



Department of Public Works
Infrastructure Services Division

Ghassan Korban
Commissioner of Public Works

Preston D. Cole
Director of Operations

Jeffrey S. Polenske
City Engineer

November 26, 2013

Subject: Specific Official Notice No. 157

Lincoln Avenue Garage
Modifications-Vehicle Service Bays
3921 West Lincoln Avenue
Milwaukee, Wisconsin

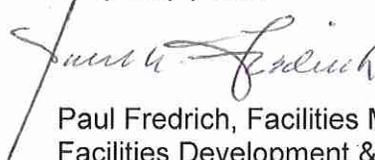
For which bid will be received on
December 10, 2013 at 10:30 A.M.

Addendum No. 1

Gentlemen:

- A. In regard to our advertisement for the Lincoln Avenue Garage, Modifications-Vehicle Service Bays, located at 3921 West Lincoln Avenue, Milwaukee, Wisconsin, this attached Addendum No. 1 is issued to modify the original documents and is hereby made part of the proposal.
- B. Each bidder shall read the entire addendum. Proposals shall include all items included in this Addendum No. 1.

Very truly yours,



Paul Fredrich, Facilities Manager
Facilities Development & Management Section



Specific Official Notice No. 157

Lincoln Avenue Garage
Modifications–Vehicle Service Bays
at 3921 West Lincoln Avenue
Milwaukee, Wisconsin

Addendum No. 1

IMMEDIATELY UPON RECEIPT OF THE ADDENDUM, PLEASE SIGN THIS RECEIPT AND FAX BACK OR EMAIL (Daniel.Pitts@Milwaukee.gov) TO DPW–FACILITIES DEVELOPMENT AND MANAGEMENT SECTION AT (414) 286-5907.

Company Name

Name

Date

ADDENDUM No. 1

November 26, 2013

Lincoln Avenue Garage
Modifications—Vehicle Service Bays
at 3921 West Lincoln Avenue
Milwaukee, Wisconsin

ON THE INVITATION TO BID (See attached):

REPLACE the bid form with the bid form attached.

ON THE DRAWINGS (See attached):

Remove and replace Drawings 10-P-02, 10-P-03, 10-E-01, 10-E-02, 10-E-03, and 10-E-04 with attached.

Add Drawing 10-H-04A (attached).

IN THE SPECIFICATIONS (Also see attached where noted):

Section 00100: INSTRUCTIONS TO BIDDERS, Page 1, Add:

Alternate No. 2:

State the Addition to the Base Bid to provide the "Gas Fired Radiant Heaters" as described in Specification Section 23 56 00 and Drawing 10-H-04A.

Section 00100: INSTRUCTIONS TO BIDDERS, Page 2, Clarification:

BASE BID EXCLUSIONS (Unchanged):

Direct Digital Controls equipment, wiring, and programming provided by Johnson Controls Inc., under a separate contract with the City.

All Electrical work is to be performed by the City with the exception of HVAC Control wiring.

Testing and balancing by others under a separate contract with the City.

Section 14 45 00, Paragraph 2.02, Revise:

- B. Rotary model MCHW418 with optional Extended Fork Kit. Two complete units required.
- C. Characteristics are to be modified to match Model MCHW418.

Section 23 05 93, Paragraph 1.01, A, Revise:

- A. The Owner will contract directly with a Test and Balance contractor to provide work described in this Section. This Contractor shall include all necessary costs associated with coordination with the Owner's Test and Balance Contractor.

Section 23 09 14, Paragraph 1.06, Add:

- H. NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages
- I. NFPA 70 National Electrical Code

Section 23 09 14, Paragraph, 2.01, M, Revise:

- M. Provide actuators located within Class1, Division2 hazardous areas in the CNG Repair Garage with housing suitable for area classification.

Section 23 09 14, Paragraph 3.01, A, Add:

Provide wiring installation within Class1 Division 2 hazardous areas in CNG Repair Garage in accordance with Code requirements for classification.

Section 23 09 15, Paragraph 3.01, Add:

- E. Alternate Bid- Radiant Heaters

Section 23 55 00, Paragraph 2.01, Add:

- R. Under the alternate bid for Low Intensity Radiant Heaters make-up air unit burner shall be three stage type with modulation control from 40% to 100% for the first stage and "on-Off" control for the second and third stages.

Section 26 51 00, Paragraph 1.01, A, 2 Revise:

- 2. Drivers for LED lamps.

Section 26 51 00, 2.01, J, 10 Revise:

- 10. 28 LEDS per module, as indicated in Fixture Schedule, 2 or 4 modules per fixture.

Section 26 51 00, Paragraph 2.01, J, add:

- 16. Suitable for installation in Class I, Division 2, Group D Hazardous Classified location.

Remove and replace Specification 23 09 93 Sequence of Operation for HVAC Controls with attached.

Add Section 23 56 00 Low Intensity Gas Fired Radiant Heaters.

(Addendum #1)

Official Notice No. 157

**LINCOLN AVENUE GARAGE MODIFICATIONS
VEHICLE SERVICE BAYS
3921 W. LINCOLN AVE
MILWAUKEE, WI**

For furnishing all material and doing all the work necessary and required for the **Lincoln Avenue Garage Modifications-Vehicle Service Bays**, all in accordance with the plans and project manual.

BID FORM:

Submit a lump sum price for the work as indicated on the drawings and specified herein, complete in every respect.

Bids will not be accepted in any form except on the bid form included with this project manual.

The contractor must recognize and abide by the right of the Owner (City of Milwaukee) to accept or reject any or all bids in the best interests of the City.

Base Bid for the Sum:

(Bid in Figures) _____ lump sum

(Bid in Words) _____ lump sum

ALTERNATE:

Each bidder shall examine the plans and project manual thoroughly to determine what extent the Alternate will affect the bid.

Alternate 1:

State the Addition to the Base Bid to provide the "Portable Vehicle Hoist" as described in Specification Section 14 45 00.

(Bid in Figures) _____ lump sum

(Bid in Words) _____ lump sum

Alternate 2:

State the Addition to the Base Bid to provide the "Gas Fired Radiant Heaters" as described in Specification Section 23 56 00 and Drawing 10-H-04A.

