolation damper open/close (x2).

.3 Control Loops:

.1 Time: EF-HFA-1/2 system runs continuously.

.2 Damper Control:

.1 Isolation dampers: damper is 100% open when the corresponding EF is running and fully closed when EF is off. Damper operation shall be simultaneous with fan during start-up and shut down to minimize backflow through fan. Confirm proposed start-up and shutdown sequences with fan manufacturer prior to preliminary shop drawing submittal.

.2 Confirm recommended actuator speed with fan manufacturer prior to preliminary shop drawing submittal.

.3 Fans:

.1 EF-HFA-1A/B: fans shall operate in a lead/standby arrangement complete with automatic alternation to exercise the standby unit. On failure of the lead fan the standby fan shall automatically start.

.2 Modulate fan speed to maintain exhaust duct SP set point, subject to rooftop EA inlet header duct SP high limit = 1,000 Pa (absolute value). Confirm initial duct SP set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 Provide two SP sensors for reliability. Locate sensors in main EA duct in Room A430.

.4 Exhaust CAV Terminal Unit Control:

.1 Fume hood exhaust: modulate damper to maintain airflow rate set point based on input from the associated face velocity controller.

.2 Refer also to 3.10 Room Control for integration with other terminal units.

.5 Power Failure:

.1 System transitions to operation on emergency power.

.6 Fire Alarm:

.1 System continues to operate.

.7 Additional Interlocks:

.1 EFs with corresponding isolation damper end switch position.

.8 Safeties:

.1 Low fume hood face velocity: local and OWS alarms, and modulate associated VAV terminal unit damper open until airflow rate rises above alarm threshold.

.2 High EA inlet header duct SP: alarm and shut down EFs. Hardwire to EF VFDs.

.3 Program EF VFDs to prevent operation above maximum rated fan speed.

.4 Program EF VFDs to prevent operation above maximum rated motor capacity.

3.9 RADIOISOTOPE FUME HOOD EXHAUST SYSTEM

.1 Equipment:

.1 Radioisotope fume hood exhaust fan system (EF-RAD-1/2) consisting of an EA inlet plenum with two variable speed exhaust fans, each complete with an airflow measuring station and isolation damper.

.2 VFDs for exhaust fans (x2).

.3 Radioisotope fume hood. Refer to drawings for quantities.

.4 Face velocity control system for each radioisotope fume hood.

.5 Fume hood exhaust CAV terminal units. Refer to drawings for quantities.

.2 Points list:

.1 Analog inputs:

.1 Exhaust fan VFD speed (x2).

.2 Exhaust duct SP (x2).

.3 EA inlet plenum SP.

.2 Analog outputs:

.1 Exhaust fan VFD control signal (x2).

.3 Binary inputs:

.1 Exhaust fan status (x2).

.2 Exhaust fan VFD trouble/fault (x2).

.3 EF isolation damper end switch position (x2).

.4 Radioisotope fume hood face velocity monitor alarm (multiple, refer to drawings).

.4 Binary outputs:

.1 Exhaust fan VFD start/stop (x2).

.2 EF isolation damper open/close (x2).

.3 Control Loops:

.1 Time: EF-RAD-1/2 system runs continuously.

.2 Damper Control:

.1 Isolation dampers: damper is 100% open when the corresponding EF is running and fully closed when EF is off. Damper operation shall be simultaneous with fan during start-up and shut down to minimize backflow through fan. Confirm proposed start-up and shutdown sequences with fan manufacturer prior to preliminary shop drawing submittal.

.2 Confirm recommended actuator speed with fan manufacturer prior to preliminary shop drawing submittal.

.3 Fans:

.1 EF-RAD-1A/B: fans shall operate in a lead/standby arrangement complete with automatic alternation to exercise the standby unit. On failure of the lead fan the standby fan shall automatically start.

.2 Modulate fan speed to maintain exhaust duct SP set point, subject to EA inlet plenum SP high limit = 1,000 Pa (absolute value). Confirm initial duct SP set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 Provide two SP sensors for reliability. Locate sensors in main EA duct in Room A341C.

.4 Exhaust CAV Terminal Unit Control:

.1 Fume hood exhaust: modulate damper to maintain airflow rate set point based on input from the associated face velocity controller.

.2 Refer also to 3.10 Room Control for integration with other terminal units.

.5 Power Failure:

.1 System transitions to operation on emergency power.

.6 Fire Alarm:

.1 System continues to operate.

.7 Additional Interlocks:

.1 EFs with corresponding isolation damper end switch position.

.8 Safeties:

.1 Low fume hood face velocity: local and OWS alarms, and modulate associated VAV terminal unit damper open until airflow rate rises above alarm threshold.

.2 High EA inlet header duct SP: alarm and shut down EFs. Hardwire to EF VFDs.

.3 Program EF VFDs to prevent operation above maximum rated fan speed.

.4 Program EF VFDs to prevent operation above maximum rated motor capacity.

3.10 AIR HANDLING SYSTEMS ROOM CONTROL

.1 Equipment:

.1 Supply air CAV terminal units with hot water reheat coils (close coupled and duct mounted).

.2 Supply air VAV terminal units with hot water reheat coils (close coupled and duct mounted).

.3 General exhaust VAV terminal units.

.4 Chemical fume hood exhaust VAV terminal units.

.5 Hydroflouric acid fume hood exhaust CAV terminal units.

.6 Radioisotope fume hood exhaust CAV terminal units.

.7 Biological safety cabinet exhaust VAV terminal units.

.8 Canopy /extraction arm exhaust CAV (open/closed) terminal units.

.9 Hot water finned tube radiation.

.10 Hot water radiant ceiling panels.

.11 Laminar flow diffusers (SA-E, SA-L) complete with HEPA filter status monitor.

Refer to drawings for quantities.

.2 Points list:

.1 Analog inputs:

.1 Room temperatures (multiple zones - refer to drawings).

.2 Room temperature set point to SA CAV and VAV terminal unit controllers (multiple zones - refer to drawings).

.3 Airflow rate – SA and EA CAV and VAV terminal unit controllers (multiple zones - refer to drawings).

.2 Analog outputs:

.1 HCV controls (multiple zones - refer to drawings).

.2 Damper control - SA and EA CAV and VAV terminal unit controllers (multiple zones - refer to drawings).

.3 Binary inputs:

.1 Laminar flow diffuser HEPA filter status (multiple zones - refer to drawings).

.4 Binary outputs:

.1 Canopy /extraction arm exhaust CAV terminal unit on/off (multiple zones - refer to drawings).

.3 Control Loops:

.1 Time:

.1 Schedule for 7-day, plus annual holidays, for occupied/unoccupied periods, unless otherwise indicated. Allow for separate schedules for each air handling system. Obtain schedules from Departmental Representative prior to final commissioning.

.2 Special event overrides, in advance.

.3 Occupancy mode changeover (occupied/unoccupied): provide both fixed and optimized start times.

.4 Control algorithms begin as appropriate to mode of operation.

.5 Occupied Mode:

.1 Normal sequences.

.2 Maintain room heating temperature set point of 21ºC and room cooling temperature set point of 23ºC, unless otherwise indicated.

.6 Unoccupied Mode:

.1 Reset room heating temperature set point to 18ºC and room cooling temperature set point to 29ºC, unless otherwise indicated.

.2 For each air handling system provide timed occupancy 'override' mode (initially set for 3 hours operation) selectable at the OWS, that will set all system zones into "occupied" mode for the set time period. Override mode shall clear after time elapses, or is overridden by next scheduled event.

.3 For each air handling system provide timed occupancy 'override' mode (initially set for 3 hours operation) selectable by the occupants via an override button located on each wall mounted temperature sensor, that will set all system zones into "occupied" mode for the set time period. Override mode shall clear after time elapses, or is overridden by next scheduled event.

.2 Room Control Types:

.1 General:

.1 Provide at least one laboratory pressure controller for each room such that failure of a single controller shall not affect more than a single room.

.2 Supply air CAV terminal unit with hot water reheat coil:

.1 Modulate SA CAV damper to maintain airflow rate set point based on occupied/unoccupied mode..

.2 Modulate reheat HCV to maintain room heating temperature set point.

.3 Supply air VAV terminal unit with hot water reheat coil:

.1 Modulate SA VAV damper to maintain room cooling temperature set point, subject to occupied/unoccupied mode minimum airflow rates.

.2 When damper is at minimum position modulate HCV to maintain room heating temperature set point.

.4 Supply air VAV terminal unit with hot water reheat coil and radiation:

.1 Modulate SA VAV damper to maintain room cooling temperature set point, subject to occupied/unoccupied mode minimum airflow rates.

.2 When damper is at minimum position modulate reheat and radiation HCVs in sequence to maintain room heating temperature set point. Radiation HCV(s) shall modulate up to 100% prior to modulating the reheat HCV.

.5 Supply air VAV terminal unit with hot water reheat coil, chemical fume hood and/or biological safety cabinet (BSC) exhaust VAV terminal units(s):

.1 Modulate SA VAV damper to maintain minimum airflow rate based on occupied/unoccupied mode.

.2 Reset SA VAV minimum airflow rate to maintain offset between SA flow rate and total EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.3 Modulate reheat HCV to maintain room heating temperature set point.

.4 Fume hood exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated face velocity controller(s). Refer also to 3.6 Laboratory Combined Exhaust System.

.5 BSC exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated BSC controls. Refer also to 3.6 Laboratory Combined Exhaust System and 3.7 Biological Safety Cabinet Exhaust System.