(Bid in Figures) _____ lump sum

(Bid in Words) _____ lump sum

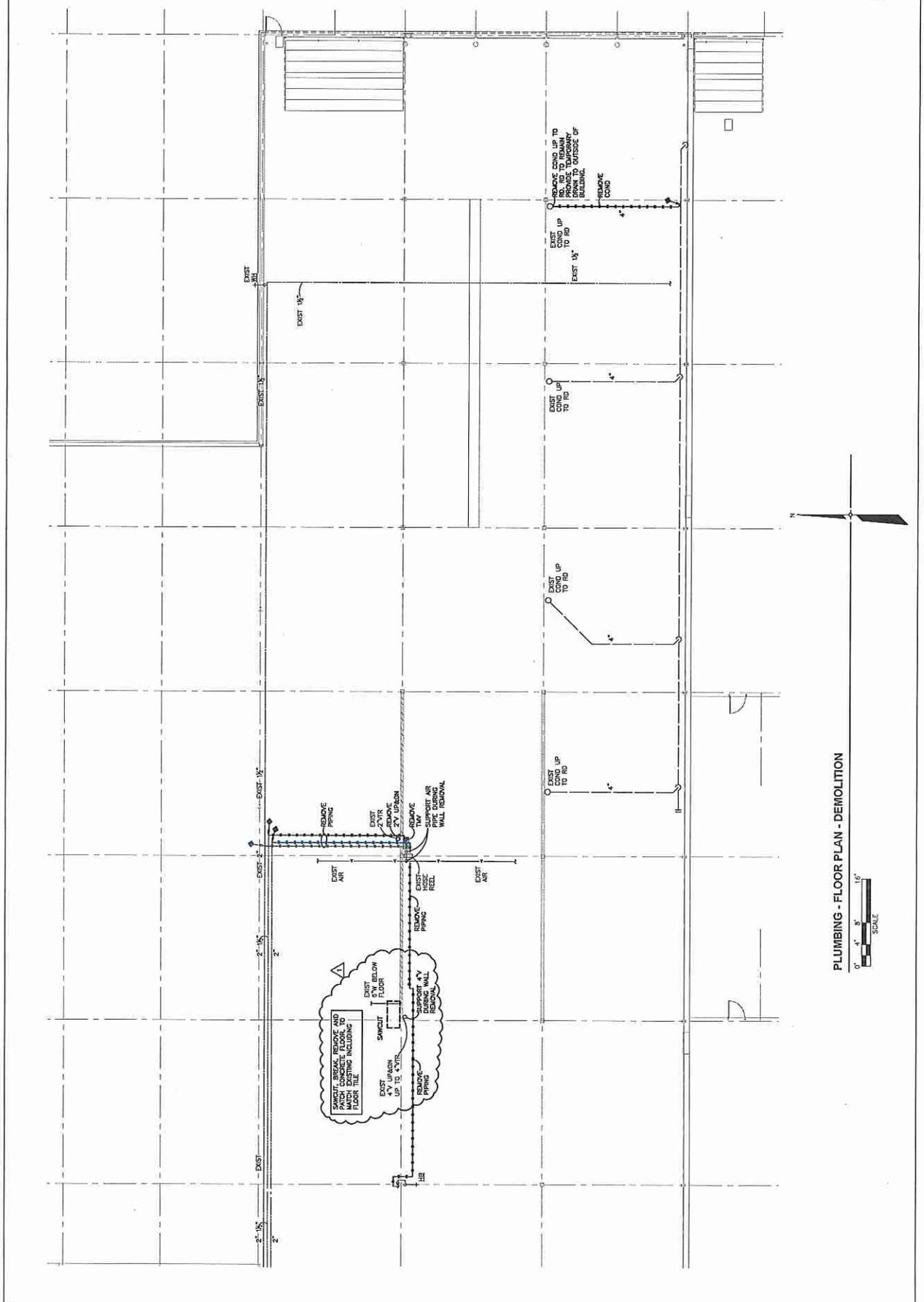
BID ACCEPTANCE

The Commissioner of Public Works shall award the contract base on the Base Bid or the Base Bid and the add alternate(s) as funds permit.

NO	REVISIONS	DATE
1	ADDITION # 1	11/26/2013

DATE	BY	CHK	APP
10/23/2013	ML	MB	ML
10/23/2013	ML	MB	ML

LINCOLN GARAGE MODIFICATIONS
 VEHICLE SERVICE BAYS
 LINCOLN AVENUE GARAGE
 3291 WEST LINCOLN AVENUE
 MILWAUKEE, WISCONSIN
 PLUMBING - FLOOR PLAN - DEMOLITION
 DATE: 2013
 CITY PROJECT # 2013000328
 ENGINEER PROJECT # 13-005
 FILENAME
 SHEET NO
 DRAWING NO 10-P-02



PLUMBING - FLOOR PLAN - DEMOLITION



PANEL SCHEDULE 10LP-1

DCI NO.	TRIP/P NO.	DESCRIPTION	PHASE	DESCRIPTION	TRIP/P NO.	DCI NO.
1	20/1	RECEP/PLCS	←→	RECEP/PLCS	20/1	2
3	20/1	RECEP/PLCS	←→	RECEP/PLCS	20/1	4
5	20/1	RECEP/PLCS	←→	RECEP/PLCS	20/1	6
7	20/1	RECEP/PLCS	←→	RECEP/PLCS	20/1	8
9	20/1	RECEP/PLCS	←→	RECEP/PLCS	20/1	10
11	20/1	RECEP/PLCS	←→	RECEP/PLCS	20/1	12
13	20/1	SECURITY DOOR LOCKS	←→	SECURITY DOOR LOCKS	20/1	14
15	20/1	WORK BENCH LIGHTS	←→	EMERGENCY AND EXIT LIGHTS	20/1	16
17	20/1	RECEP/PLCS ON ROOF	←→	DOC ATC PANEL	20/1	18
19	20/1	SPACE	←→	DIG DETECTOR PANEL	20/1	20
21	20/1	SPACE	←→	RECEP/PLCS	20/1	22
23	15/3	10-000-109	←→	RECEP/PLCS	20/1	24
25	20/1	SPACE	←→	SPACE	20/1	26
27	20/1	SPACE	←→	SPACE	20/1	28
29	15/3	10-000-108	←→	SPACE	20/1	30
31	20/1	SPACE	←→	SPACE	20/1	32
33	20/1	SPACE	←→	SPACE	20/1	34
35	15/3	10-000-107	←→	SPACE	20/1	36
37	20/1	SPACE	←→	SPACE	20/1	38
39	20/1	SPACE	←→	SPACE	20/1	40
41	20/1	SPACE	←→	10-000-106	15/3	42

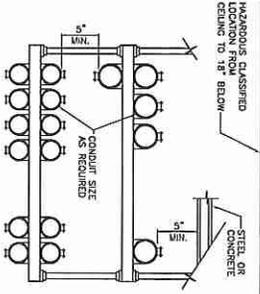
* PROVIDE LOCK ON FEATURE ON CIRCUIT BREAKER.

PANEL SCHEDULE 10LP-2

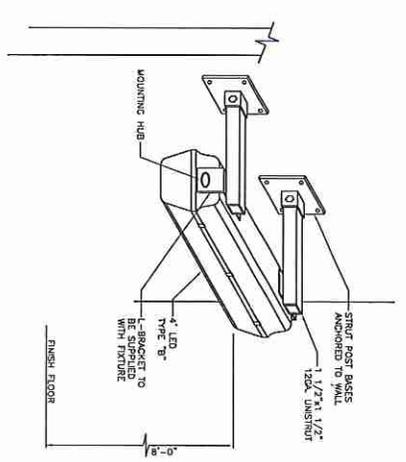
DCI NO.	TRIP/P NO.	DESCRIPTION	PHASE	DESCRIPTION	TRIP/P NO.	DCI NO.
1	20/1	R-01-1	←→	IR-01-10	20/1	2
3	20/1	R-01-1A	←→	IR-01-1E	20/1	4
5	20/1	R-01-1B	←→	IR-01-1F	20/1	6
7	20/1	R-01-1C	←→	CONDENSATE PUMP RECEPTACLE	20/1	8
9	15/2	VP-01	←→	SPACE	10	10
11	20/1	SPACE	←→	SPACE	12	12
13	20/1	SPACE	←→	SPACE	14	14
15	20/1	SPACE	←→	SPACE	16	16
17	20/1	SPACE	←→	SPACE	18	18
19	20/1	SPACE	←→	SPACE	20	20
21	20/1	SPACE	←→	SPACE	22	22
23	20/1	SPACE	←→	SPACE	24	24

LIGHTING FIXTURE SCHEDULE

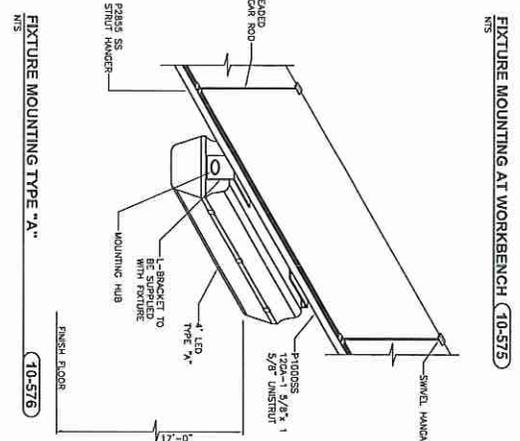
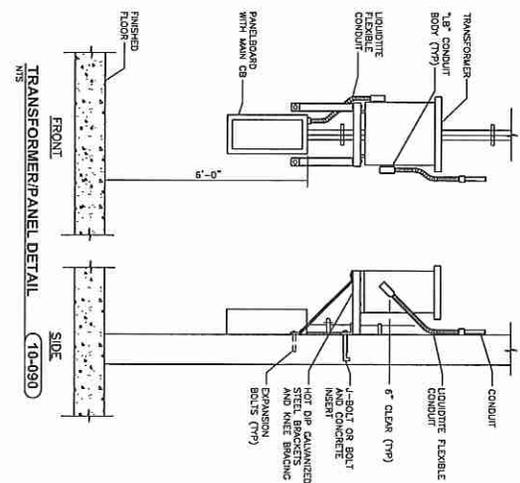
TRC DES.	LAMPS NO. (GRP. MB)	DESCRIPTION/CATALOG NO.	FINISH	LENS	MOUNTING	NOTES
1	4 W0 LED	CLASS 1, DIV. 2 GROUP 2 PANEL HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
2	2 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
3	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
4	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
5	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
6	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
7	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
8	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
9	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
10	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
11	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
12	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
13	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
14	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
15	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
16	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
17	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
18	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
19	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
20	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
21	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
22	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
23	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	
24	1 W0 LED	CLASS 1, DIV. 2 GROUP 0 RATED HAZARDOUS CLASSIFIED LED FIXTURE, INHERENT F1704/US/SCW OR EQUAL.	PODERCLASS FINISHED	TYPE DR ACrylic PRISM/SEE DETAIL (10-575)	SEE DETAIL (10-575)	



CONDUIT RACKING SYSTEM (10-051)
 NTS NOTE LOCATE BELOW HAZARDOUS CLASSIFIED LOCATION AND TO THE SIDES OF THE VEHICLE TRAFFIC LANES.



FIXTURE MOUNTING AT WORKBENCH (10-575)
 NTS



FIXTURE MOUNTING TYPE 'A' (10-576)
 NTS

	DATE: 11/25/13 BY: KMB/NRW CHECKED: DRN/CHK
	REVISIONS: 1 ALTERNATE BD NO.2
PROJECT: LINCOLN GARAGE MODIFICATIONS VEHICLE SERVICE BAY'S LINCOLN AVENUE GARAGE 3291 WEST LINCOLN AVENUE MILWAUKEE, WISCONSIN	DRAWING NO: 10-E-04

4135 TECHNOLOGY PARKWAY
 SHREVEPORT, LA 70563-1833
 TEL: 504.835.8171 FAX: 504.835.8512
 WWW.AECOM.COM

(REVISED SECTION)

SECTION 23 09 93

SEQUENCE OF OPERATION FOR HVAC CONTROLS

(This Section is for Reference Only)