.6 Supply air VAV terminal unit with hot water reheat coil, chemical fume hood and/or biological safety cabinet (BSC) exhaust VAV terminal units, and canopy /extraction exhaust CAV terminal unit(s):

.1 Modulate SA VAV damper to maintain minimum airflow rate based on occupied/unoccupied mode.

.2 Reset SA VAV minimum airflow rate to maintain offset between SA flow rate and total EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.3 Modulate reheat HCV to maintain room heating temperature set point.

.4 Fume hood exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated face velocity controller(s). Refer also to 3.6 Laboratory Combined Exhaust System.

.5 BSC exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated BSC controls. Refer also to 3.6 Laboratory Combined Exhaust System and 3.7 Biological Safety Cabinet Exhaust System.

.6 Canopy /extraction arm exhaust CAV damper(s) modulate to maintain airflow rate set point. Provide manual on/off switch with pilot lights for each CAV terminal unit. Confirm location in preliminary shop drawing submittal.

.7 Supply air VAV terminal unit with hot water reheat coil, radiation, chemical fume hood and/or biological safety cabinet (BSC) exhaust VAV terminal units, and canopy /extraction exhaust CAV terminal unit(s):

.1 Modulate SA VAV damper to maintain minimum airflow rate based on occupied/unoccupied mode.

.2 Reset SA VAV minimum airflow rate to maintain offset between SA flow rate and total EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.3 Modulate reheat and radiation HCVs in sequence to maintain room heating temperature set point. Radiation HCV(s) shall modulate up to 100% prior to modulating the reheat HCV.

.4 Fume hood exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated face velocity controller(s). Refer also to 3.6 Laboratory Combined Exhaust System.

.5 BSC exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated BSC controls. Refer also to 3.6 Laboratory Combined Exhaust System and 3.7 Biological Safety Cabinet Exhaust System.

.6 Canopy /extraction arm exhaust CAV damper(s) modulate to maintain airflow rate set point. Provide manual on/off switch with pilot lights for each CAV terminal unit. Confirm location in preliminary shop drawing submittal.

.8 Supply air VAV terminal unit with hot water reheat coil, canopy /extraction exhaust CAV terminal unit(s), and general exhaust air VAV terminal unit:

.1 Modulate SA VAV damper to maintain room cooling temperature set point, subject to occupied/unoccupied mode minimum airflow rates.

.2 Reset SA VAV minimum airflow rate to maintain offset between SA flow rate and total canopy /extraction EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.3 When SA VAV damper is at minimum position modulate HCV to maintain room heating temperature set point.

.4 Canopy /extraction arm exhaust CAV damper(s) modulate to maintain airflow rate set point. Provide manual on/off switch with pilot lights for each CAV terminal unit. Confirm location in preliminary shop drawing submittal.

.5 Modulate general exhaust VAV damper to maintain offset between SA flow rate and total EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.9 Supply air VAV terminal unit with hot water reheat coil, chemical fume hood and/or biological safety cabinet (BSC) exhaust VAV terminal units, canopy /extraction exhaust CAV terminal unit(s), and general exhaust air VAV terminal unit:

.1 Modulate SA VAV damper to maintain room cooling temperature set point, subject to occupied/unoccupied mode minimum airflow rates.

.2 Reset SA VAV minimum airflow rate to maintain offset between SA flow rate and total chemical fume hood, BSC, and canopy /extraction EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.3 When SA VAV damper is at minimum position modulate HCV to maintain room heating temperature set point.

.4 Fume hood exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated face velocity controller(s). Refer also to 3.6 Laboratory Combined Exhaust System.

.5 BSC exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated BSC controls. Refer also to 3.6 Laboratory Combined Exhaust System and 3.7 Biological Safety Cabinet Exhaust System.

.6 Canopy /extraction arm exhaust CAV damper(s) modulate to maintain airflow rate set point. Provide manual on/off switch with pilot lights for each CAV terminal unit. Confirm location in preliminary shop drawing submittal.

.7 Modulate general exhaust VAV damper to maintain offset between SA flow rate and total EA flow rate. Allow for a fixed (L/s) or percentage offset. Allow for adjustment during commissioning.

.10 Supply air CAV terminal unit with hot water reheat coil and hydroflouric acid fume hood exhaust CAV terminal unit(s):

.1 Modulate SA CAV damper to maintain airflow rate set point.

.2 Modulate reheat HCV to maintain room heating temperature set point.

.3 Hydroflouric acid fume hood exhaust VAV damper(s) modulate to maintain airflow rate set point based on input from the associated face velocity controller(s). Refer also to 3.8 Hydroflouric Acid Fume Hood Exhaust System.

.11 Supply air CAV terminal unit with hot water reheat coil and radioisotope fume hood exhaust CAV terminal units:

.1 Modulate SA CAV damper to maintain airflow rate set point.

.2 Modulate reheat HCV to maintain room heating temperature set point.

.3 Radioisotope fume hood exhaust VAV dampers modulate to maintain airflow rate set point based on input from the associated face velocity controller. Refer also to 3.9 Radioisotope Fume Hood Exhaust System.

.12 Exhaust air CAV terminal unit:

.1 Modulate EA CAV damper to maintain airflow rate set point.

.13 Hot water radiation:

.1 Modulate HCV to maintain room heating temperature set point.

.14 Miscellaneous:

.1 Provide 24 VAC power to laminar flow diffuser HEPA filter pressure drop monitors.

.2 Connect to dry contacts on each laminar flow diffuser HEPA filter pressure drop monitor and alarm when 'loaded' condition occurs.

.15 Power Failure:

.1 Systems continue to operate on UPS power.

.16 Fire Alarm:

.1 Room controls continue to operate.

3.11 SPLIT TYPE ROOM AIR CONDITIONERS

.1 Equipment:

.1 Split-type DX room air conditioning systems (x14), each complete with indoor evaporator unit, outdoor air-cooled condensing unit with variable speed compressor, packaged controls, wall-mounted controller, and EMCS I/O interface controller.

.2 Points list:

.1 Analog inputs:

.1 Room temperature (x14).

.2 Analog outputs:

.1 Room temperature set point (x14).

.2 Operating mode (x14).

.3 Fan speed (x14).

.3 Binary inputs:

.1 On/off (x14).

.2 System fault (x14).

.3 Compressor on/off (x14).

.4 Operating mode (x14).

.4 Binary outputs:

.1 On/off (x14).

.3 Control Loops:

.1 Time: air conditioning systems run continuously.

.2 Room control:

.1 Evaporator fan cycles on demand for cooling.

.2 Cooling capacity is modulated by packaged controls to maintain room temperature set point = 24ºC.

.3 Power Failure:

.1 Systems transition to operation on emergency power.

.4 Fire Alarm:

.1 Systems continue to operate.

.4 Miscellaneous:

.1 Install and wire all controls supplied with air conditioning systems.

.2 Confirm wall-mounted controller locations with Departmental representative during review of preliminary shop drawings.

3.12 PENTHOUSE UPS ROOM HVAC

.1 Equipment:

.1 Packaged DX cooling rooftop unit (RTU-1), complete with supply fan, filters, fully modulating air side economizer with motorized mixed air dampers, and power exhaust fan.

.2 Points list:

.1 Analog inputs:

.1 Outdoor air temperature (common).

.2 Outdoor air relative humidity (common).

.3 Supply air temperature (downstream of supply fan).

.4 Room temperature.

.5 Room relative humidity.

.6 SF current.

.7 Filter pressure drop.

.2 Analog outputs:

.1 Mixed air damper control.

.3 Binary inputs:

.1 Supply air temperature low limit switch.

.4 Binary outputs:

.1 RTU-1 on/off.

.2 1st stage DX cooling control.

.3 2nd stage DX cooling control.

.3 Control Loops:

.1 Time: RTU-1 runs continuously.

.2 Cooling:

.1 Modulate free cooling and mechanical cooling in sequence to maintain the room temperature set point = 24ºC.

.2 Free cooling - modulate MA dampers up to 100% OA flow rate, subject minimum SA temperature = 13ºC and scheduled minimum OA flow rate.

.3 When the OA temperature exceeds 15ºC, or if DX cooling is operating, the MA dampers shall revert to minimum OA flow rate.

.4 Mechanical cooling – cycle 2 cooling stages in sequence. Confirm minimum run time and inter-stage time delays with equipment manufacturer.

.3 Mixed Air Damper Control:

.1 OA damper remains at minimum position until such time as increased OA flow rate is required for free cooling. During free cooling MA dampers modulate up to 100% OA flow rate, subject to OA minimum flow rate.

.2 RA damper position inversely tracks OA damper position.

.3 OA damper is closed and RA damper is 100% open during unoccupied mode.

.4 Fans:

.1 SF runs continuously.

.2 Power exhaust shall be enabled/disabled from adjustable OA damper actuator end switch.

.5 Power Failure:

.1 System transitions to operation on emergency power.

.6 Fire Alarm:

.1 System continues to operate.

.7 Interlocks:

.1 Controls with supply airflow.

.2 Safeties:

.1 Low SA temperature: alarm and shut down SF. Provide manual reset low limit switch set at 5 ºC.

.4 Miscellaneous:

.1 Install and wire all controls supplied with rooftop unit.

3.13 PENTHOUSE ELECTRICAL ROOM HVAC

.1 Equipment:

.1 Packaged DX cooling rooftop unit (RTU-2), complete with supply fan, filters, fully modulating air side economizer with motorized mixed air dampers, and power exhaust fan.