PART 1 - GENERAL

1.01 SCOPE

- A. The Owner will contract directly with Johnson Controls, Inc. to provide control sequences described in this section for HVAC equipment as well as equipment furnished by others that may need monitoring or control. Included are the following topics:

PART 1 - General

- 1.01 Scope
- 1.02 Related Work
- 1.03 Reference
- 1.04 Description of Work
- 1.05 Submittals
- 1.06 Operation and Maintenance Data
- 1.07 Design Criteria

PART 2 - Products

- 2.01 Not applicable to this Section

PART 3 - Execution

- 3.01 General
- 3.02 Make-Up Air Unit Control
- 3.03 Garage Exhaust Fan Control
- 3.04 Vehicle Exhaust Fan Control
- 3.05 CNG Exhaust Fan Control
- 3.06 Alternate Bid – Radiant Heater Control
- 3.07 Functional Performance Testing

1.02 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this Section.
- B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC – Coordination
- C. Section 23 09 14 - Electric Instrumentation and Control Devices for HVAC
- D. Section 23 09 23 - Direct Digital Controls (DDC)
- E. Division 23 - HVAC - Equipment provided to be controlled or monitored
- F. Division 26 - Electrical - Equipment provided to be controlled or monitored

1.03 REFERENCE

- A. Section 23 09 14 work includes furnishing and installing all field devices, including electronic sensors for the DDC of this section, equipment, and all related field wiring, interlocking control wiring between equipment, sensor mounting, etc., that is covered in that section.
- B. Motorized control dampers and actuators, thermowells (temperature sensing wells), are also covered in Section 23 09 14.

1.04 DESCRIPTION OF WORK

- A. Control sequences are hereby defined as the manner and method by which automatic controls function. Requirements for each type of operation are specified in this section.

- B. Operation equipment, devices and system components required for automatic control systems are specified in other Division 23 control sections of these specifications.
- C. All temperature, and pressure sensing, and all other control signal transportation for the control sequences shall be furnished under Section 23 09 14. All electronic and electric input/output signals shall be extended under Section 23 09 14, with adequate lead length for termination within the appropriate control panel being provided under Section 23 09 24.
- D. Sequences for equipment controlled by Direct Digital Controls (DDC) as specified are accomplished by hardware and software provided under Section 23 09 24. Sequences for equipment controlled by electric self-contained controls are accomplished by hardware provided under Section 23 09 14.

1.05 SUBMITTALS

- A. Refer to Division 1, General Conditions, Submittals, Section 23 05 00 and Sections 23 09 24, and 23 09 14 for descriptions of what should be included in the submittals.
- B. Shop drawings shall be provided by contractor(s) providing equipment under Sections 23 09 24 and 23 09 14. The contractor providing the DDC equipment shall provide a complete narrative of the sequence of operations for equipment that is controlled through the DDC system. The contractor providing the 23 09 14 equipment shall provide a complete narrative of the sequence of operation for equipment that is controlled directly from that equipment (without control logic through the DDC system). The narrative of the sequence of operation shall not be a verbatim copy of the sequences contained herein, but shall reflect the actual operation as applied by the contractor.

1.06 OPERATION AND MAINTENANCE DATA

- A. All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

1.07 DESIGN CRITERIA

- A. Reference Section 23 09 14.

PART 2 - PRODUCTS

2.01 NOT APPLICABLE TO THIS SECTION

- A. Reference Sections 23 09 24 and 23 09 14 for product descriptions.

PART 3 - EXECUTION

3.01 GENERAL

- A. Setpoints
 1. All setpoints indicated in the control specification are to be adjustable. The setpoints shall be readily available to be modified in the mechanical system software system summary (either textual or graphic based) and under the same software level as hardware points. Some less used setpoints may be provided on a lower software level, if requested by the Owner for clarity. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on requirements of the building. The control contractor shall work with the balancing contractor and the Owner to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use. Document all final setpoints on the as-built control drawings. Any questions regarding the intended operation of the HVAC equipment and control systems shall be referred to the HVAC design engineer through the appropriate construction communication process. The following setpoints should be used as initial setpoints unless otherwise specified in the individual control sequences:

- a. Occupied Space Terminal Unit Heating: 60°F
 - b. Mechanical or Unoccupied Space Heating: 60°F
 - c. Discharge air temperature Heating: 80°F
- B. Anti-Cycling
 - 1. When HVAC equipment or a sequence is specified to be started and stopped by a temperature, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable. Temperature differential setpoints shall be set at 2° F and non- temperature setpoints shall be set at 10% of the controlled range unless otherwise specified. Setpoints shall indicate at when the process should be turned on. Heating differentials shall be set for above setpoint and will be used to turn the process off. For example, a heating lockout setpoint of 50° F would turn on heating control at 50° F and off at 52° F Non-temperature differentials shall be set above setpoint if the setpoint is indicating a minimum value or below setpoint if the setpoint is indicating a maximum value. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Unless otherwise specified in the individual control sequences, fans shall have a minimum runtime on timers of 15 minutes (adj.) and off timers of 5 minutes (adj.). Safeties shall override runtime timers.
- C. Deadbands
 - 1. Provide deadbands for all control loops to prevent constant hunting of output signals to controlled devices. Deadbands shall be set to provide adequate control around setpoint as follows unless otherwise specified in the individual control sequences:
 - a. Temperature Control: $\pm 0.5^{\circ}$ F
 - b. AHU Static Pressure Control: ± 0.01 in. w.c.
- D. Alarms
 - 1. Provide all alarmed points with adjustable time delays to prevent nuisance tripping under normal operation and on equipment start-up. For all commanded outputs that have status feedback, provide an alarm that will indicate the commanded output is not in its commanded state. Provide alarms on all points as indicated on point charts.
- E. Equipment Start/Stop Failure States
 - 1. All start/stop points for equipment shall utilize normally open contacts unless called out specifically in the individual control sequences.
- F. Variable Frequency Drive (VFD) Motor Run Status
 - 1. Use the VFD programmable relay dry contact output specified to be provided with the VFD under Section 23 05 14 to prove motor run status and detect belt loss or coupling break. If a bypass contactor is provided with the VFD, provide an adjustable current switch and wire it in parallel with the VFD output for proving motor status.
- G. VFD Bypass & Safety Interlocks
 - 1. VFD's equipped with bypass starters shall be interlocked so that the start/stop and safety circuits that are called out for VFD operation shall be functional when the VFD is indexed to the bypass starter mode. Unless otherwise specified in the sequence below, the switch from inverter to bypass starter modes shall be through a manual switch provided on the VFD/bypass starter package.
- H. VFD Minimum Speed & Ramp Timers
 - 1. The VFD start-up technician shall work with the Temperature Control Contractor determine the minimum speed required for the motor controlled by the VFD to provide cooling of the motor as installed to prevent heat related problems. This minimum speed shall be set in the VFD controller. The VFD start-up technician shall work with the Temperature Control Contractor to set the acceleration and deceleration timers in the VFD controller at 30 seconds.
- I. Current Switch Setup