.2 Hot water unit heater.

.2 Points list:

.1 Analog inputs:

.1 Outdoor air temperature (common).

.2 Outdoor air relative humidity (common).

.3 Supply air temperature (downstream of supply fan).

.4 Room temperature.

.5 Room relative humidity.

.6 SF current.

.7 Filter pressure drop.

.2 Analog outputs:

.1 Mixed air damper control.

.2 HCV control.

.3 Binary inputs:

.1 Supply air temperature low limit switch.

.4 Binary outputs:

.1 RTU-2 on/off.

.2 1st stage DX cooling.

.3 2nd stage DX cooling.

.3 Control Loops:

.1 Time: RTU-2 runs continuously.

.2 Heating:

.1 Cycle unit heater fan and modulate HCV to maintain room temperature set point = 18ºC.

.3 Cooling:

.1 Modulate free cooling and mechanical cooling in sequence to maintain room temperature set point = 29ºC.

.2 Free cooling - modulate MA dampers up to 100% OA flow rate, subject minimum SA temperature = 13ºC and scheduled minimum OA flow rate.

.3 When the OA temperature exceeds 15ºC, or if DX cooling is operating, the MA dampers shall revert to minimum OA flow rate.

.4 Mechanical cooling – cycle 2 cooling stages in sequence. Confirm minimum run time and inter-stage time delays with equipment manufacturer.

.4 Mixed Air Damper Control:

.1 OA damper remains at minimum position until such time as increased OA flow rate is required for free cooling. During free cooling MA dampers modulate up to 100% OA flow rate, subject to OA minimum flow rate.

.2 RA damper position inversely tracks OA damper position.

.3 OA damper is closed and RA damper is 100% open during unoccupied mode.

.5 Fans:

.1 SF runs continuously.

.2 Power exhaust shall be enabled/disabled from adjustable OA damper actuator end switch.

.6 Power Failure:

.1 System transitions to operation on emergency power.

.7 Fire Alarm:

.1 System continues to operate.

.8 Interlocks:

.1 Controls with supply airflow.

.9 Safeties:

.1 Low SA temperature: alarm and shut down SF. Provide manual reset low limit switch set at 5°C.

.4 Miscellaneous:

.1 Install and wire all controls supplied with rooftop unit.

3.14 PENTHOUSE VENTILATION SYSTEM

.1 Equipment:

.1 Existing built-up ventilation system (AH-MECH-1) complete with supply fan, filters, steam heating coil, RA and OA dampers.

.2 Points list:

.1 Analog inputs:

.1 None.

.2 Analog outputs:

.1 None.

.3 Binary inputs:

.1 None.

.4 Binary outputs:

.1 None.

.3 Provide new RA damper and pneumatic actuator as indicated on the drawings..

.4 Remove and re-install existing heating coil steam control valve with pneumatic actuator as indicated on the drawings.

.5 Control Loops: existing control sequence to remain unchanged.

3.15 3RD AND 4TH FLOOR AHU GLYCOL HEATING COIL SYSTEM

.1 Equipment:

.1 Shell-and-tube heat exchangers (HX-1/2) with a single pair of steam control valves sized for 1/3 and 2/3 of total steam capacity respectively.

.2 Variable speed distribution pumps (P-1A/B).

.3 VFDs for pumps (x2).

.4 Flow meter.

.5 Packaged heat transfer fluid make-up system (GFP-1).

.6 Pump minimum flow rate bypass complete with modulating valve.

.2 Points list:

.1 Analog inputs:

.1 Outdoor air temperature (common).

.2 GHS temperature.

.3 GHR temperature.

.4 Pump VFD speed (x2).

.5 GHS flow rate.

.6 GHS/GHR main differential pressure.

.2 Analog outputs:

.1 Steam valve control.

.2 Pump VFD control signal (x2).

.3 Minimum flow rate bypass valve control.

.3 Binary inputs:

.1 Pump status (x2).

.2 Pump VFD trouble/fault (x2).

.3 Heat transfer fluid make-up system storage tank ‘low level’.

.4 Binary outputs:

.1 Pump VFD start/stop (x2).

.3 Control Loops:

.1 Time:

.1 Steam control valves are closed and pumps are off when OAT > (highest AHU SA temperature set point + adjustable offset).

.2 Heating:

.1 Modulate 2 steam valves (1/3 plus 2/3) in sequence to maintain GHS temperature set point.

.2 Reset HGS temperature set point from 82.2°C at -28.9°C OAT to 37.8°C at +10°C OAT.

.3 Pumps:

.1 Pumps shall operate in a lead/standby arrangement complete with automatic alternation to exercise the standby unit. On failure of the lead pump the standby pump shall automatically start.