1. When current switches are used for proving fan status, they shall be set up so that they will detect belt or coupling loss by the reduction in current draw on loss of coupled load. The current switch set up shall be redone by the 23 09 14 Contractor after the balancer is complete.
- J. Damper Interlocks for Fans with Starters
1. For fan systems with magnetic starters and shutoff dampers, the damper interlock shall be hardwired in such a way that the damper shall open if the fan starter hand/off/auto switch is in the hand or in the auto position and being called to start.
- K. Damper Interlocks for Fans with VFD's
1. For fan systems with VFD's and shutoff dampers specified with end switches, hardware interlock the shutoff damper with the fan VFD. When the fan is remotely or locally commanded to start, VFD contacts shall energize damper actuator to open damper. The damper position end switch shall be wired to run permissive input on the VFD and enable the VFD to start when the damper position end switch provides the damper is open. This operation shall be provided for VFD and bypass operation if the VFD is provided with a bypass. The damper end switch shall also be monitored by the DDC system.
- L. Fan Interlocking
1. Provide interlocks between supply and exhaust fan systems as scheduled on the plans or called out in individual control sequences. If controlled, interlocks shall be done through DDC start/stop points unless otherwise specified in individual control sequences. If not DDC controlled, interlocks shall be accomplished via hardwire interlocks between fan starters or VFD's.
- M. Thermostats and Sensors
1. All devices and equipment including terminal units, specified to be controlled in a control sequence by a thermostat or sensor, shall be provided with a thermostat or sensor, whether or not the device is indicated on the plans. Consult the HVAC design engineer for the thermostat or sensor location.
- N. Original Equipment Manufacturer (OEM) Controller DDC Integration
1. Provide DDC programming to define all equipment integral input/output points, setpoints, data points, calculations, etc. that are available through the manufacturers communication interface. Consult with the Owner's DDC operations personnel to determine if some of the points should be omitted (for clarity or lack of value). The following equipment shall be integrated into the DDC system:
 - a. Indirect Fired Make up air unit controller
 - b. Natural Gas detection controller
 - c. Variable Frequency Drives
 - d. Radiant Heater controller
- O. Weekly Scheduling
1. Provide scheduling of units based on occupancy. Individual units shall be able to receive temporary schedules that will override the global schedules. Temporary override switch shall override the scheduling to "Occupied".
- 3.02 MAKE-UP AIR UNIT CONTROL
- A. General
1. The Make-Up Air Unit is variable air volume, 100% outdoor air unit.
 2. The Make-Up Air Unit is controlled by a manufacturer provided and controls.
 3. The Make-Up Air Unit is equipped with the following:
 - a. Supply fan with VFD.
 - b. Supply air damper furnished by manufacturer.
 - c. 10:1 turndown modulating gas burner (6:1 under Alternate Bid).
 - d. Filter section with differential pressure switch.
 - e. Discharge air and space temperature controls
 - f. Remote control panel and DDC controller.

B. Fan Control

1. "Occupied-Unoccupied": The DDC program shall start the supply fan via the VFD, open the supply air damper and enable the unit controls. Provide a manual switch on the remote control panel to override the program and index unit to "Occupied".
 - a. On "Occupied" the supply fan shall start and the supply air damper shall open. The supply fan shall operate at minimum 40% volume (adj.) subject to the space static pressure control and gas detection system.
 - b. On "Unoccupied" the supply fan shall be off and the outside air damper closed subject to the "Unoccupied" temperature control and gas detection system.
Under the Base Bid, on a call for heat the unit supply fan shall start and supply automatic damper shall open. The supply fan shall operate at minimum speed and the burner shall be controlled from the room override thermostat.
Under the Alternate Bid the unit shall be off.
2. Current Status Switch: Provide as described under GENERAL, VFD Motor Run Status, in this Section for the supply fan.
3. Supply Fan Speed Control: Provide supply fan speed control to maintain a slightly negative pressure within the space. The supply fan VFD shall modulate the supply fan speed from its minimum speed setting of 40% (adj.) to maintain a constant negative differential pressure between the space and adjacent space of 0.05 in w.g. (adj.) up to the full speed. Provide control to prevent wide fluctuations in building pressure control due to opening and closing of doors. Coordinate with make-up air unit manufacturer and Testing and Balancing Contractor to optimize this setting.

C. Filters

1. Install manufacturer supplied differential static pressure switch across the filter bank. Ensure that the static probes do not impede filter removal.
2. Provide dirty filter alarm annunciation at the remote control panel.

D. Burner Control

1. Under Base Bid: The burner shall modulate from 10% to 100% of the firing rate to reset the discharge air temperature from 65 deg F to 85 deg F (adj.) to maintain the room temperature setpoint of 60 deg F (adj.).
Under Alternate Bid: The discharge air control shall energize the first stage burner and modulate burner firing rate from 40% to 100% to maintain the discharge air temperature setpoint of 80 deg F (adj.). A continued call for heat from the discharge sensor shall energize the subsequent stages of heat in sequence (two stages) and modulate the first stage burner from 40% to 100% to maintain discharge air temperature setpoint. A room temperature sensor shall override the discharge air control and index the first stage burner to fire and modulate and the second and third stage burners to fire, subject the manufacturer supplied secondary discharge air control setpoint of 120 deg F (adj.), to maintain the room temperature setpoint of 60 deg F (adj.).
2. All manufacturer safeties shall be hard wired to the supply fan VFD safety circuits. Starters shall not function in the "Hand" or "Auto" and VFD's shall be disabled if they are indexed to the "Auto" or "Hand" position in either the VFD or bypass modes.
3. OA Temperature Lockout: When outdoor temperature exceeds 55 deg F (adj.) the burner shall be automatically locked out.
4. Install an electric freezestat (refer to specification Section 23 09 14 for location) to shut down the unit (see Unit Shut down for additional information) if the temperature downstream of the heat exchanger drops below 35° F (adj.). A freezestat trip shall be annunciated at the remote control panel and DDC system.

E. Unit Shutdown

1. Whenever the make-up air unit is indexed off, the supply fan shall stop. On a failure of the supply fan, an alarm will be sent to the remote control panel and the DDC system. Whenever the supply fan is off for any reason the following shall occur:
 - a. The outside air dampers damper shall close.
 - b. The gas valve shall close.

3.03 GARAGE EXHAUST FAN CONTROL

A. General

1. The garage exhaust system consists of two separate exhaust fans each with three duct drops to the floor.
2. The exhaust system interlocked with the make-up air unit "Occupied-Unoccupied" control.
3. The garage exhaust system is equipped with the following:
 - a. Two constant speed exhaust fans.
 - b. Isolation air dampers for each fan. (Refer to 23 09 14)
 - c. Damper actuators for each damper. (Refer to 23 09 14)

B. Occupied/Unoccupied Control

1. "Occupied/Unoccupied" control shall be as scheduled by the make-up air unit DDC program schedule.
 - a. On "Occupied" the exhaust fans shall start and operate continuously.
 - b. On "Unoccupied" the exhaust fans shall be off.

C. Fan Control

1. Current Status Switch: Provide for each exhaust fan and set up as described under GENERAL, in this Section.
2. Start/Stop: The make-up air unit DDC program schedule shall start the exhaust fans via motor starter interlock.

D. Alarms

1. Prove fan operation with current switch and notify operator through pilot light at the respective fan starter switch of failure.

3.04 VEHICLE EXHAUST FAN CONTROL

A. General

1. The vehicle exhaust system consists of two separate fan systems each with three hose reels for the source capture of vehicle exhaust.
2. Each exhaust system is controlled manually by a remote Start/Stop switch and a variable speed drive controlled from duct static pressure. Each fan is designed with the capacity to operate up to two hoses simultaneously.

B. Fan Control

1. Current Status Switch: Provide for each exhaust fan and set up as described under GENERAL, VFD Motor Run Status, in this Section.
2. Start/Stop: The operator shall start the exhaust fans via their remote starter switch.
3. Fan Speed Control:
 - a. A static pressure sensor (located near the fan inlet the downstream of all branch takeoffs), shall vary the fan speed to maintain a duct static pressure setpoint (adj.) determined by Testing and Balancing Contractor.

C. Safeties:

1. When fan is inadvertently left in "On" position and hose reel dampers are closed as determined by VFD and pressure sensor, the exhaust fan shall shut down.
 - a. Control shall automatically reset to normal fan operation when fan is turned to off.

D. Alarms

1. Prove fan operation using VFD, and notify operator through pilot light at the respective fan remote starter switch of failure.
2. Provide alarm light on motor starter switch to energize when static pressure exceeds setpoint by more than 20% (adj.) for a period of 30 seconds (adj.).

3.05 CNG EXHAUST FAN CONTROL

A. General

1. The exhaust system consists of four exhaust fans each with a variable speed drive.
2. The exhaust system shall be controlled by the gas detection system.

3. The CNG exhaust system is equipped with the following:
 - a. Four exhaust fans with variable speed drives.
 - b. Isolation air dampers for each fan. (Refer to 23 09 14)
 - c. Damper actuators for each damper. (Refer to 23 09 14)
 - d. Gas detection system consisting of controller, sensors and audio and visual alarm indication. (Refer to 23 09 14).
 - e. An outside air intake hood with automatic damper and duct. (Refer to 23 09 14).
- B. Occupied/Unoccupied Control
 1. "Occupied/Unoccupied" control shall be as scheduled by the make-up air unit "Occupied-Unoccupied" program schedule.
 - a. On "Occupied" the exhaust fans shall start and operate continuously at 33% speed (adj.) subject to the gas detection system control. The gas detection system shall modulate the exhaust fan speed from minimum speed at 10% LEL (lower explosive limit) to 100% speed at 20% LEL. Coordinate with the Testing and Balancing Contractor to determine the exhaust fan minimum speed to maintain negative pressure in CNG Repair Garage.
 - b. Under the Base Bid: On "Unoccupied" the exhaust fans shall be off subject to the gas detection system. On a call for heat the exhaust fans shall cycle with the make-up air unit and operate at 50% speed (adj.).
Under the Alternate Bid: On "Unoccupied" the exhaust fans shall be off subject to the gas detection system.
- C. Emergency CNG Ventilation Control
 1. During "Occupied" or "Unoccupied" when the gas detection system senses the natural gas concentration of 25% LEL the exhaust fans shall start at full speed and operate, continuously and the two position automatic damper in the outside air intake hood shall open.
 2. Provide a control interlock to shut-off the make-up air unit, close the unit's supply damper and lockout the unit burner on activation of the emergency CNG ventilation control.
 3. Provide audio and visual indication of alarm at the gas detection controller in the event of activation or failure of the emergency CNG ventilation system.
- D. Fan Control
 1. Current Status Switch: Provide for all exhaust fans and set up as described under GENERAL, VFD Motor Run Status, in this Section.
 2. Start/Stop: The make-up air unit "Occupied-Unoccupied" program shall start the exhaust fans via their VFD's.
 3. Emergency CNG Ventilation Control: The gas detection system shall start exhaust fans for emergency ventilation control.
- E. Unit Shutdown
 1. Whenever an exhaust fan is off for any reason the following shall occur:
 - a. The exhaust fan shall stop and the exhaust air damper shall close.
- F. Alarm
 1. Prove fan operation using VFD, and notify operator through pilot light at the respective fan remote starter switch of failure.