.2 Modulate pump speed to maintain the pressure differential set point between GHS and GHR mains. Reset the set point so that the HCV of the heating coil with the greatest demand is 95% open. Allow for adjustment during TAB. Confirm initial set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 Differential pressure to be sensed between the take-offs to AH-LAB-L3 and AH-LAB-L4 heating coils.

.4 Minimum pump flow rate bypass valve:

.1 Modulate valve to maintain minimum flow rate = 1.9 L/s.

.4 Power Failure:

.1 System transitions to operation on emergency power.

.5 Fire Alarm:

.1 System continues to operate.

.6 Interlocks:

.1 Steam control valve operation with pump flow.

.7 Safeties:

.1 Program pump VFDs to prevent operation above maximum rated motor speed.

.2 Program pump VFDs to prevent operation above maximum rated motor capacity.

.8 Additional Alarms:

.1 Heat transfer fluid make-up system storage tank ‘low level’.

3.16 3RD AND 4TH FLOOR HOT WATER HEATING/REHEAT SYSTEM

.1 Equipment:

.1 Shell-and-tube heat exchangers (HX-3/4) with a single pair of steam control valves sized at 1/3 and 2/3 of total steam capacity.

.2 Variable speed distribution pumps (P-2A/B).

.3 VFDs for pumps (x2).

.4 Flow meter.

.5 Make-up water meter.

.2 Points list:

.1 Analog inputs:

.1 Outside air temperature (common).

.2 HWS temperature.

.3 HWR temperature.

.4 Pump VFD speed (x2).

.5 HWS flow rate.

.6 HWS/HWR main differential pressure.

.7 Make-up water consumption.

.2 Analog outputs:

.1 Heat exchanger steam control valve signal (2 valves).

.2 Pump VFD speed control (x2).

.3 Analog outputs:

.1 Pump VFD control signal (x2).

.4 Binary inputs:

.1 Pump status (x2).

.2 Pump VFD trouble/fault (x2).

.5 Binary outputs:

.1 Pump VFD start/stop (x2).

.3 Control Loops:

.1 Time:

.1 System runs continuously.

.2 Heating:

.1 Modulate 2 steam valves (1/3 plus 2/3) in sequence to maintain HWS temperature set point = 60.0°C.

.2 Allow for HWS temperature set point reset based on OA temperature.

.3 Pumps:

.1 Pumps shall operate in a lead/standby arrangement complete with automatic alternation to exercise the standby unit. On failure of the lead pump the standby pump shall automatically start.

.2 Modulate pump speed to maintain the pressure differential set point between HWS and HWR mains. Reset the set point so that the HCV of the heating terminal unit/reheat coil with the greatest demand is 95% open. Allow for adjustment during TAB. Confirm initial set point with Departmental Representative during shop drawing submittal based on proposed sensor location. Allow for adjustment during TAB.

.3 Differential pressure to be sensed at the take-offs to the most hydraulically remote heating terminal unit/reheat coil.

.4 Pump minimum flow rate is maintained by selected reheat coil 3-way HCVs. Refer to drawings for locations.

.4 Power Failure:

.1 System transitions to operation on emergency power.

.5 Fire Alarm:

.1 System continues to operate.

.6 Interlocks:

.1 Steam control valve operation with pump flow.

.7 Safeties:

.1 Program pump VFDs to prevent operation above maximum rated motor speed.

.2 Program pump VFDs to prevent operation above maximum rated motor capacity.

.8 Additional Alarms:

.1 Monitor and record make-up water consumption. Alarm if make-up rate or total consumption exceeds limits. Confirm limits with Departmental Representative during commissioning.

3.17 STEAM SYSTEMS

.1 Equipment:

.1 Duplex (lead/standby) condensate pump package (CRU-1) complete with integral controls.

.2 LPS pressure reducing station (PRV-1) complete with safety relief valve.

.2 Points list:

.1 Analog inputs:

.1 LPS pressure downstream of pressure reducing station.

.2 Steam safety valve vent temperature.

.2 Analog outputs: none.

.3 Binary inputs:

.1 Condensate receiver high water level.

.2 Condensate pump status (x2).

.4 Binary outputs: none.

.3 Control Loops:

.1 Pumps:

.1 Condensate pumps are controlled from integral controls.

.2 Power Failure:

.1 Condensate pump unit shuts down. Follow normal start-up on restoration of power.

.3 Fire Alarm:

.1 System continues to operate.

.4 Additional Alarms:

.1 High LPS pressure (>103 kPa).

.2 High steam safety valve vent temperature (>93 ºC).

.3 Condensate standby pump start (advisory).

.4 Condensate receiver high water level.

.5 Condensate pump cycle time exceeds 10 minutes.

3.18 REVERSE OSMOSIS WATER SYSTEM

.1 Equipment:

.1 Reverse osmosis water system complete with duplex water softener, carbon filter, packaged RO unit, storage tank, duplex distribution pumps with control panel, and UV water sterilization unit.