3.06 ALTERNATE BID – DDC CONTROLS

- A. See Section 01 23 00 Alternate Bids.
- B. The radiant heater manufacturer will provide controls consisting of a BACNet compatible DDC controller, room and outside air temperature sensors, vacuum pump VFD and pressure sensor, etc. Coordinate manufacturer supplied controls with the radiant heater manufacturer.
- C. Install radiant heater manufacturer supplied controls including relays, wiring, conduit, etc. as recommended by the radiant heater manufacturer and required for a complete installation to accomplish the control sequence described below.

- D. The radiant heater control shall be as scheduled by the make-up air unit "Occupied-Unoccupied" program schedule.
 - 1. On "Occupied": The two room temperature sensors shall be averaged and the output signal extended to the vacuum pump VFD to control the speed of the vacuum pump. The radiant heater burners shall operate and modulate in unison from 60% to 100% of output to maintain room setpoint of 60 deg. F (adj).
 - 2. On "Unoccupied": The two room temperature sensors shall be averaged and the output signal extended to the vacuum pump VFD to control the speed of the vacuum pump. The radiant heater burners shall operate and modulate in unison from 60% to 100% of output to maintain room setpoint of 60 deg. F (adj).
 - E. Provide control wiring interlock from manufacturer supplied high level float switch at condensate pump to indicate alarm at the DDC system.
- 3.07 FUNCTIONAL PERFORMANCE TESTING
- A. Contractor is responsible for functional performance test procedures to ensure proper system operation prior to completion.

END OF SECTION

(NEW SECTION)

SECTION 23 56 00

LOW INTENSITY GAS FIRED RADIANT HEATERS

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes specifications for low intensity gas fired radiant heaters. Included are the following topics:

PART 1 - General

- 1.01 Scope
- 1.02 Related Work
- 1.03 Reference
- 1.04 Reference Standards
- 1.05 Quality Assurance
- 1.06 Submittals
- 1.07 Operation and Maintenance Data
- 1.08 Warranty

PART 2 - Products

- 2.01 Low Intensity Gas Fired Radiant Heaters

PART 3 - Execution

- 3.01 Installation
- 3.02 Manufacturer Start-Up and Report
- 3.03 Owner Training

1.02 RELATED WORK

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment
- B. Section 23 05 23 – General-Duty Valves for HVAC Piping
- C. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- D. Section 23 11 00 – Facility Fuel Piping
- E. Section 23 51 00 – Flue Vents

1.03 REFERENCE

- A. Applicable provisions of Division 1 govern work under this section.

1.04 REFERENCE STANDARDS

- A. AGA American Gas Association
- B. ANSI Z21.20 Gas Fired Infrared Heaters
- C. ANSI A83.20 Gas-Fired Low Intensity infrared Heaters
- D. CSA 2.34 Gas-Fired Low Intensity infrared Heaters
- E. GAMA Gas Appliance Manufacturers Association
- F. NFPA 30A Code for motor Fuel Dispensing Facilities and Repair Garages
- G. NFPA 54 Fuel Gas Code
- H. NEC National Electrical Code

1.05 QUALITY ASSURANCE

- A. Refer to Division 1, General Conditions, Equals and Substitutions.

- B. The completed heater assembly, control and safety system as well as the burner and gas manifold shall be factory fire tested prior to shipment.
 - C. Provide unit with printed installation and maintenance instructions, burner operating and maintenance instructions, piping and wiring diagrams and Installation Start-up data sheet.
 - D. CSA Compliance: Provide CSA Seal affixed to each burner name plate and vacuum pump assembly. Provide CSA certification of heater design as 'Vented Infrared Heater'. Provide written CSA Certification for Specialty Fuel Applications.
 - E. Temperature-Indicating and Regulating Equipment: Construct and certify radiant heater temperature controls in accordance with latest edition UL873 including all current supplements.
- 1.06 SUBMITTALS
- A. Refer to Division 1, General Conditions, Submittals.
 - B. Include specific manufacturer and model numbers, equipment identification corresponding to project drawings and schedules, dimensions, capacities, materials of construction, ratings, weights, power requirements and wiring diagrams, filter information and information for all accessories.
- 1.07 OPERATION AND MAINTENANCE DATA
- A. All operation and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.
- 1.08 WARRANTY
- A. Manufacturer's standard form in which manufacturer agrees to repair or replace: burner, burner head, electronics of fuel-fired radiant heater that fail in materials and workmanship within (3) three years from date of Substantial Completion.
 - B. Manufacturer's standard form in which manufacturer supplying Schedule '40' Pipe, hanging materials, supports, reflectors of fuel-fired radiant heater that fail in materials and workmanship within (15) fifteen years from date of Substantial Completion.
 - C. Manufacturer's standard form in which manufacturer supplying cast iron combustion chambers for fuel-fired radiant heater that fails in materials and workmanship within (25) twenty-five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LOW INTENSITY GAS FIRED RADIANT HEATERS

- A. Manufacturer shall be Roberts Gordon, Inc. Induced Draft Vacuum Type. ASHRAE Type 1 (b) In Series Vacuum - Modulating Infrared Systems.
- B. Induced Draft -In Series Burners
 1. Condensing System: Design gas fired radiant systems to operate such that water vapor present in products of combustion will be condensed, and this heat of condensation will be extracted by the system and will be added to the heated space.
 2. Vacuum Vented: To preclude the possibility of combustion gases escaping into the building, the entire system must be under a negative pressure at all times and vacuum vented to the outside atmosphere.
 3. Modulating Infrared: Design gas fired radiant systems to modulate firing rate input continuously between 60% and 100% of designed firing input based upon space temperature. Modulation of system shall be accomplished via a VFD speed control of the vacuum pump motor.
- C. Induced Draft - In-Series Burner Features
 1. The design of the burners supplied shall provide for maintaining a constant proportion of

fuel gas to combustion air. Vacuum on the downstream side of the flow metering orifices shall establish flow for both fuel and combustion air, both introduced atmospheric pressure. If combustion air flow is impeded, gas flow rate will decrease in constant proportion to maintain proper gas/air mixture for complete combustion.

2. Mixing of Air and Gas to be accomplished in the burner head prior to release thru gas orifice. The orifice shall be a honeycombed ceramic block and grid with a minimum of 126 ports per square inch.
3. Burners shall be supplied to fire at an input firing rate as scheduled on the drawings.
4. Burners shall be designed for firing in series without adverse effects from combustion gases from upstream burners.