.2 Duplex domestic cold water booster pump complete with packaged controls.

.2 Points list:

.1 Analog inputs: none.

.2 Analog outputs: none.

.3 Binary inputs:

.1 RO unit common alarm.

.2 RO storage tank low water level alarm.

.3 Distribution pump status (x2).

.4 UV sterilizer unit ‘lamp-out’ alarm.

.5 Booster pump common alarm.

.4 Binary outputs:

.1 UV sterilizer enable/disable.

.2 Booster pump enable/disable.

.3 Control Loops

.1 Time: system operates continuously during heating season and is shut down in summer. Manual on/off control.

.2 RO Unit: operates from integral controls.

.3 Distribution pumps: operate from duplex pump control panel.

.4 UV water sterilization unit: enable when distribution pump flow is verified.

.5 Power Failure:

.1 System shuts down.

.6 Fire Alarm:

.1 System continues to operate.

.7 Interlocks:

.1 UV sterilizer lamp operation with distribution pump flow. Lamp shall be de-energized on a ‘no flow’ condition.

.8 Alarms:

.1 RO unit common alarm.

.2 RO storage tank low water level.

.3 UV sterilizer unit ‘lamp-out’.

.4 Booster pump common alarm.

.9 Miscellaneous:

.1 Install and wire all controls supplied with RO equipment.

3.19 LAB COMPRESSED GAS SYSTEMS ALARMS

.1 Equipment:

.1 Lab gas manifolds in rooms A325, A357, A424, A429, and penthouse (x2).

.2 Points list:

.1 Binary inputs:

.1 High pressure ((x6).

.2 Low pressure/changeover (x6).

.3 Alarm (x6).

.3 Alarms:

.1 High pressure.

.2 Low pressure.

.3 Alarm.

3.20 EQUIPMENT ROOM OXYGEN DEPLETION ALARMS

.1 Equipment:

.1 Wall-mounted sensors to monitor O_2 concentration in rooms A325, A340B, A346F, A357, A424, A429, and A437B. Refer to drawings for sensor locations.

.2 Points list:

.1 Binary inputs:

.1 Low O_2 concentration (x7).

.3 Alarms:

.1 Space O_2 concentration < 19.5%, warning alarm.

.2 Space O_2 concentration < 18%, critical alarm.

.3 Provide audible and visual alarm indication inside and outside of each room.

3.21 LAB EQUIPMENT ALARMS

.1 Equipment:

.1 Lab freezers complete with dry contacts for remote alarm monitoring. Refer to specification Section 11 06 00 Equipment Schedule and Drawings AQ430 to AQ433 and A4440 to AQ443 for locations and quantities.

.2 Control panels for walk-in cooler rooms A336B and A454 complete with dry contacts for remote alarm monitoring.

.2 Points list:

.1 Binary inputs:

.1 Freezer equipment alarms (one for each piece of equipment). Allow for 52 on the 3rd floor and 22 on the 4th floor.

.2 Walk-in cooler room alarms (x4).

.3 Alarms:

.1 Freezer equipment alarms.

.2 Walk-in cooler room ‘out-of-temperature limit’ alarm (x2).

.3 Walk-in cooler room ‘door ajar’ alarm (x2).

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section includes materials and installation of variable frequency drives for HVAC equipment including fans and pumps.

.2 Refer to sections beginning with 26 05 for electrical common work results.

.3 Refer to sections beginning with 25 05 for EMCS common work results.

1.2 REFERENCES

.1 Canadian Electrical Code (CEC)

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.

.3 Institute of Electrical and Electronics Engineers (IEEE)

.1 IEEE 518-2 - Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources

.2 IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.3 SUBMITTALS

.1 In accordance with Section 01 33 00 and Section 01 78 00.

.2 Submit the following additional information:

.1 Dimensions and weights of drives including enclosure.

.2 Catalogue and technical data.

.3 Control and schematic drawings indicated all external connections and devices.

.4 Instruction manuals for installation and programming, including start-up configuration data.

Part 2 Products

2.1 VARIABLE FREQUENCY DRIVES (VFD)

.1 General:

.1 Drives shall be capable of constant torque as specified and as required by the application.

.2 Selection of VFD shall be coordinated with manufacturer of the equipment and motor to be controlled to ensure compatibility and optimum performance.

.3 VFD shall be housed in NEMA 12 rated enclosure suitable to the location where it is installed. All drives located indoors shall be sprinkler proof.

.4 The enclosure and installation location shall be selected as to minimize RFI and EMI emissions.

.5 Drives shall comply with FCC and CRTC regulations with respect to emissions and radio interference.

.6 Drives shall be UL, C-UL listed and CSA approved.

.7 Drives shall include all necessary devices, relays, protective devices, wiring and programming to form a complete working system. The adjustable frequency drive shall convert three phase, 60 Hz utility power to an adjustable frequency output for speed control from 0 - 200% of base speed.

.8 The drive must be modifiable to accept standard input voltages accurately.

.9 The adjustable frequency control shall be designed specifically for variable speed fan and pump applications.

.10 All products supplied as part of drive including, but not limited to: disconnect switches, circuit breakers. Disconnect switches and motor starters shall be NEMA rated.

.2 Filters and Reactors

.1 General: The VFD shall meet with the First Environment restricted level of EN61800-3, through the use of EMI/RFI filters.

.2 Provide filters, 5% reactors and other devices required on the load side of the variable frequency drive to minimize RFI, EMI and harmonic emissions from the drive.

.3 Provide filters, reactors and other devices required on the line side of the variable frequency drive to protect the drive from interference and emissions that will compromise its operation.

.3 Basic Design:

.1 Micro processor based pulse width modulation, design employing IGBT technology to convert three-phase AC to a fixed DC voltage.

.2 A constant speed displacement power factor of 0.95 shall be maintained at all speeds and rated loads.

.3 Insulated grade bipolar transistors in the inverter section convert a fixed DC voltage to a three phase adjustable frequency output.

.4 Drive output employ a high carrier frequency to ensure quiet motor operation.

.4 System Features

.1 Drive inline/bypass/isolation contactor.

.2 Bypass overload.

.3 Three position selector switch (VFD / VFD TEST / ISOLATION)

.4 Drive input circuit breaker, lockable in the open position.

.5 Thermal overloads.

.6 Thermistor input for motor over-temperature protection.

.7 Fused control power transformer.

.8 Diode or fully-gated bridge on input.

.9 DC bus inductor on all VFD rated at 7.5 hp and larger.

.10 Auxiliary contacts as follows:

.1 Drive alarm.

.2 Drive speed.

.3 Control power on.

.4 Drive fault.

.5 Drive run.

.11 Communications to include RS232/422/485 and industry standard protocols including BACnet.

.5 Control Panel:

.1 Drive status indicators on the control panel include multi-point status and diagnostics.

.2 Adjustments accessible by means of keypad switches:

.1 Acceleration/deceleration time: Independently adjustable from approximately 2 to 300 seconds.

.2 Minimum speed/maximum speed: Can be calibrated from 0 to 120 Hz..

.3 Overload: Adjustable for any percentage of rated current up to 110% to protect motor from excess current at low speeds.

.4 Individual selectable resettable fault control: Automatic functioning of the fault counter reset can be allowed or denied for ground fault, over voltage, under voltage, over current, phase loss, overload, over temperature, external fault, and motor open fault.

.5 Auto rest time: Calibration available from 0 to 300 seconds to prevent too short a reset time from fault occurrence.

.6 Step-over frequency (2 ranges): Adjustable from 0 to 100% speed to allow for critical frequency avoidance.

.6 Additional Features (in addition to start/stop and variable speed):

.1 0-10 VDC follower capacity

.2 Current limit protection

.3 Independently adjustable acceleration/deceleration

.4 Automatic restart

.5 Over/under voltage protection

.6 Over temperature and ground fault protection

.7 Minimum 650 V rating

.8 96% efficiency

.9 Input door-interlocked disconnect switch.

.7 Quality Assurance:

.1 To improve quality and eliminate premature failures, all drives shall be pre-tested and cycled with a motor at an elevated ambient temperature.

Part 3 Execution

3.1 GENERAL

.1 Review shop drawings for the equipment to be connected to the variable frequency drive and confirm compatibility of the equipment.

.2 Coordinate installation requirements with Division 25.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's requirements.

.2 Install drives on strut or other suitable brackets on wall or free-standing in a location that minimizes the length of load side wiring for the equipment. Review with Departmental Representative prior to installation. Refer to tender Drawing E504, Detail 5, for typical installation details.

.3 Connect all control wiring and configure to achieve requirements of controls sequence of operation. Controls wiring shall be separated from power wiring by at least 600mm and shall be shielded to prevent problems resulting from interference.

.4 The manufacturer's representative shall program, start-up, commission and test the drives and shall confirm that settings have been optimized for the application.

.5 Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.

.6 Provide purpose-built variable frequency drive output cables connecting VFD to associated AC motor. Refer to Section 26 05 21 – Wires and Cables (0–1000 V).

.7 Power for all VFDs shall be fed from purpose-built drive isolation transformers. Refer to Section 26 22 14 – Drive Isolation Transformers.

3.3 TRAINING

.1 Provide minimum of 8 hours training for each type of variable frequency drive supplied under this contract. Training shall be site-specific and be focused on the particular application.

.2 Provide training materials in written and electronic format. Ensure that operating manuals and drawings are available and provided to trainees, and form part of the training materials.

.3 Training shall be focused on the application as well as the operation and maintenance of the drive.

END OF SECTION