D. Infrared Heater Components

1. Burner Head and Combustion Chamber:
 - a. Burner head to incorporate a cast iron burner assembly with ceramic block and grid orifice.
 - b. Combustion chamber to include mica site glass for positive confirmation of ignition. Combustion Chamber to be Cast Iron.
 - c. Burners shall be capable of being placed anywhere in a branch without the need of adjustment, switches or other mechanical devices. Burner heads requiring field tuning during initial installation will not be accepted.

E. Heat Exchanger Tubing

1. Tubing shall be Schedule 40 Black Steel, ASTM A120 with seamless, carbon steel weld fittings.

F. Reflector

1. Provide aluminum reflector installed to provide continuous coverage of heat exchanger. To maximize radiant output and minimize convection losses, reflectors are to extend below the bottom of the heat exchanger pipe and have an engineered parabolic design of no less than 7 bends in the useable field of Infrared waves.
2. Side Reflector/Perimeter reflectors shall be arranged for fixed connection, to lower reflector lip, of standard reflector. Clearance to combustibles to be maximum of 9" from edge of tube. Tilting of reflectors is not allowed.
3. Low Clearance Shields shall be same material as reflector, hung by supports 12" long, at first 10' of heat exchanger from burner or as noted.
4. End Caps shall be same material as reflector. Each end and transition to have end caps as required to complete the encapsulation of tubing and prevent unnecessary convective losses.

G. Controls

1. The control of the radiant heating system shall be via Roberts Gordon ULTRAVAC BacNet compatible DDC controller capable of communication and control from the building JCI Metasys DDC ATC system. The controller shall provide modulation of the CoRayVac system firing rate based on space temperature. The system shall be provided with variable frequency drive to modulate vacuum pump speed and burner input continuously between 60% and 100% input. The Roberts Gordon controls shall incorporate the following features:

BacNet compatible DDC controller	(7) Day Programming
(4) Program periods per day	Provide Occupant Override
Daylight Savings adjustment	Two (2) Remote Space Temperature Sensors
Comfort Adjust for Override	Outdoor Air Temperature Sensor
Display w/time, system mode & space temp.	

- H. Sensors:
 1. Sensors: Provide where indicated, low voltage type heat demand control device. Mount thermostat 4'-0" above finish floor or otherwise as noted on the drawing. Provide sensors with heavy duty wore or cast aluminum guard.
- I. Venting: Horizontal and Vertical
 1. Vertical venting shall be vented with Metal-Fab "Saf-T-Vent, stainless steel, AL29-4C vent material with gasketed joints and manufacturer supplied accessories. Vent material shall incorporate built-in locking band with integral gasketing.
 2. Common venting of infrared heaters allowed only with sweeping 'Tee' or 'Y' connection. Common vented appliances must be controlled by a common space temperature control.
 3. Vent thru roof with roof curb, flashing accessories and terminate with rain cap.
 4. Provide drain tee at discharge side of vacuum pump and route vent vertically via a 90 degree elbow.
- J. Condensate Piping:
 1. Provide drain piping, fittings, and accessories constructed of Schedule 40 galvanized steel with threaded fitting and Schedule 40 PVC with solvent welded joints in accordance with appliance manufacturer's recommendations.
 2. Provide condensate connections at vertical rise in radiant tube, entrance of vacuum pump and at the base of the flue vent riser.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install radiant heaters with 1/2" slope per 20' from first burner until 40' after the last burner – traveling towards the pump. From 40' after the last burner to the pump the slope shall be 1" per 20'. Suspension points to be from structure and or field. Installed support points as required. Suspension of system to be 6' O.C. (max).

Install and connect gas-fired radiant heaters, associated fuel, vent features, and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

3.02 RADIANT TUBE INSTALLATION

- A. Inspect pipe, fittings, equipment and accessories before installation. Remove all foreign material from interior and exterior of pipe and fittings. Any items that are unsuitable, cracked or otherwise defective shall be not be used and removed from the job site. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion shall not be used.
- B. Exercise care in storage, handling and erecting piping to prevent entry of foreign matter into piping. Do not erect or install any item that is not clean.
- C. Remove all lose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.
- D. During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.
- E. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.
- F. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult

drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

- G. Install tapings and piping specialties, including items furnished by others, as specified or required.

3.03 WELDED PIPE JOINTS

- A. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
- B. Welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.
- C. Contractor shall follow these steps where pipe sections will be joined by welding:
 - 1. Cleaning – Welding surfaces will be clean and free of defects.
 - 2. Alignment – Inside diameter of piping components will be aligned as accurately as possible. Internal misalignment shall not exceed 1/16".
 - 3. Spacing – Pipe sections will be spaced to allow deposition of weld filler material through the entire weld joint thickness.
 - 4. Girth Butt Welds:
 - a. Girth butt welds shall be complete penetration welds.
 - b. Concavity will not exceed 1/32"
 - c. Under cuts will not exceed 1/32"
 - d. As welded surfaces are permitted however surfaces will be free from coarse ripples, grooves, abrupt ridges and valleys.
- D. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

3.04 CONNECTIONS

- A. Support: Suspend heater, burner, gas piping, electrical and venting from building structure as indicated and in accordance with manufacturers installation instructions.
- B. Connect gas piping to gas train inlet; provide union with clearance for burner removal and service. Provide CSA-approved flexible units. Provide gas pressure regulator valve at gas inlet connection.
- C. Connect vents according to Section 23 51 00 "Flue Vents".
- D. Electrical: Comply with applicable requirement in Division 26 Sections. Ground equipment according to Division 26 Section "Grounding and Bonding".
- E. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.05 MANUFACTURER START-UP AND REPORT

- A. Prior to start-up provide initial inspection and review of the installation shall be by a factory authorized service representative. Factory authorized service representative shall review unit installation, verify proper installation of unit and wiring of unit controls and test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Factory authorized service representative shall provide start-up of heaters and complete manufacturer's start-up data sheet recording operating data and the final burner adjustments. The start-up data sheet shall be submitted at completion of start-up, included with the Operation and Maintenance Manuals and returned to the unit manufacturer to validate factory warranty.

3.06 OWNER TRAINING

- A. Contractor and factory authorized representative shall provide maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours.

END OF SECTION